

# Trace Element Supplementation of Beef Cattle and Sheep



Hybu Cig Cymru / Meat Promotion Wales  
Tŷ Rheidol, Parc Merlin, Aberystwyth SY23 3FF  
Tel: 01970 625050 Fax: 01970 615148  
Email: [info@hccmpw.org.uk](mailto:info@hccmpw.org.uk)

[www.hccmpw.org.uk](http://www.hccmpw.org.uk)

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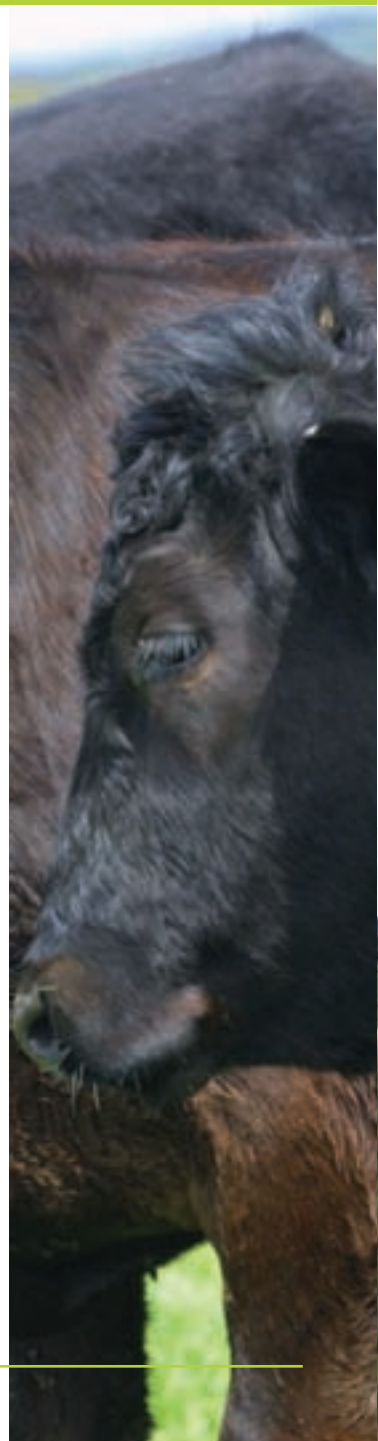


Cattle and sheep need at least 15 different minerals for good health and productivity. The major elements such as calcium and phosphorous are required in relatively large amounts but others known as trace elements (TEs) are required in much smaller quantities. In England and Wales, the most economically important trace elements are copper (Cu), selenium (Se), cobalt (Co) and iodine (I). Zinc (Zn) and manganese (Mn) deficiencies are much less of a problem. Other minerals can interfere with the utilisation of essential trace elements, for example the impact of molybdenum (Mo) and sulphur (S) in precipitating a copper deficiency.

This booklet reviews the role of the important TEs for beef and sheep production in England and Wales and provides guidance on assessing deficiencies and supplementation.

## Key messages

- Copper, cobalt, selenium and iodine are the most important trace elements for cattle and sheep in England and Wales
- Deficiencies of trace elements can cause poor production but there are other common causes of low productivity such as parasites or energy deficiency
- A deficiency should be confirmed by independent testing and advice before supplementation
- Grass and forage varies widely in trace element content due to soil type, pH, drainage, plant species and fertiliser use
- In general clay soils have higher trace element levels than sandy soils
- Soil testing may reveal gross deficiencies but is usually only a guide
- Herbage analysis can be misleading and needs careful interpretation
- A deficiency is more accurately diagnosed from blood or tissue tests than from herbage analysis
- Trace element requirements vary with age and production level - young, pregnant and lactating animals have the greatest need
- Diagnosis of deficiency should be confirmed by monitoring the response to a supplement. An increase in tissue or blood trace element levels may not always show cost effective improvements in performance
- Over supplementation is not only a waste of money but could make matters worse due to imbalance or interactions





# Trace Element deficiencies in England and Wales

Farmers are usually well aware of the impact on their stock of a number of TE deficiencies. Obvious examples are cobalt deficiency and 'ill thrift' or 'pine' in weaned lambs; selenium deficiency linked with 'white muscle' disease and infertility; 'swayback' problems resulting from copper deficiencies on peaty land. 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 clinical signs associated with TE deficiencies in sheep in particular can be slow to develop and the only sign 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.

