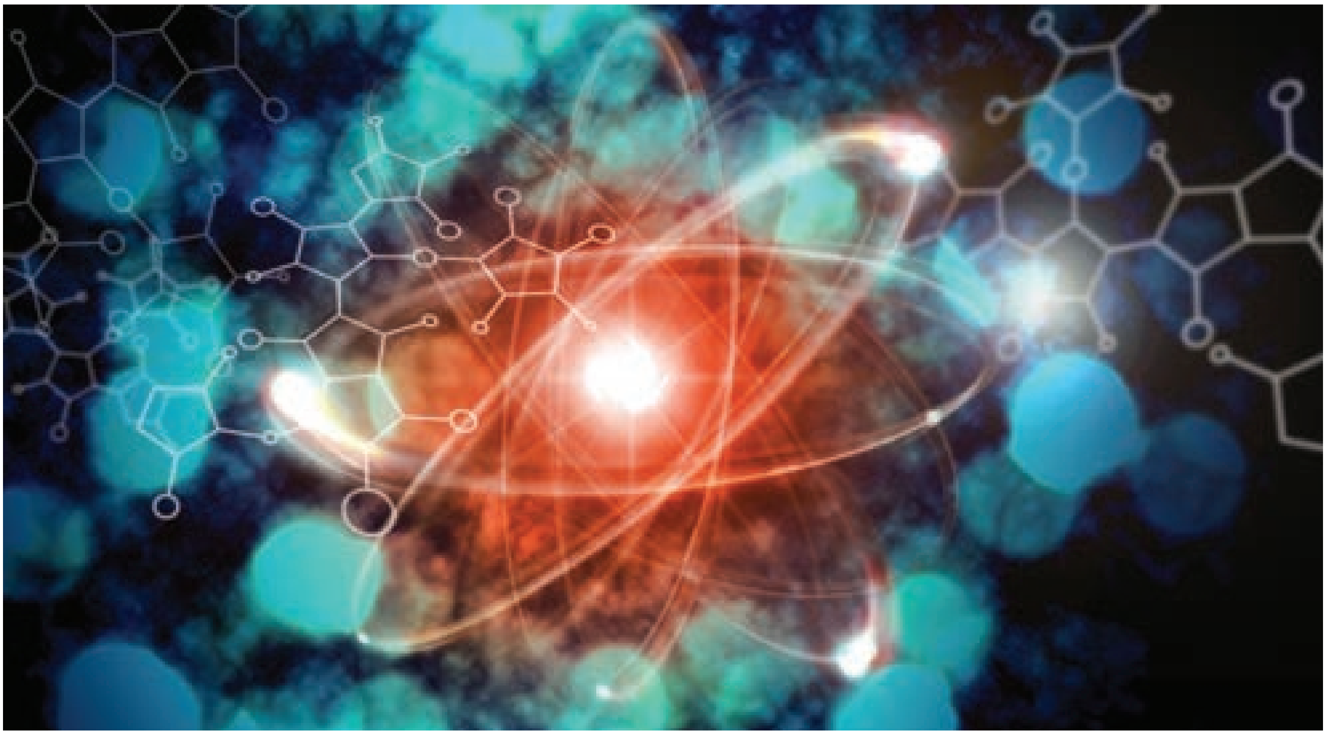
IMPORTANCE OF TRACE ELEMENTS IN CATTLE FERTILITY AND PRODUCTIVITY

With trace elements playing such a critical role in the fertility, productivity and welfare of dairy and beef cattle, it is vital that veterinarians proactively engage with their farming clients at this time of year. This helps to ensure nutritional requirements are factored into herd health management, and that appropriate diagnostics are taking place, writes Dr Renée Lodder BVSc BCom, technical veterinarian, Europe, Bimeda Animal Health Limited



"Dietary deficiencies in single or multiple trace elements can have profound effects on the reproductive performance of dairy cattle. Infertility, decreased conception rate, anoestrus and delayed onset of puberty in cattle has previously been reported to be associated with clinical copper deficiency and high dietary molybdenum intakes" (Mackenzie *et al*, 2001).

In Ireland, many farmers are aware of the potential for deficiencies in trace elements such as copper (Cu), cobalt (Co), selenium and iodine (I) and are aware of many of the clinical signs of these, such as coat discolouration, hair loss around the eyes, increased bone fractures, diarrhoea, white muscle disease, retained placentas, weak new-born calves, goitre, lethargy and poor growth. However, trace element clinical signs are the true tip of the iceberg when reviewing deficiencies. Many times, deficiencies are subclinical and are not easily observable by the farmer. The losses from trace element deficiencies occurs in the forms of poor growth rates, lower reproductive results and lower production compared to their genetic capabilities.

In addition, a condition called thiomolybdate toxicity can also appear clinically like copper deficiency. The absorption of copper can be significantly reduced by the ingestion of molybdenum and sulphur in the diet (Gould & Kendall 2011).

Molybdenum and sulphur combine in the reticulorumen to form thiomolybdates, namely mono-$MoSO_3^{2-}$, di-$MoS_2O_2^{2-}$, tri-MoS_3O^{2-} and tetra-MoS_4^{2-} anions. These react with Cu to form insoluble Cu thiomolybdates. This means that Cu is lost from the animal via excretion in faeces (Grace *et al* 2010).

