ASSESSING TRACE ELEMENTS STATUS IN CATTLE HERDS: IMPLEMENTATION AND BENEFITS

Pascal Lebreton (*), Lionel Reisdorffer (*), Charles-Eric Descotes (*), Karine Troadec (*)

(*) NBVC, F-69380 Lissieu, France, (oligo-elements@nbvconsultants.com)

Key words: cattle, population, risk factors, trace elements, nutrition, biochemistry

Introduction

There are many possible causes to performance losses among which nutritional disorders account for a major part. Mineral and vitamin deficiencies should be investigated and rectified before performance goes down. In hard economic times, saving on minerals and vitamins may lead to poor productivity and jeopardise health and growth, although deficiencies may not be clinically visible.

Material and methods

Nutritional biochemical investigations from animal samples enable to know the animal situations. This has been carried out on three trace elements, copper (Cu), zinc (Zn) and selenium (Se). Plasma Cu and plasma Zn have been measured by flame atomic absorption spectrophotometry whereas Se has been measured through erythrocytic glutation peroxidase (GSH-pxe) by the Paglia-Valentine standard method [Paglia et al., 1967] on Hitachi 717.

Biochemical analyses have been carried out by NBVC, F-69380 Lissieu, France, on the request by veterinary practitioners, either during disease circumstances, or as a routine check up in healthy herds. They are not representative of the average situation, healthy herds being underrepresented. However, Odds ratios enable to assess relationships between disease occurrences and nutritional statuses in various trace elements.

Nutritional statuses of cattle have been classified in the following five categories:

1. “Adequate” status when values enable normal homeostasis for this trace element;
2. “Marginal” status when the measured value is slightly below the reference value. Storage is being used. Consequences are non specific and include lower immunity.
3. “Sub-clinical” status is not only a shortage but also the inability to perform critical functions dependent on this trace element. Consequences are non specific on performances, in particular reproduction, productivity and growth.
4. “Clinical” status is worse. In that case essential functions related to this trace element are impossible and clinical consequences may be enough to diagnose the deficiency.

5. "Excessive" come either from higher supplies than need with possible deterrent effects or from particular conditions: infectious and inflammatory situations increase blood copper.

Relationships have been established between trace element statuses and diseases by Odds ratios from a database of 6776 cows from 1600 farms, based in France and Belgium (submitted paper). Diseases considered here include reproduction disorders, newborn morbidity, vaccination failures, respiratory diseases and delayed growth. Reproduction disorders have been detailed into fertility disorders, abortion and post partum troubles. Newborn morbidity includes stillbirth, infectious diseases (mostly enteritis), myopathy and immune failure.

Results

Table 1 shows the depths of deficiencies related with significant disease occurrence.

Table 1: Risk factors associated with trace-elements status

Cu Status	Level from which the risk of disorders is significant
Marginal	
Subclinical	Vaccination failure; Mortinatality; Enteritis; Insufficient growth
Clinical	Reproduction; Abortion

Zn Status	Level from which the risk of disorders is significant
Marginal	Reproduction; Myopathy; Insufficient growth
Subclinical	Abortion; Retained foetal membrane; Vaccination failure; Mortinatality; Enteritis
Clinical	

Se Status	Level from which the risk of disorders is significant
Marginal	Reproduction; Abortion; Retained foetal membrane; Vaccination failure; Mortinatality; Enteritis; Myopathy; Respiratory disorders; Insufficient growth
Subclinical	Metritis
Clinical	

Thus for example, reproduction disorders are significant from clinical Cu status, marginal Zn status and from marginal Se status. It means that fertility troubles will therefore worsen at lower levels like subclinical or clinical statuses of Zn and Se.