To assess trace element status on your farm first take forage samples (free from soil contamination) from a representative number of fields. Take samples when grass is actively growing in the spring and autumn and send to a reputable laboratory. This will identify key deficiencies from forage alone. This should be followed up by blood samples from a cross section of stock; suckler cows; growing cattle; ewes and lambs. Bloods should be taken when stock are at grass when receiving little or no supplementation (early summer). The results can then be reviewed with your vet or advisor and a programme of appropriate supplementation put in place.



# Geology and soil

The main reason for different TE 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 TE to the plant 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 finishing lambs.

In general:

- sandy soils contain lower TEs than clay soils
- free draining soil contains less TE's than poorly drained soils
- soil derived from 'acid' rocks such as granite are low in TEs
- excessive liming will reduce herbage cobalt levels but increase molybdenum. The latter can reduce the availability of copper.



The TE content of plants can vary widely even on the same soil. In general herbs and weeds have much higher levels of TEs than grasses. Clover is generally richer in TEs than grass. Re-seeding with a limited range of ryegrass varieties in the mixture, replacing the diversity of plants in permanent pasture, can reduce TE intake. Rapid, lush pasture growth following fertiliser application has the same impact. Organic production which encourages a greater sward diversity and clover growth can often reduce the need for TE supplementation.





## Copper

Copper is an essential part of a number of different enzymes in the body. 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 is accumulating in the liver over a long period of time.

**Deficiency:** The classic deficiency is 'swayback' in lambs where the deficiency results in damage to the spinal cord. In cattle it is most easily seen in young animals where the classic description is 'spectacling' of dark coated cattle (reduced pigmentation of the hair around the eyes).

A more serious deficiency will result in poor growth, scouring and in extreme cases a thickening of bones around the joints. Infertility in cattle is often linked with copper deficiency but there is debate as to whether this is the result of excess molybdenum in forages rather than a straight copper deficiency. Swayback is becoming increasingly rare perhaps because of the trend to indoor lambing and a clear recognition of the risk on certain soils and farms.



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There is considerable variation across different breeds of sheep with respect to copper absorption. Breeds, such as the Texel, which absorb copper very efficiently, are at risk of copper toxicity. Whilst breeds such as the Scottish Blackface, which are less efficient at absorbing copper, are more likely to suffer from a copper deficiency. Sheep are more at risk of copper toxicity than cattle, although the number of cases in cattle has been rising over recent years. Where sheep are fed concentrates for a long period of time, they are at risk of copper poisoning.

The diagnosis of copper deficiency may be made from blood samples. However, in cases of copper toxicity, the blood copper levels may be normal, whilst the liver is overloaded with copper. Hence, liver copper gives a better indication of the animals' copper status. Liver biopsy can be carried out on the live animal but more commonly liver samples are taken from slaughtered/dead animals.



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**Pasture Levels:** Copper deficiency is either a primary deficiency due to low copper intake or due to the interference of other elements specifically iron (Fe), molybdenum and sulphur which reduce the availability and absorption of copper from the rumen. Certain areas within the UK (e.g. the 'teart' area of Somerset) are well known for the problem of high soil molybdenum causing a copper deficiency. Across the country as a whole iron is probably a more important contributor to deficiency. Soil is relatively rich in iron and hence contamination of pasture or silage can reduce availability of copper to the animal. Iron compounds form in the rumen and limit copper absorption.

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, whilst cattle feeds and minerals do. Due to the risk of copper toxicity, cattle feed and cattle minerals should not 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. For cattle, extra copper may be added to the feed, but not for sheep because of the risk of toxicity. Copper may be given orally in the form of drenches or slow release capsules or boluses, or by injection. Alternatively, copper may be applied to the pasture, usually in combination with other trace elements.

## Case study 1

A recent case study on a farm in mid-Wales with 760 ewes and 22 Welsh Black suckler cows highlighted both 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.



Results indicated low copper availability from pasture and copper deficiency in cows and growing cattle. Likewise selenium deficiency was identified in cattle and sheep.

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.

