

# Trace elements supply and requirements in Dutch dairy farming

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## Abstract

Well-supplied trace elements are necessary for production and animal health. The Water Framework Directive requires a reduction of the output of heavy metals. The tool 'Spoorwijzer' (Trace element guide) is used to calculate the supply of Zn, Se, Cu and Co of different groups of dairy cattle. Zn and Cu are necessary for animal health. Zn is amply supplied on most conventional Dutch dairy farms. Young stock, dry cows and end-lactation cows receive little or no concentrate feed, causing low supply of Se, Cu or Co. Using tailor-made mineral mixtures on a number of farms did not have a negative effect on production and animal health. The surplus per ha on these farms was decreased by 52% for Zn, 28% for Cu, 22% for Se and 56% for Co. It is concluded that Zn is not necessary in mineral mixtures on Dutch conventional dairy farms. Considerable cost reduction is possible by using tailor-made mineral mixtures. In conclusion, the studies found that using tailor-made mineral mixtures is positive for high-output dairy farming and eco-efficient farming.

**Keywords:** animal health, cattle feeding, surplus per ha, trace elements

## Introduction

Intensive dairy farming with high production of grassland and fodder crops requires sufficient nutrients for crop growth. Crop-fertilisation with trace elements, e.g. zinc (Zn), selenium (Se), copper (Cu) and cobalt (Co), is often not given sufficient attention. Dairy cattle need sufficient trace elements for good production animal health. Supplementing the ration with trace elements takes place by feeding compounds and mineral mixtures. Shortage and excess is detrimental for production and animal health. Trace elements, not utilised for growth of milk production are secreted in the manure, which is applied to the field. Römken and Rietra (2008) showed that the Cu and Zn content in the cattle slurry in 2008 was significantly higher than in 1996. Cu and Zn are not only essential nutrients but also heavy metals. The Water Framework Directive requires a reduction of surplus heavy metals. Optimising trace element balances is necessary for high-output dairy farming and eco-efficient farming.

In a number of projects the trace element supply of dairy cattle and young stock with Zn, Se, Cu and Co is calculated. In the province Noord Brabant two pilots were carried out: pilot 'De Beerze' with 8 dairy farms (Den Boer *et al.*, 2007) and pilot 'Hooge Raam' with 7 dairy farms (Den Boer en Van der Draai, 2008). Both studies were commissioned by ZLTO (Southern Agriculture and Horticulture Organization). The province of Drenthe commissioned two province-wide studies on trace element supply: on 25 dairy farms (Den Boer en Van der Draai, 2007) and 8 dairy farms (Den Boer *et al.*, 2011) respectively. The first three projects were aimed to ascertain the problem, create awareness among the dairy farmers, feed suppliers and veterinarians and resolve bottlenecks in reducing the supplementation of trace elements. Recommendations were drawn up to improve trace element balances. Several participants were hesitant to reduce the trace element supply because of animal health issues. To convince these participants that feeding in accordance with recommendations is possible, while also maintaining animal health and production, tailor-made mineral mixtures were fed on 8 farms during one year (grazing period and housing period). The health status was verified through the analysis of the trace element content of blood samples.

## Material and methods

The supply of dairy cattle with trace elements Zn, Se, Cu and Co during lactation and dry period and of young stock is calculated using NMI's 'Spoorwijzer' (Trace element guide), a software tool commissioned by the Dutch Dairy Board. The recommended levels of trace elements are based on the Dutch COMV (2005). The calculations are carried out for different groups: calves (0.5-1 year), young heifers (1-2 years),

dry cows, new-lactating, mid-lactating, and end-lactating cows. Ration compositions were provided by the participating farmers. The trace element content in silage (grass and maize) was analysed. The trace element composition of the compounds and mineral mixtures were provided by the suppliers.

On 5 dairy farms using tailor-made mineral mixtures, blood samples were analysed at the beginning and halfway of the grazing period and at the beginning and end of the housing period. On each sampling date per farm 12 blood samples (two samples per aforementioned group) were analysed giving in total 240 blood samples. The analyses were carried out by GD Animal Health. Per trace element a one-way Anova was conducted to compare the sampling dates and a post hoc Tukey HSD test was used to differentiate between the sampling dates.

The reduction of the surplus of trace elements per ha is evaluated. The output of trace elements through milk and meat is deducted from the cattle uptake (uptake year<sup>-1</sup> × stocking density). Trace element deposition and manure content are totalled into the supply per ha. The surplus is calculated as the supply minus the crop uptake per ha.

