Environmental Impact of Copper Supplementation for Ruminants

By Dr Rahma Balegi & Dr Alessandra Monteiro, Animine

Copper (Cu) is an essential element to all living beings as it plays an important role in many biological processes. For this reason, it has to be supplemented in the diet in order to cover animal's requirements. However, Cu is also a non-renewable resource, and some estimates of world reserves indicated that Cu scarcity may occur in the next 20–30 years. Furthermore, when excreted into the environment, it may impose a medium- or long-term toxicity risk to plants and micro-organisms.

Between Cu essentiality and Cu toxicity: particularities of ruminants

Copper serves as a co-factor of several important enzymes, including lysyl-oxidase, tyrosinase, and cytochrome c oxidase. These enzymes are essential for the synthesis of erythrocytes, myelin, keratin and collagen, as well as for supporting effective immune and anti-oxidant responses. Unlike monogastric animals, ruminants exhibit poor homeostatic control of Cu levels. Ensuring adequate Cu supplementation in ruminants is challenging for nutritionists due to the complexity of Cu metabolism and the very small margin between deficiency and toxicity. Copper deficiency occurs due to either a primary or a secondary deficiency. The primary deficiency is mainly associated with low Cu diets (<4 ppm), while the secondary deficiency happens even at the adequate level of Cu supplementation due to the three-way interaction between Cu, molybdenum and sulfur (Cu-Mo-S) in the rumen. To guarantee Cu absorption regardless of the presence of antagonists, there is a tendency to supplement Cu above nutritional requirements. The narrow margin between the copper physiological needs and the copper concentrations at which toxic effects can occur makes the establishment of a maximum tolerable level in ruminants a difficult task.

Copper excretion into the environment

The use of Cu in ruminant nutrition, and in livestock in general, as a dietary supplement contributes to the overall environmental exposure of this element. Copper intake by ruminants is almost entirely excreted in the manure, which is spread on arable land and grassland as part of normal farming practices. Copper is mainly eliminated via the faecal tract, with most of it represented by dietary Cu that has not been absorbed, along with a small amount of Cu from cell desquamation. In addition, Cu is eliminated via the biliary route, and to a lesser extent via urinary and mammary tracts. In adult ruminants, only 2-10% of dietary Cu is absorbed, leaving 90-98% of dietary Cu in the faeces.

In this context, feed manipulations are an area where Cu can be improved. To know the contribution of Cu reduction in the feed, a simulation was performed by EFSA (2016) for dairy cows and cattle for fattening, based on the average EU feed production for each category and the current Cu level supplemented in the feed (Table 1).

According to the simulations, a reduction in 5 mg/kg in the Cu supplemented (14% in Cu supplementation) can save 113 tonnes of Cu in the dairy cow feed per year. This means that tonnes of a non-renewable resource can be saved thanks to this small adjustment. If we go further in the simulations, other scenarios could be explored, with reductions of 28% in Cu supplementation (which means a reduction of 10 mg/kg in Cu supplementation).

Table 1. Estimation of savings of copper emission to the environment

Animals	Previous EU regulation	2016 New proposal	Cu reduction in feed	Corrected EU feed production	Amount Cu saved
	mg Cu/kg	mg Cu/kg	mg/kg	x1,000 tonnes	tonnes/year
Cattle for fattening	35	30	5	10,900	54
Dairy cow	35	30	5	22,600	113

Data from the Scientific Opinion of EFSA on copper content in complete feed (2016).

How the Cu source can help with decarbonization?

All the Cu sources emit CO_2 to the environment during the extraction, processing and transport. The primary melting process used to extract Cu from its ore involves the combustion of fossil fuels, such as coal and oil, to generate the high heat required for smelting and refining.

However, not all the Cu sources emit the same amount of CO_2. Emissions depend on the energy required for the extraction process and the final concentration of the product. For example, 1 kg of Cu from $CuSO_4$ emits 8.82 kg of CO_2, whereas the same quantity of Cu from the Animine Cu source (CoRouge®) emits only 3.30 kg of CO_2.

Taking into account the current Cu overdosage in European dairy farms, and following the proposal of the previous simulation where Cu supplementation was reduced by 28%, another simulation has been made to assess the reduction in CO_2 emissions resulting from a similar decrease in Cu supplementation (Figure 2).