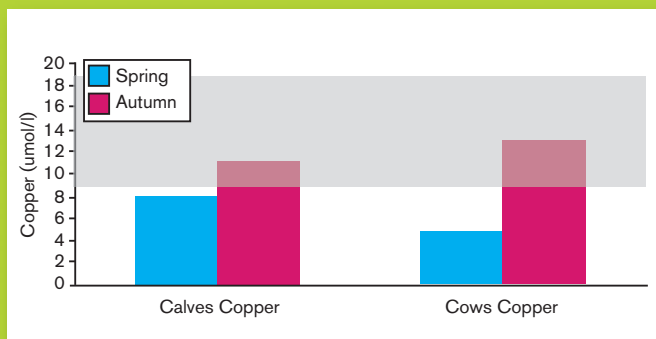


Figure 1 shows the spring and autumn copper levels for the cattle blood results. The grey area represents the recommended reference range showing that only after supplementation were blood levels satisfactory.

*Figure 1 Blood copper levels*

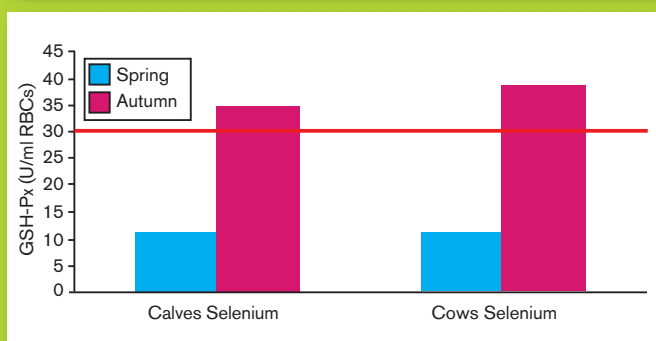


Figure 2 shows the selenium levels in cattle bloods. The red line is the recommended reference level (> 30 u/ml) with the autumn selenium levels just above the line.

*Figure 2 Blood selenium levels*

Half the finishing cattle were given a trace element bolus and weight gains were compared to those that had not been given boluses. The cattle averaged 371 kg live-weight when treated. The untreated animals gained on average 70kg (0.8 kg/day) and the bolused animals gained 76.5kg (0.9 kg/day) over 87 days.

Liver samples from lambs showed that 5 out of 6 lambs were selenium deficient. White muscle disease had been a problem on this farm in the past and supplementation was in place to address this. These lambs had been given a multivitamin drench three weeks before slaughter and this had not corrected the deficiency. An alternative method of supplementation needs to be considered.

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

The results highlighted to the farmer the extent of the copper and selenium deficiencies on his farm. Consequently he has treated both cattle and sheep differently this year compared to previous years with additional supplementation. Performance will be monitored carefully in future.

## Cobalt

Cobalt is an essential component of vitamin B12, an important vitamin associated with energy metabolism. This vitamin is produced by micro-organisms in the rumen and hence animals require a regular supply of cobalt in the diet.

Growing animals generally have a higher requirement for vitamin B12 than adults. However, suckling lambs and calves have a lower requirement as most of their energy comes from milk.

**Deficiency:** Also known as 'pine', results in 'ill-thrift' accompanied by poor appetite. In order of susceptibility to cobalt deficiency, weaned lambs are most at risk, then adult sheep followed by growing cattle and lastly 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 B12 from the gut, so may induce cobalt deficiency even where dietary cobalt is adequate.

Diagnosis based on these clinical signs is supported by low blood or liver vitamin B12 levels. There is usually a lag period before deficiency symptoms develop in lambs grazing deficient pasture; i.e. until vitamin B12 reserves have been depleted. Cobalt deficiency in adult ewes may be associated with reduced fertility and increased perinatal lamb mortality.



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**Pasture Levels:** Pasture cobalt availability is affected by soil pH. Different plant species take up different amounts of cobalt, for example clovers will contain much higher levels of cobalt than ryegrass in the same sward. Pasture levels of cobalt tend to be lower in the spring than the autumn. As soils have a much higher level of cobalt than pasture, soil contamination can be a source of cobalt and on marginally deficient pastures a low stocking rate is more likely to induce a deficiency than heavy grazing. In general, the concentration of cobalt in pasture grasses declines as soil pH rises, hence liming can induce a cobalt deficiency.