WHAT ARE THE SUBCLINICAL EFFECTS OF DEFICIENCY?

- Cu is an integral part of several enzymes with oxidase functions:
  - Caeruloplasmin – the major Cu-carrying protein in the blood which is also involved in iron (Fe) and (Cu) metabolism. Deficiencies in mobilisation of Fe can cause anaemia;
  - Tyrosinase – a Cu-containing enzyme that catalyses the production of melanin; and
  - Lysyl oxidase – inactivity of this enzyme can cause pathological fractures (Lean 2017).
- Cu deficiency affects immune functions by impairing the action of phagocytes, reducing antibody production and neutrophilic chemotaxis.
- Thiomolybdate toxicity can also cause subclinical affects in the cattle, namely in reproduction. Thiomolybdate

ions are also absorbed into the blood and it has been demonstrated that they can prevent luteinising hormone-induced differentiation of the bovine theca cells which are an important element of the developing ovarian follicle (Grace *et al* 2010).

- Se is an integral part in the glutathione peroxidase (GSH-Px) enzymes, which are involved in the protection from oxidant stress. These enzymes have a synergistic role with vitamin E and other antioxidants in removing toxic peroxides from tissue and preventing oxidative damage to membranes. Se is required in the thyroid gland for the conversion of T4 to T3, the active thyroxine molecule as Se is required in the iodothyronine deiodinase enzymes. The supplementation of selenium has also shown to enhance antibody responses to a variety of antigens in sheep and cattle (Grace *et al*, 2010)
- Co is an integral part in in the production of Vitamin B12 (cyanocobalamin). This vitamin is synthesised by micro-organisms in the rumen and is absorbed from there into the systemic circulation. Vitamin B12 acts as a co-enzyme in several metabolic pathways (methylmalonyl coenzyme A mutase and methionine synthase) and in ruminants its main role is in the metabolism of propionate, which is required for synthesis of glucose via succinate in the liver.
- I is required for the synthesis of triiodothyronine (T3) and tetraiodothyronine (thyroxine T4) in the thyroid gland. These hormones are derivatives of the amino acid tyrosine. The function of the I hormones is to affect basal metabolic rate and thus accelerate growth and increase the oxygen consumption. The consumption of foods containing goitrogens can also cause clinical and sub-clinical signs of iodine deficiency to occur. Goitrogens are substances particularly found in brassicas (kale, cabbage, rape) which inhibit the iodination of tyrosine and hence the synthesis of thyroxine T4.

The diagnosis of trace element deficiencies can be challenging as a full picture of inputs and utilisation by the animal is not always easy to collect. The requirements by the animal involves calculating what is required for milk production, growth, foetal growth and also what is lost from the system via endogenous loses via urine and faeces. Ideally, forage analysis, blood analysis and liver biopsies (both live or from the abattoir) would be beneficial to get an indication of intakes and levels in the animals. When testing there are different tests available:

- Se
  - GPX – reflects longer term Se levels of three to five months. This is affected by red blood cell turnover.
  - Serum Se – more recent Se levels.
  - Liver Se – this is well correlated to GPX and serum Se levels.
- Cu
  - Plasma or serum Cu – levels of circulating copper which can be elevated when inflammation is occurring. This is not a good indicator of stored copper so blood levels could be in within normal limits but the liver may be depleted.
  - Liver Cu – Levels of stored Cu as the liver is the storage organ in body for Cu. This level will generally change before blood levels do.
- Co
  - B12 serum – serum and liver levels are not well correlated.
  - B12 liver.
- I (iodine)
  - Serum I – reference ranges are often debated.
  - Milk I – reference ranges are often debated.
  - T4 serum – can be affected by parasitism, disease, poor planes of nutrition and early lactation.

Forage analysis is important in getting a picture of what trace elements are being supplemented to the animals. A general guideline (Lean 2017) for assessing feed with regards to Cu intake is to check if the Cu levels are above 10mg/kg DM. As discussed previously, Cu supplementation to cattle can be affected by thiomolybdate toxicity. Therefore, a guideline for forage sampling is to check if molybdenum levels are below 0.5 (certainly below 2mg/kg DM) so that the copper:molybdenum ratio is > 4.1. Also, it is useful to check if iron levels are below 250mg/kg DM and that sulphur levels are below 0.4g/kg DM. As cobalt deficiency is difficult to diagnose in the animal the forage sample can be helpful and levels above 0.04mg/kg DM are recommended in the forage.

Knowing who to test is also a challenge on the farm. Generally, the animals with the highest requirements for trace elements are a good place to start. Younger, rapidly growing cattle have high requirement for trace elements as do cows with calves at foot and high producing dairy cows. If ill-thrift is the concern by the farmer or dairy heifers are not meeting their weight targets of 85% of their adult weight at 22 months, beef cattle are not meeting their growth targets or reproduction targets are not being met then testing for trace elements can be useful. Once infectious diseases are ruled out, completing a forage analysis and taking some samples from the age group concerned can support a helpful trace element discussion with farming clients.

Trace element work can be very rewarding to the farmer – veterinarian relationship. Measuring levels in forages and animals can allow for a regular monitoring on the farm and an evidence-based approach to treatment of deficiencies (and toxicities). The results of treating clinic and sub-clinical deficiencies can also be observed and measured.

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