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Trace Elements in Organic Beef Cattle and Sheep Production
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In the UK, the most economically important trace elements (TE's) are Copper (Cu), Selenium (Se), Cobalt (Co) and Iodine (I). Zinc (Zn) and Manganese (Mn) deficiencies are very 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 Cu deficiency.

This brief update summarises some of my conclusions on the subject having been involved in recent work looking at the relationship between the important trace elements in herbage, blood and liver levels in cattle and sheep.

Key Messages

- **Copper, Cobalt, Selenium and Iodine are the most important trace elements for cattle and sheep.**

- **There are areas of the UK where TE deficiencies are a major risk factor.**

- **Deficiencies of trace elements can cause 'ill thrift' and infertility but there are other far more common causes of low productivity such as a parasite burden or energy deficiency.**

- **A deficiency state should be confirmed by independent testing and advice before applying for approval to supplement stock with extra trace elements.**

- **Grass and forage varies widely in trace element content due to soil type, pH, drainage, plant species and manure usage.**

- **In general clay soils have higher trace element levels than sandy soils.**

- **A deficiency is usually more accurately diagnosed from blood or tissue tests than a herbage analysis.**

- **Soil testing may reveal gross deficiencies but is usually only a guide.**

- **Herbage analysis needs careful interpretation. Levels can vary throughout the growing season and analysis may not represent what the animals are eating in a diverse pasture nor account for soil contamination effects on mineral availability.**

- **The animals trace element requirements vary with age and production level - young, pregnant and lactating animals have the greatest need. There are marked differences between the TE requirements of cattle and sheep.**

- **A diagnosis of deficiency should always be confirmed by monitoring the productive response to supplementation. An increase in blood trace element levels following supplementation may not be associated with any improved or economically beneficial performance.**

- **Pasture application of trace elements can be effective but not for example to overcome a Cu problem on land high in Mo or for Co on alkaline soils.**

- **Avoid overgrazing - soil ingestion can cause copper deficiency.**

- **Whilst a chelated trace element can be shown to have a greater availability in the animal, inorganic sources approved for organic supplementation are cheaper and can be just as effective.**

- **A single herbage analysis indicating a potential deficiency without other evidence does not justify seeking approval for 'blanket' supplementation.**

Deficiencies

Farmers are usually well aware of the impact on their stock of a number of TE deficiencies. Obvious examples are Co deficiency and 'ill thrift' or 'pine' in weaned lambs; Se deficiency linked with 'white muscle' disease and infertility; 'swayback' problems resulting from Cu 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'.

. Over the last 10 years veterinary agencies throughout the UK have noted fewer overall deficiencies of Cu, Co and Se on conventional farms. This is due to the greater awareness of the problem and action taken to provide routine supplementation. 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. It can be convenient for farmers to blame trace element deficiencies even though other management factors are the real cause. A deficiency state should be confirmed by independent testing and advice before supplementing stock with extra trace elements.

Geology and Soil

The reason for the occurrence of different TE deficiencies across the UK is due to the variable geology and soils. Organic cattle and sheep production is largely grass and forage based. If the soil cannot supply sufficient TE to the plant, it is not surprising that a deficiency will occur.

In general:

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

The TE content of plants can vary widely even on the same soil. There have been relatively few studies measuring the TE content of grasses, legumes and herbs grown on the same soil type under the same conditions. It is widely accepted that in general the levels of TE are higher in legumes and herbs compared with grasses although there is much variation across soil types and stage of growth. It is well established that chicory has significantly higher levels of the important TE's compared with grasses. There is much anecdotal evidence which shows that TE deficiencies are much less of a problem or can completely disappear after moving to organic production due to a greater sward Re-seeding with a limited range of ryegrass varieties in the mixture, replacing the diversity of plants in a permanent pasture, can reduce TE intake.

Levels in Pasture

There are no widely accepted standards for adequate and deficient levels of TE's in pasture samples. The following table has been widely used as a standard in ADAS.

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

Recommendation depends on pasture levels of Mo, S and Fe
*Sheep grazing / **Cattle grazing
^ Growing and dry stock. ^^ pregnant and lactating stock

Mineral and TE suppliers and analytical laboratories use different standards to indicate whether a level is adequate or deficient. Often the desirable level in the total diet is used. For example , a figure of 10 mg Cu/kg in the total diet is often used as the minimum level and any value in herbage less than this is regarded as deficient.

These recommendations are often misleading. For example recent detailed tests on a farm showed that whilst levels of Copper in herbage samples were below the levels in the above table, levels of copper in the blood and liver of the cattle and sheep were normal. On another farm, herbage selenium levels were regarded as deficient yet blood sampling showed no deficiency.

Clearly reaching a conclusion that there is a TE deficiency on a farm from taking a single herbage level can be very misleading. It certainly should not be used as the sole justification to obtain approval for 'blanket' Te supplemented of stock.

Some Comments on Herbage Levels.

Copper deficiency is either a primary deficiency due to a low Cu intake or due to the interference of other elements specifically Fe, Mo and S which reduce the availability and utilisation of Cu. Certain areas of the country e.g. the 'teart' area of Somerset are well known for the problem of high soil Mo causing a Cu deficiency. Across the country as a whole Fe is probably a more important contributor

to deficiency. Soil is relatively rich in Fe and hence contamination of pasture or silage can precipitate a Cu deficiency.

Cobalt. Liming and high pH soils are often associated with increased incidence of Co deficiency. Work in Scotland indicates that acid upland soils (<pH 5) are associated with poor availability of Co and careful liming will reduce the risk of Co deficiency. Different plant species take up different amounts of Co e.g. clovers will contain much higher levels of Co than ryegrass in the same sward. Pasture levels of Co tend to be lower in the spring than the autumn. As soils have a much higher level of Co than pasture, soil contamination can be a source of Co and on marginally deficient pastures a low stocking rate is more likely to induce a deficiency than heavy grazing.

Selenium. Unlike most TE's, there is a better relationship between Se levels in soil, grassland and in the animal. This is often used as a basis for predicting the likelihood of animals developing a deficiency .. Note however that different plant species take up different amounts of Se e.g. on some soil types clovers have been shown to contain less Se than ryegrass. A herbage analysis can therefore be misleading if it does not represent what the animals are eating in a diverse pasture. The Se 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 show 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.

Iodine. The levels of I in pastures 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. Coastal regions see the highest level of pasture I due to the influence of the sea. The typical level of I in pasture grasses is 0.2-0.3 mg/kg DM. The levels of I 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 I. Pregnant and lactating animals have a much higher I requirement (compared with 'dry' stock) and pasture without extra supplementation is often short of I to fully satisfy their requirements . Some forage crops i.e. brassicas contain substances called goitrogens which interfere with the production of thyroxine and hence produce symptoms typical of I deficiency.

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

Soil pH has a marked effect. Acid soil and poor drainage is associated with a greater increase in the accumulation of Mn in plants. Hence a deficiency is extremely unlikely in hill and upland pastures. Over liming (to over pH 6.5) will significantly reduce pasture Mn levels.

Zinc. As Zn is not easily mobilised within the body, the animal relies on a continuous dietary supply. Herbage analyses are often reported with Zn 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.

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Further references:

www.organicadvice.org.uk/papers/Res_review_5_herbal_pastures.pdf
www.organicvet.co.uk