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**Preventing deficiency:** Oral drenching with cobalt raises the blood vitamin B12 level for only about 7 days. In practice, drenching every 3-4 weeks is often sufficient to maintain vitamin B12 levels in weaned lambs. Vitamin B12 injections are an alternative to drenching, but, once again, need to be given every 3-4 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, but must be administered with care to avoid injury to the back of the throat.

Top dressing pastures with cobalt sulphate (at the rate of 2kg/ha every third year) is practiced but is not as common these days, as it is not considered cost effective in the UK.



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## Selenium (Se)

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

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**Deficiency:** Mostly widely recognised as white muscle disease (WMD), ill-thrift, and infertility. The occurrence of WMD is now generally low. A typical experience would be with young stock newly turned out onto lush pasture (containing high levels of unsaturated fats) and not used to exercise, suffering muscle damage which can prove fatal. A deficiency in young lambs can show as an inability to stand because leg muscles are affected. Retained placenta in cattle can be associated with a selenium deficiency.



*The muscle on the left indicates white muscle disease compared to the normal muscle on the right*

In young growing animals, selenium deficiency may be a cause of ill thrift. Selenium deficiency may also cause poor reproductive performance. In the female, selenium deficiency can cause early embryonic death, resulting in poor scanning figures in sheep and an extended calving period in cattle. Selenium deficiency also affects fertility in the male, so where a deficiency is identified, it is important that rams and bulls are also supplemented.

Excess selenium is toxic to sheep and cattle, although the risk is very much less than with copper, and cases of selenium toxicity are rare.

Diagnosis of selenium deficiency is usually by blood sampling and measuring levels of the enzyme, glutathione peroxidase, which contains selenium.



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**Pasture Levels:** Unlike most TEs, there is a good direct relationship between selenium levels in soil, grassland and in the animal. Thus if soil or pasture levels are known, the likelihood of animals developing a deficiency can be predicted with some confidence. Note however that different plant species take up different amounts of selenium (e.g. clovers contain less than ryegrass). A herbage analysis can therefore be misleading if it does not represent what the animals are eating in a diverse pasture. 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 more than 0.06 mg/kg DM, it is widely recommended that the whole diet should contain in excess of 0.1 mg/kg DM. Sulphur which is now increasingly used in fertilisers for grass silage can interfere with selenium uptake by plants and hence an overuse can exacerbate a marginal deficiency of selenium.

**Preventing deficiency:** Oral drenching with selenium salts can provide adequate supplementation for 1 to 3 months. Selenium may also be given by injection, with slow release formulations providing up to 12 months supply from a single injection. Selenium can also be given in a rumen bolus, or applied to pasture in combination with other trace elements.



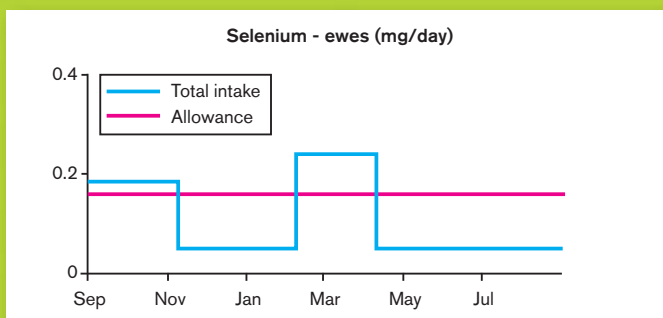
## Case study 2

A recent case study on a mixed farm in the West Midlands revealed significant selenium deficiency in breeding ewes. 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.



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

For the suckler cows and breeding ewes the estimated daily trace element intake 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 ewes had been reliant on grass alone for several months (see figure 3 below).



*Figure 3 Intake of selenium compared to the recommended allowance.*

Blood samples taken from ewes in May showed selenium levels to be satisfactory but by September levels for the majority were below the reference range 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. Ewes were bolused in late September and then blood sampled around a month later. The results showed cobalt and selenium to have increased by three to four fold. Performance of the flock will be monitored to assess the cost-effectiveness of the treatment but scanning improved by 10% on the previous year.



