2. Forages and Precision Mineral Feeding: Lessons from the USA

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Forages account for 45 to 65% of the dry matter intake of dairy cows, providing a substantial proportion of nutrients at a lower cost than purchased concentrates and macro-premixes. Dairy producers practising precision feeding are well aware of this; they regularly analyse their forages and adjust rations accordingly.

The higher the protein content in the forages, the less soybean meal needs to be purchased. Similarly, if dairy cows require 100 g of phosphorus daily, but their maize silage already supplies 40 g, it is unnecessary to buy the full 100 g from mined phosphate sources.

However, when it comes to balancing trace minerals, the reality is quite different: few nutritionists take advantage of the native supply from forages. Yet, there are savings to be made and environmental excesses to be avoided. This article shares insights from the United States and offers tips to extend precise nutrition practices from macro-nutrients to trace elements.

The USA possesses the world's largest databases

In the first article of this series, we compared the mineral concentrations of forages grown in various regions of the United States, using 20,000 analyses cited in 12 publications. In the USA, private laboratories and university extension services routinely analyse trace minerals, accumulating vast amounts of data and providing summaries to their clients. NASEM (2021) has documented copper, iron, manganese, zinc and molybdenum levels in feedstuffs.

With data available for all forage categories based on more than 200,000 samples, native contents cannot be ignored anymore.

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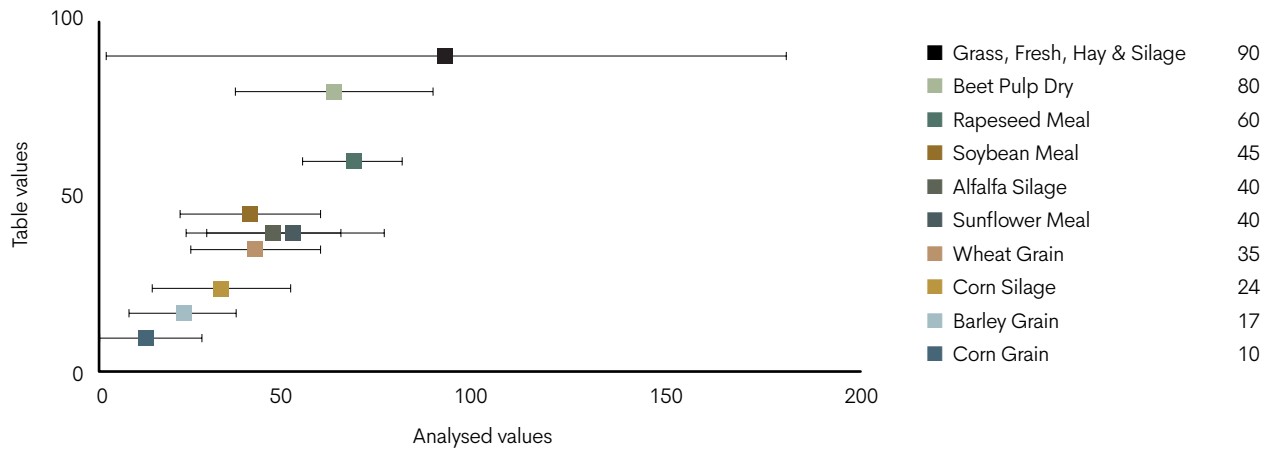
Fig. 1. – Manganese contents (ppm or mg/kg dry matter) in 10 major feedstuffs commonly fed to dairy cattle.
Table values from INRA (2018) and analysed values from Dairy One Forage Lab (average ± 1 standard deviation). This graph can be used as a guide to decide which feedstuffs should be prioritised for analysis, because they are usually low in manganese but can occasionally be high, or vice versa.



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On average, maize silage already meets 30% of the trace mineral requirements of dairy cattle

Literature and our own ration calculations show that typical basal diets cover between one-third and two-thirds of the daily trace mineral needs of dairy cattle. Maize silage alone would satisfy around 20%, 30%, and 40% of copper, zinc, and manganese requirements, respectively.

Neglecting these contributions from the basal diet often results in premixes that are unnecessarily high in minerals. Over-supplementation has a financial impact: every wasted €100 per tonne of macro-premix equates to a direct profit loss of €1,000 per 100 cows annually. It also increases mineral excretion into manure, contributing to soil enrichment and accumulation in subsequent forage crops – a cycle that could easily be broken by integrating forage mineral values into rationing software.

Saving money and protecting the planet?

It is well known that nitrogen and phosphorus are the most valuable nutrients: low supply can cause deficiencies and reduce performance, while excessive supply results in higher feed costs and wasted nutrients released into the environment. The quantity relative to the animal's requirement determines whether a nutrient becomes a burden to the animal, the farmer, and the planet. For over 30 years, dairy nutritionists have used rationing software and feed additives to strike the right balance.

With the advancement of laboratory services, precision nutrition has become more prevalent: nutritionists now analyse their own feedstuffs to create farm-specific rations, rather than relying solely on table values. Extending precise nutrition from macro- to micro-elements would further reduce the environmental impact of dairy operations and save up to €10 per cow per year in feeding costs.

Precise nutrition begins with reliable data

A good starting point for our precision mineral nutrition journey is to consult published feedstuff composition data. The encouraging news is that, in general (with manganese as a prime example), there is a strong agreement between average trace element concentrations reported in reference tables from the USA (NASEM, 2021) or Europe (INRA, 2018), and reference libraries.

Analytical procedures are sufficiently accurate and precise to discern meaningful differences between ingredients, even though concentrations are 100 times lower than those of phosphorus and other macronutrients. As a result, ingredients can be reliably ranked according to their usual contents (from top to bottom in Fig. 1).

After examining average data, let's consider variations, as there is no reason to assume our own forage will be "average". The horizontal bars in Fig. 1 show the concentration ranges for 10 main feedstuffs commonly given to dairy cattle. With manganese contents as low as 20 ppm and as high as 200 ppm, grass hays and silages are much more variable than maize silage, mainly due to the wider diversity of plant species. Variations in maize silage may appear minor, yet its manganese content can still vary by a factor of two: on some farms, it will be below the cow's requirement (about 50 ppm), on others, it will be around the requirement, and mineral supplementation should be reduced accordingly.

Measuring trace minerals in forages has never been easier

Laboratories use either wet chemistry or rapid methods to measure nutrient levels in feedstuffs. In recent decades, near infra-red spectroscopy (NIR) has become popular, as it does not involve hazardous solvents or costly dedicated instruments.
It is quick, cost-effective, and precise.

Calibrations have been developed to match wet chemistry results, making NIR a reliable routine method for most nutrients linked to organic matter, such as starch and amino acids. However, NIR is less suitable for mineral analysis, which is where XRF comes in.

XRF, or X-ray fluorescence, works on the same principle: calibrations are developed to match reference methods for trace mineral analysis (inductively coupled plasma optical emission spectrometry, ICP-OES, and inductively coupled plasma mass spectrometry, ICP-MS). Like NIR, XRF is rapid, cheaper, and precise, and is now also available as a portable device (Fig. 2). ■

References are available from the author on request

Fig. 2. Measuring trace minerals in forages using portable XRF.