This simulation was done for a dairy farm with 100 cows and an average dry matter intake of 18 kg. By reducing Cu supplementation from 20 ppm with $CuSO_4$ to 14.4 ppm with CoRouge® (28% less Cu), this farm would reduce in one year the CO_2 emission from 116 kg to 31 kg, meaning 73% less CO_2.

Conclusions:

Over-supplementing Cu in feed leads to the excretion of this nonrenewable source into the soils and the environment. Aside from CO_2 emission, the extraction of raw Cu is causing damage to surrounding ecosystems as well as marine pollution from the mining operations, but also significant land and water use. The reduction of dietary Cu to cope with the requirements is one of the most effective ways towards the sustainability of Cu use in animal nutrition. With the right Cu dosage and with a more bioavailable source, it is possible today to maintain animal performances and to reduce CO_2 emission as well as the total amount of Cu excreted into the soils.

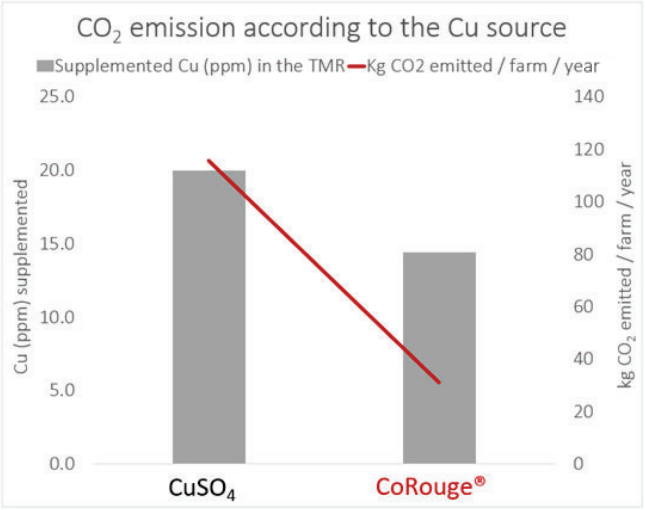


Figure 2. Copper supplementation level (ppm, grey bars) and amount of CO_2 emitted to the environment (red line).

2024 Edgar Pye Scholarship

Applications are now open for the Edgar Pye Scholarship 2024.

The Edgar Pye Research Scholarship Trust was founded following the untimely death of R. Edgar Pye in July 1989, President of the Society of Feed Technologists, to perpetuate his memory by offering research scholarships relating to the animal feed industry.

The Trust welcomes applications from anyone studying agriculture or a related subject, or who is already employed in the Animal Feed Industry in the UK or Ireland, and is resident in the United Kingdom or the Republic of Ireland.

The award will be given to the applicant, who, in the opinion of the panel of judges, has most capably:

- Identified an area of research relevant to the UK and Irish Compound Feed Industry in the
- forthcoming five years
- Prepared a programme thoroughly, including sources of information
- Provided a realistic budget for the costs of the project
- Presented the proposals clearly and according to the rules

In 2023, an award of £2000 was given to one applicant for the project: Identifying optimal ratios of porcine milk oligosaccharides for supplemental use in enhancing gut health and pre-weaning survival using an in vitro piglet hindgut model.

In addition to the monetary award, successful applicants receive early exposure to the feed industry with enhanced employment opportunities and actively contribute to developments in the animal feed industry.

John Dunne, David Wilde, Richard Remmer and Dr. Jules Taylor-Pickard have been appointed judges for 2024. The judges are at liberty to seek specialist assistance as required.

The closing date for submissions is 31st October 2024 and applications should be sent to secretary@sft.uk.com. Applications should be typewritten, double-spaced, not exceeding 5,000 words and single sided on A4 paper. The proposed research must be within the broad subject areas of farm animal feeding including animal nutrition, management, welfare, feed production and marketing. Please ask if uncertain.