## Iodine (I)

**Deficiency:** Iodine is a component of the important hormone thyroxine which controls the animals' energy metabolism and is also essential for the growth and development of the foetus. As it is needed for proper thyroid function, a deficiency is typically associated with an enlarged thyroid, commonly known as goitre. Typical signs are late abortions with still born or weak calves and lambs. Neonatal mortality is markedly increased. Cows have a tendency to retain 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 level in herbage and rock or soil type. Coastal regions see the highest level of pasture iodine due to the influence of the sea. The typical level in pasture grasses is 0.2-0.3 mg/kg DM. The levels in improved grass species compared with unimproved is usually higher, hence a high percentage of the pastures in upland Wales are recognised as low in iodine. Pregnant and lactating animals have a much higher iodine requirement (compared with 'dry' stock) and pasture (without extra supplementation) is often unable to fully satisfy requirements. Some forage crops i.e. brassicas contain substances called goitrogens which interfere with the production of thyroxine. Animals grazing brassica crops have an increased requirement for iodine compared with those grazing grass.

The thyroid gland from stillborn lambs or calves is the best sample for diagnosing iodine deficiency. In adult animals, blood can be tested for the hormone thyroxine, or for inorganic iodine.

**Preventing deficiency:** Iodine may be given by oral drench or in a slow release rumen bolus. Alternatively, it can be applied to pasture in combination with other trace elements. Avoid over-supplementation since high levels of iodine (over 10 mg of iodine per ewe per day) have been shown to reduce absorption of colostrum in lambs.



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## Manganese

**Deficiency:** Manganese is an important TE, essential for the correct functioning of several enzyme systems within the body. Diagnosis of deficiency is very uncommon. Deficiency symptoms are reported as joint and bone abnormalities, and often linked with a 'stiff' gait. Low manganese intakes are also reported to cause a delayed or irregular oestrus and poor conception. In England and Wales, deficiency is unlikely in grazing animals since the majority of pastures contain sufficient to satisfy requirements.

**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 is associated with a greater increase in the accumulation of manganese in plants. Hence a deficiency is extremely unlikely in hill and upland pastures. Over liming (to over pH 6.5) will significantly reduce pasture levels.



## 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 hence a deficiency affects a wide range of body functions. Deterioration of hair or wool texture, stiff joints, thick, scaly cracked skin are accompanied or preceded by poor growth. Reproductive function is impaired. A deficient diet will not produce all of these symptoms and usually clinical signs do not appear unless the diet contains zinc 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 are often reported with zinc levels as inadequate but there is little evidence to suggest a deficiency with levels above 25 mg/kg DM. 50 mg/kg DM is often recommended.

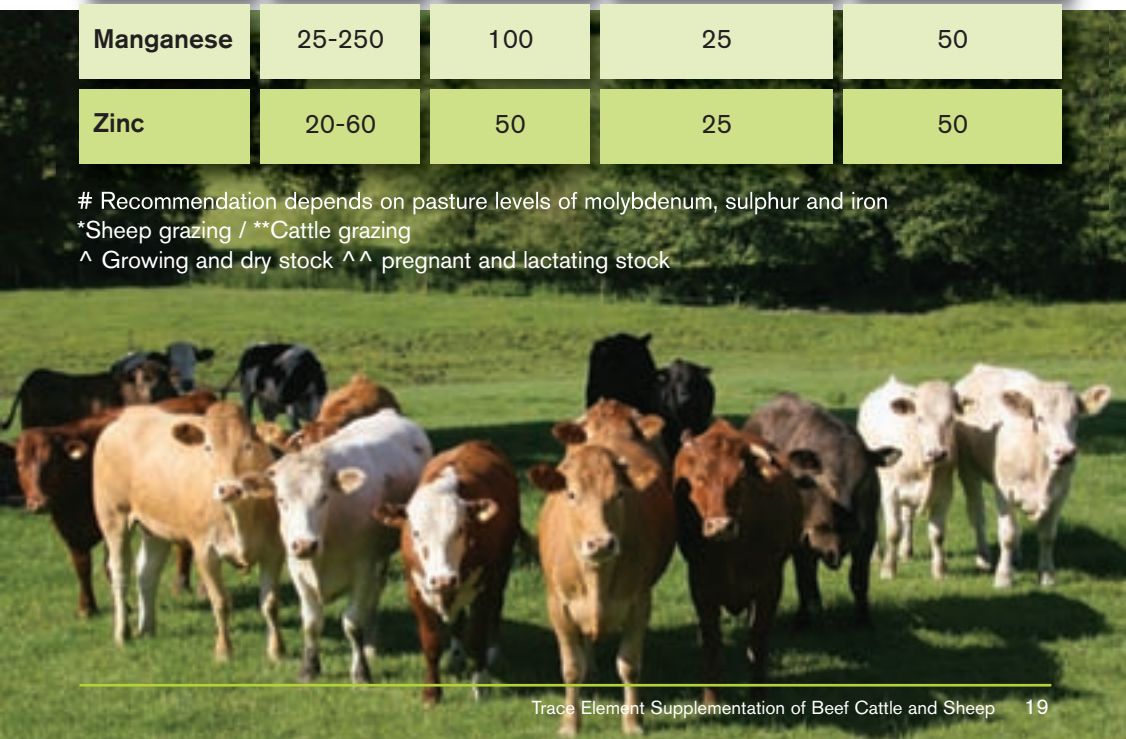
## Trace Element Levels in Pasture and Recommended Levels