## Results and discussion

### *Zinc*

In all four projects the studies showed ample Zn supply, often more than twice the recommended level (ranging from 1.5 in lactating cows to 5 times in dry cows). Calculations on the supply showed that addition of Zn to mineral mixtures was not necessary, with the exception of an organic dairy farm growing their own concentrates. Dutch mineral mixtures often contain 1000-7,500 mg Zn kg<sup>-1</sup> dry matter (DM). It is highly desirable that producers decide not to add any or only small amounts of Zn to mineral mixtures (<500 mg kg<sup>-1</sup> dm).

### *Selenium*

Se (and Zn, Cu, Co) is normally added to compounds. Studies showed ample Se supply at the beginning of the experimental period, and where Se fertilisation was carried out and Se-containing mineral mixtures are fed, the combination was not necessary. On farms without Se fertilisation, supplementation with a small amount of Se-containing mineral mixture is necessary for animals not receiving compounds (young heifers, dry cows, end-of-lactation cows). The Se content of mineral mixtures was adapted to the group requirements.

### *Copper*

The Cu supply varied strongly between farms. On farms where animals were not fed mineral mixtures, a deficiency occurred with young stock, end-lactation cows and dry cows. Supplementation of dry cows and young stock with a Cu-containing mineral mixture is almost always necessary. Supplementation of cows at end of lactation is not necessary because of mobilisation of the body reserve which can be replenished when compounds are being fed.

### *Cobalt*

The Co supply varied strongly, from deficiency to an excess of 10 times recommended level. For young stock, end-lactation cows and dry cows not receiving compounds, supplementation with an appropriate Co-containing mineral mixture was necessary.

### *Health status*

The 8 dairy farms with tailor-made mineral mixtures were supervised by the farmers' veterinarian. Feeding tailor-made mineral mixtures did not lead to lower production, extra hoof disorders or mastitis. Table 1 shows the average blood levels of Zn, Se and Cu for the four sampling periods (Co in blood is an unreliable health status indicator). Table 2 shows the effect of feeding tailor made mineral mixtures on the surplus per ha.

Table 1. Average Zn and Cu ( $\mu\text{mol l}^{-1}$ ) and Se content (GSH-Px in  $\text{U g}^{-1}$  Hb) in blood and corresponding recommended levels of 5 dairy farms on 4 moments of measurement.<sup>1</sup>

Trace element	Recommended level	Grazing period		Housing period	
		May 2010	August 2010	November 2010	April 2011
Zinc	12-23	14.9 ab	14.3 a	15.2 ab	15.9 b
Copper	7.5-18	11.4 a	11.7 a	11.4 a	11.6 a
Selenium	120-600	387 b	307 a	293 a	311 a

<sup>1</sup> Per trace element, means with same letter are not significant different from each other at  $P=0.05$ .

Table 2. Calculated surplus of Zn, Cu, Se and Co ( $\text{g ha}^{-1} \text{year}^{-1}$ ) of 8 dairy farms in Drenthe without and with feeding tailor made mineral mixtures and calculated decrease (%).

Trace element	Without tailor made mineral mixture	With tailor made mineral mixture	Calculated decrease %
Zinc	511	247	52
Copper	245	177	28
Selenium	5.4	4.2	22
Cobalt	8.4	3.7	56

Feeding of mineral mixtures without Zn did not result in lower blood levels. At the start of the project 8 sampled animals had Zn levels below and 2 above the recommended level. At the end of the project only one animal was below the recommended level. The Cu blood content remained stable during the entire period. At the beginning three sampled animals were above and one animal below the recommended level. At the end all animals were within the recommended level. The Se-content in blood dropped during the grazing period; however, they were well within the recommended levels. During the housing period more compounds are fed, increasing the Se-content slightly compared to end of the grazing period.

Using tailor-made mineral mixtures without Zn reduced the surplus ( $\text{g ha}^{-1}$ ) by more than 50%. Adjusting the Cu, Se and Co to the requirements reduces the surplus by 28, 22 and 56% respectively. Five dairy farms used copper sulphate in the footbaths, which is not included in the results of Table 2. If included in the calculations the surplus increases two-fold.

On conventional dairy farms feeding according to recommended levels of mineral mixtures is about  $\text{€}500 \text{ year}^{-1}$  (80 cattle; cost mineral mixture  $\text{€}50$  per 100 kg). On dairy farms with a high supply of mineral mixtures the cost amounts to about  $\text{€}2000 \text{ year}^{-1}$ .

## Conclusions

The studies found that the optimization of trace element balances is positive and of importance for high-output dairy farming and eco-efficient farming.

## References

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