Discussion

Satisfying nutritional statuses will be achieved with proper feed supply and also by avoiding antagonistic factors causing secondary deficiencies. In most cases there is no reliable data addressing the trace element content in fodder. Furthermore the content can vary greatly with environment (soil, rock, and climate) and between years. French investigations carried out on fodder showed lacks of Cu, cobalt (Co) and Zn; iodine in some instances. Table 2 shows how diseases have already been related to deficiencies.

Table 2: Consequences of deficiencies in beef cattle [Underwood et al., 1999; Mc Dowel, 1992]

	Copper	Zinc	Selenium	Iodine
Reproduction	✓	✓	✓	✓
Abortion	✓ (early)	✓	✓	✓
Retained foetal membrane			✓	✓
Metritis	✓*	☞*	✓	✓*
Vaccination failure	✓*	☞*	✓*	✓*
Mortinatality	✓*	☞*	✓*	✓*
Enteritis	✓*	☞*	✓*	✓*
Myopathy			✓	
Respiratory disorders	✓*	☞*	✓*	✓*
Insufficient growth	✓	✓	✓	✓

✓ : Published

* : Possible or published indirect consequences of immune disorders

☞ : Relationships evidenced in other species

Impact of iodine deficiencies earlier described (See Table 2) has been similarly observed on fertility disorders, mortinatality, and late abortions during year 2004. However iodine assessments are more recent, therefore NBVC statistics are not yet significant. Plasma inorganic iodine (PII) has been measured, yielding the circulating mineral iodine concentration [Spicer *et al.*, 2001; Rogers, 1999; Aumont *et al.*, 1987].

To our knowledge, Co is not routinely investigated because vitamin B12 is a limited indicator. Manganese (Mn) deficiencies do not occur in France. Vitamin assessments are expensive. Liposoluble vitamins A, D_3 and E are the most relevant, although related risks can be reduced in the field. Indeed grazing may supply enough vitamins A and E from grass, and sun exposure may provide enough vitamin D. Hydrosoluble vitamins are not at risk in adult cattle under usual farming conditions.

Conclusion

Trace elements, especially zinc, copper, selenium and iodine, are early health indicators of the herd. They must be included among other risk factors. Good farm management of health and performances must anticipate; this is done by investigating and rectifying trace elements before disorders occur, i.e. before risk periods. Table 3 shows how to implement this methodology along the year.

Table 3: Example schedule for assessing trace elements in dairy cattle

	Assessing status	**Check up after corrections**
Calving disorders	Around 3 weeks before calving	At the time of drying off
Troubles in newborn calves (and dams)	Between 5 and 8 months of pregnancy	Before reproduction
Heifers	At the time of gathering for reproduction	By pregnancy confirmation
Youngsters (for fattening or for replacing cows)	At weaning	

Deficiencies are demonstrated by low levels of trace elements or low activities of enzymes or hormones requiring trace elements. Corrections accorded to the lacking elements and to the depth of deficiencies reduce risks. Corrections should take into account farm situations and the lag time to fix up statuses by nutritional supply. Eventually, herds should be followed up to meet expected performances.

References

1. *Aumont G, Tressol J.C. (1987): Rapid method for the direct determination of inorganic iodine in plasma using ion-exchange chromatography and the Sandell-Kolkoff reaction. Analyst. 112:875-878.*
2. *Paglia, D. E., and W. N. Valentine (1967): Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. J. Lab. Clin. Med. 70:158-169.*
3. *Mc Dowell L.R. (1992): Minerals in animal and human nutrition. Academic Press, San Diego (USA), 523 pages*
4. *Rogers PAM. (1999): Iodine supplementation of cattle. Beef production series 1999; 20: 3-34.*
5. *Spicer L.J., Alonso J., Chamberlain C. S. (2001): Effects of thyroid hormones on bovine granulosa and thecal cell function in vitro: dependence on insulin and gonadotropins. J. Dairy Sci., 84, 1069-1076.*
6. *Underwood E.J., Suttle N.F. (1999): The mineral nutrition of livestock. Cabi Publishing, London (UK), 614 pages*