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

# Recommendation depends on pasture levels of molybdenum, sulphur and iron

\*Sheep grazing / \*\*Cattle grazing

^ Growing and dry stock ^^ pregnant and lactating stock



# Methods of supplementation

## Free-choice minerals

Widely used but intake can be very variable. The widespread belief that animals are somehow aware of a mineral deficiency and hence will only take what they 'need' is unproven. Individual variation in intake of mineral mixes, licks and blocks both between animals in the same group and across breeds and farms is huge. Some animals take little or none at all, others taking several times more than they require. Self help minerals contain a lot of common salt to control intake – it is this mineral which stock are attracted to. Simply supplying rock salt is often beneficial.



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## In-feed minerals

Purchased compound feeds and balancers are generally well fortified with trace elements although the level of feeding obviously dictates the amount of TEs the stock receive. 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 e.g. if a pregnant ewe requires 25g per head per day, and is being fed 1kg of concentrates, the mineral inclusion rate will be 25kg per tonne.

Following independent forage analysis bespoke minerals can be manufactured to suit the farm.

Chelated or organic sources of trace elements may be absorbed by the animal more effectively than cheaper inorganic sources, but the benefits of using these have not always been seen in practice.





## Drenches and injections

Clearly a very effective method of ensuring each animal gets the required level. Where copper absorption is challenged by high levels of molybdenum or iron then direct injection of copper overcomes the problem and may be the only reliable method of choice in some areas (e.g. Teart areas of Somerset). Drenches containing iodine and cobalt need repeating at regular intervals. As cobalt is required by rumen micro-organisms for the production of vitamin B12, it has to be supplied through the diet. The alternative and very effective method to rapidly overcome a deficiency is direct injection of the vitamin.

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

A variety of products are available on the market 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 accordingly.

## Slow Release Bullets or Boluses

These can be very effective in targeting individual TE deficiencies, providing supplementation for a longer period than oral drenches, (e.g. for a straight copper deficiency - copper oxide needles administered in a gelatine capsule at a dose rate of 0.1g copper oxide per kg liveweight). Cobalt bullets have been widely used but may suffer from the problem of rumen regurgitation or coating preventing cobalt release. They may be an expensive method of cobalt supplementation for lambs which only require a short period of supplementation.

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



## Top Dressing of Pasture

Provides a longer term solution to raise the level of TEs in grassland. This can be very effective in the case of simple deficiencies but not where availability is restricted by other factors e.g. high levels of molybdenum or alkaline soils. This method does require a discipline in approach with accurate records of application rates and timing.

In all situations, it is important to monitor trace element levels in ruminants on a regular basis, at least annually. Changes to pasture, such as reseeded or liming may change the availability of trace elements. The weather can also affect availability – in a wet season, animals will ingest more soil than in a dry year, which will make cobalt more available but copper less so.

Where routine supplementation is practiced, monitoring levels in the animals is necessary to check that the level of supplementation is adequate. Assess intake of TEs from all sources to avoid over-supplementing.

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

Further information on related topics and full details of the farm case studies can be found at [www.hccmpw.org.uk](http://www.hccmpw.org.uk)