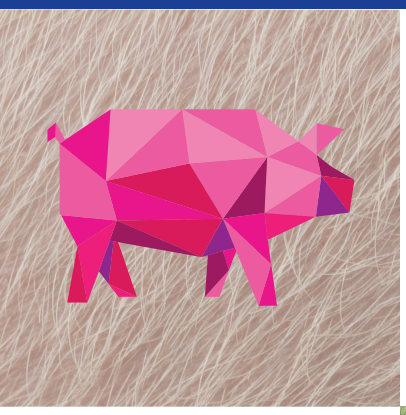
The Society of Feed Technologists undertakes the management of the Trust and the Research Scholarship. The activities of the Trust are financed from a modest investment fund and the generosity of sponsors without whom the award levels would not be possible.

The Trust gratefully acknowledges the support in 2023 of Premier Nutrition, DSM, Devenish, John Long, Trouw Nutrition, Zinpro and De Lacy.

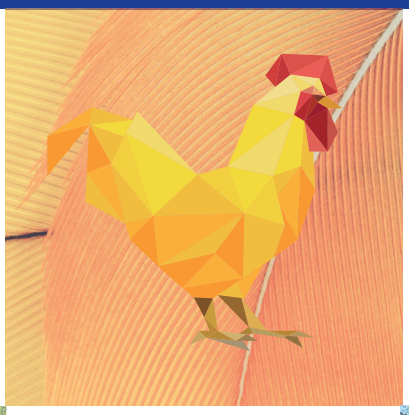
To download the full information pack please scan the QR code below.

WIN THE GAME

BY PLAYING WITH UNIQUE MINERAL SOURCES!

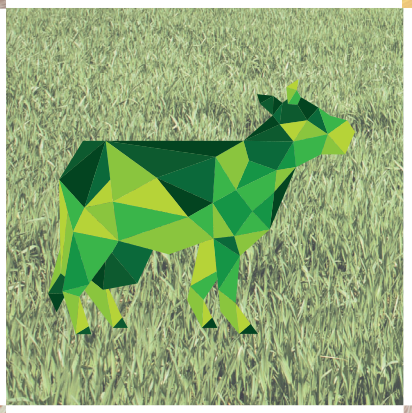


HiZox®
POTENTIATED
ZINC

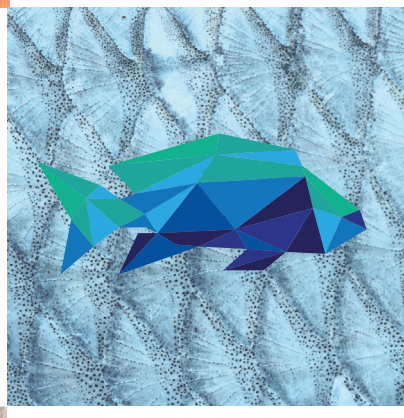


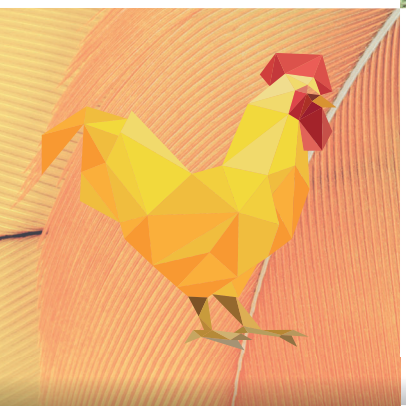
CoRouge®
MONOVALENT
COPPER

ManGrin®
PURIFIED
MANGANESE

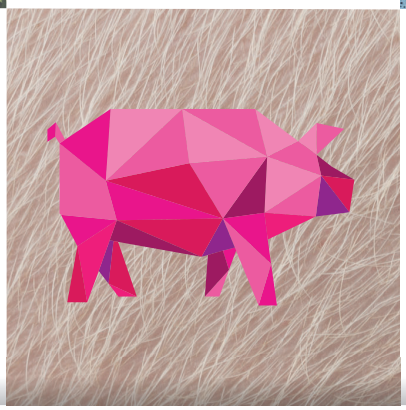


HiZox®
POTENTIATED
ZINC





CoRouge®
MONOVALENT
COPPER



ManGrin®
PURIFIED
MANGANESE

SULFATE & CHLORIDE FREE

High

- ✓ **Concentration** 75%
- ✓ **Flowability**
- ✓ **Safety standards**
- ✓ **Stability**
- ✓ **Bioavailability**
- ✓ **Performance**

Animine, an international and independent supplier of Precision Minerals

www.animine.eu