Fertility, mastitis, lameness and nutrition are key management issues for Irish farmers and for their advisors. For example, poor fertility is still the biggest cause of involuntary culling on Irish dairy farms and according to Teagasc this will be the main limiting factor to expansion in the coming years.

It is estimated that reducing the empty rate from 15 to 10 per cent will result in an increase of one cent/litre in net margin for the average Irish dairy herd, equivalent to €3000 additional profit per annum for the average dairy herd. Additionally poor fertility and poor calving patterns are significantly reducing profitability on many dairy farms due to reduced capacity for efficient production of milk from grass.

In the upcoming non-quota scenario, productivity and earlier mean calving date will not only result in greater profitability at farm level but will also allow greater plant utilisation at processing level. As we are all aware, infertility and productivity are multifactorial issues and every aspect of a farm’s management must be looked at carefully. Improved performance at farm level can only be achieved through the application of an optimum breeding management programme, good herd nutrition, increased number and quality of replacements, maintaining good herd health status and the use of genetically superior AI bulls (EBI).

Minerals: A Key Part of Nutrition, Productivity & Fertility

In terms of nutrition, having cows in the correct body condition score at dry off and calving is a prerequisite to minimise calving difficulty, minimise metabolic disease around calving time (e.g. milk fever and retained placenta) and to maximise subsequent milk yield and fertility performance in that lactation. Correct transition cow management to minimise the effects of Negative Energy Balance is critically important for ensuring high submission rates and conception rates in Irish dairy herds. However, I believe that the mineral status of our clients’ cows should also be looked at more closely as trace elements, or more precisely the lack of an adequate and continuous supply of them, can have a negative impact on both the expression of oestrous and conception rates during the breeding season, as well as on the ability of cows to hold onto their pregnancy.

In my practice in North Cork we have some of the top dairy herds in the country, run by some of the most competent stock men in Europe. The vast majority supplement with trace elements both in the dry cow period and during lactation. However, in some of these well supplemented herds over the last number of years, there have been clinical signs of disease among the cows which would traditionally have been linked to copper deficiency. It is very notable that investigation of these herds almost invariably reveals that affected cows have normal blood copper levels. This certainly highlights the lack of sensitivity of this method of testing when compared to liver biopsy, but also highlights the fact that the copper deficiency syndrome is a much more complex disease entity than we often consider. The missing link in the disease chain relates to the interaction between copper and molybdenum, a very common trace element in this country, as well as sulphur. This is often referred to as molybdenum toxicity or thiomolybdate toxicity.

Thiomolydate Toxicity (TMT) & the Copper Myth

The common symptoms attributed to copper deficiency, including ginger tinged coats and grey and bald rings around the eyes, are actually the result of molybdenum toxicity in the
form of sulphur-molybdenum (thiomolybdate) compounds. Sulphide is formed by ruminal micro-organisms from dietary sulphate or organic sulphur compounds; the sulphide then reacts with molybdenum to form thiomolybdate. In the rumen, thiomolybdate combines with copper to form an insoluble copper thiomolybdate, (CuMnS₄), which is excreted in the faeces thereby preventing thiomolybdate absorption. It is considered likely that if thiomolybdate is formed in the absence of adequate rumen-available copper, the thiomolybdate may be absorbed from the digestive tract and exert a systemic effect on copper metabolism in the animal, i.e. thiomolybdate toxicity (TMT). To prevent thiomolybdate absorption, adequate rumen-available copper is needed. The effects of TMT are reduced weight gain, decreased food intake, reduced efficiency of food conversion, alteration in hair/wool texture and pigmentation, delayed puberty, reduced conception rate, and inhibition of oestrus.

The farmer’s response to the symptoms described will typically be to try and increase copper intake. However, in my experience, supplementation with many of the readily available copper-containing supplements on the market will not do the trick. I have seen many cattle show a temporary improvement in coat characteristics following supplementation in the form of copper injections, oral bagged supplementation and licks, only for regression to occur after a few weeks, while overall performance indicators of fertility in particular remain disappointingly low. On the contrary, I have always seen the value of soluble glass mineral boluses, which give a continued, controlled and quantifiable release of trace elements over a documented period of time. This ensures that each animal gets the required amount of trace elements necessary. However, with some boluses, there is massive confusion in relation to efficacy and expectation and frequently the expected performance improvements promised by the marketing campaigns are not realised. I firmly believe, and much research has demonstrated, that in relation to the molybdenum toxicity-copper deficiency syndrome that is so prevalent in this country, the crucial requirement is a form of copper that is rumen available.

Rumen-available copper is necessary because the copper is needed in the rumen to bind to the rumen-formed thiomolybdate and to prevent its absorption into the bloodstream, where it causes problems. The rumen-available copper acts as sacrificial copper which will bind with thiomolybdate to ensure it passes safely through the enteric tract and is harmlessly eliminated.

Unfortunately most boluses contain copper as Copper Oxide which is not rumen-available and is only activated in the low pH of the abomasum. At this stage much of the thiomolybdate has already been absorbed and is doing damage (TMT is occurring). Therefore these copper oxide containing boluses have not been effective at improving performance indices in my herds.

A compounding factor in the thiomolybdate story is iron, and due to prevailing soil types, modern intensive farming and farmers using their own wells, iron intake tends to be high in my area and throughout the country. Iron forms a complex with sulphur in the rumen and this complex will bind rumen-available copper present. As levels of dietary iron increase, less copper is then available to react with thiomolybdate in the rumen. Thiomolybdate is then free to get into the animal and causes symptoms which appear as what we previously thought was clinical copper deficiency. This ultimately reinforces the need for a continuous supply of sacrificial copper to bind with the iron and the thiomolybdate, to prevent the thiomolybdate from being absorbed into the circulation.

As previously noted, fertility is a big problem with many multifactorial causes. Thiomolybdate is well researched and the consensus of the literature matches what is been seen in the fields of Ireland. Chidambaram et al. showed tetramolybdate to inhibit all of the following Cu-containing oxidase enzymes: caeruloplasmin, cytochrome oxidase, superoxide dismutase, ascorbate oxidase, and tyrosinase at physiologically relevant levels. The effects of thiomolybdate have been shown to include reduced conception rates, anovulation and anoestrous, which were associated with a decreased release of LH. Also the development of the pre-ovulatory follicle is negatively affected which will negatively affect conception rates.

Behavioural oestrus and ovulation and early embryonic survival have been shown to be affected by thiomolybdate’s effects on copper-dependent enzymes. The deactivation of
sex hormones is not the only critical factor associated with reduced profitability caused by TMT. Poor feed conversion has been seen and even low thiomolybdate levels can reduce milk production significantly.

**Diagnosis**

Changes to the coat and underperforming animals in terms of fertility and feed conversion efficiency will be the conversation starter. At farm level, soil, forage and milk analysis are all used to assess levels of all minerals but particularly in terms of Thiomolybdate Toxicity (TMT) the levels of iron, sulphur, copper and molybdenum are vital. I personally find forage analysis to be particularly beneficial in assessing what the local intake risk factors are. For an accurate determination of copper status, liver biopsy is the gold standard test. However, with TMT, plasma/serum and liver copper values will often be normal. Therefore I use a lab in the UK based at Nottingham University who, in an indirect way, are able to diagnose Thiomolybdate Toxicity. Using blood copper and caeruloplasmin ratios this lab can accurately identify herds where Thiomolybdate Toxicity, due to high levels of molybdenum, and sulphur and iron to a lesser extent, are problematic to the herd health and profitability of the farm.

In my opinion, for treatment and prevention of Thiomolybdate Toxicity, what is needed is a constant and adequate form of sacrificial copper to bind the thiomolybdate before absorption. Chelated minerals can be beneficial but require constant administration. In recent years I have switched many farmers successfully onto soluble glass boluses which contain ionic copper. Ionic copper is rumen available and the particular formulation ensures continuous rumen available ionic copper to cows and excellent results for my clients, as well as a continuous supply of selenium, iodine and cobalt.

---

1 Dairy Cow Fertility
Reproductive performance for efficient pasture-based systems
International Conference 2012
2 Role of the rumen in copper and thiomolybdate absorption Gould L, and Kendall NR.
School of Veterinary Medicine and Science, University of Nottingham
3 Inhibition of caeruloplasmin and other copper oxidases by thiomolybdate.
4 Effect of copper and thiomolybdates on bovine theca cell differentiation in vitro
Kendall NR, Marsters P, Guo L, Scaramuzzi RJ and Campbell BJ.