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Diagnosis of mineral deficiencies in sheep and cattle

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ABSTRACT

Where mineral deficiencies have characteristic clinical signs (e.g.; milk fever or hypocalcaemia) or necropsy findings (e.g.; white muscle disease) diagnosis is comparatively easy. However, many mineral deficiencies are characterised by poor growth or production which are non-specific signs that can be caused by many factors. In these instances a systematic approach is required to determine if a mineral deficiency is likely to be involved.

This paper outlines such an approach which includes:

Description of the animal health problem including a comparison with target weights and production parameters.

Deduction of likely causes using clinical signs, soil, climate, plant and management clues.

Diagnosis using appropriate diagnostic tests. The best tests are animal response trials or analysis of animal tissue parameter levels which can be related to a production response. Choice and results of animal diagnostic tests must be considered in relation to what the sampled tissue represents (e.g.; mineral intake, storage site or where the element functions), and the limitations placed on the test by other factors (e.g.; effect of concurrent disease). The importance of sufficient sample numbers to reflect herd mineral status and selection of animals for sampling in a random manner is emphasised.

Interpretation of results and advice should be based on epidemiological knowledge of the mineral deficency and the economic benefits of mineral supplementation.

The use of animal diagnostic tests to predict some mineral deficiencies (preventive medicine), especially in areas of marginal deficiency, is briefly discussed.

Because of the complexity of some mineral deficiency problems a team approach involving farmer, agricultural adviser and veterinarian is recommended.

Keywords Diagnosis; animal mineral deficiencies

INTRODUCTION

Mineral deficiencies in sheep and cattle can cause considerable economic loss and the cost of treatment and preventive measures is often substantial. Therefore it is important to know if a deficiency is present or may occur on a farm.

Where a mineral deficiency has specific clinical signs (e.g., milk fever) or necropsy findings (e.g., white muscle disease) diagnosis presents few problems. However when a mineral deficiency is manifested by non specific signs such as poor growth or production, which can have many causes, a systematic approach is required (Clark, 1983a and b; Towers and Clark, 1983). Such an approach is outlined below.

Defining or Describing the Problem

This involves the gathering of information on factors that act as clues to recognising the cause of the problem. Such factors are clinical signs, production performance in relation to target figures, soil type, pasture growth, species, and mineral content, climatic considerations and management practices (e.g., fertiliser use, stocking rates, irrigation; Reuter, 1975). As with a detective solving a crime, the ability to solve a mineral problem depends on collection and interpretation of the correct information.

Defining the Likely Cause(s) of the Problem

This involves consideration of all possible causes of the problem e.g., nutrition, parasitism, infectious disease. Production problems are often multifactorial and it is only by correcting all factors that the problem can be resolved.

The possibility of a mineral deficiency being involved is deduced by consideration of clinical signs, soil, plant, climatic and management factors that suggest a specific mineral deficiency is likely. A knowledge of how these factors predispose to a specific mineral deficiency is necessary (Clark, 1983a and b; Cornforth, 1984).

Selection of Appropriate Test(s) to Diagnose Deficiency

This is the area in which there appears to be the most confusion. Which is the best test to use; soil, plant or animal? Previous workers have outlined the usefulness and limitations of soil and plant factors in determining an animal's mineral status (Cornforth, 1981; Cornforth, 1984; Fraser, 1984).

Even when animals have mineral intakes that apparently meet the estimated daily requirements for that class of stock (Grace, 1984), factors operating within the animal can affect the adequacy of the mineral intake. Some minerals reduce the availability of others e.g., the effect of sulphur and molybdenum on copper. Intestinal parasitism can damage the gut wall and adversely affect the animal's ability to absorb minerals. On the other hand some elements and metabolites (e.g., copper and vitamin B_{12}) are stored in the animal and can act as a reserve during a seasonal period of inadequate intake.

Therefore soil and plant mineral status can only act as a guide to the mineral status in the animal. The animal's mineral status is best determined by tests on the animal, which includes growth or production response trials and analytical tests on animal tissues.

Production Response Trial

A production response trial is the definitive diagnostic test and has an important role where mineral diagnostic tests have not been perfected or where tissue results are equivocal. Production trials suffer from the disadvantage that they take more time and effort to set up and there can be a considerable delay before results are known.

It is important that trials involve the group of animals most sensitive to the mineral deficiency and at the time of the year when deficiency is most likely to occur. Treated and untreated groups should be selected to ensure each group has an equal opportunity to respond e.g., in dairy cattle milk production trial groups must be balanced as to breed, age, calving date and production. This subject is well discussed by Towers *et al.* (1983).

Analytical Tests on Tissues

Selection of test

When selecting an animal tissue there are 2 major considerations:

(1) What does the mineral content in the tissue represent? Some tissue concentrations reflect current mineral intake, some the mineral reserves in the body and others, often an enzyme containing the mineral, the concentration at the site where the mineral acts i.e., functional site.

Thus to determine if poor growth or production is due to a mineral deficiency, it is necessary to select a sample that reflects the mineral concentration at the site where it functions (Suttle, 1976). These samples more accurately reflect the likelihood of a production response to supplementation. If the concern is to prevent a mineral deficiency (preventive medicine) then the mineral content of the storage site (reserves) is required.

Tissues reflecting current intakes yield the least useful data as it is generally not known how long the animals have been on such intakes and whether intakes are rising or falling, without multiple samplings over a period of time.

Some diagnostic tests do not clearly fall into the categories of reflecting intake, reserves or functional site. An example is serum vitamin B_{12} in sheep in which the amount of cobalt ingested plays the major role. However, when cobalt intake is low the amount of vitamin B_{12} in the liver (reserves) influences serum vitamin B_{12} levels.

Unfortunately not all minerals have animal tests that reflect intake, reserves or functional site. The development of these diagnostic tests and determining production-related reference ranges are an obvious research priority.

(2) The reliability of the results. This can influence the choice of tissue and interpretation of results. Concurrent diseases can affect some tests (e.g., facial eczema can raise serum vitamin B_{12} levels and therefore give a false indication of vitamin B_{12} status in sheep). Haemolysis can also affect the results, and should be minimised, for example, by keeping blood samples out of sunlight and decanting the serum as soon as possible.

Diagnostic tests

Current diagnostic tests and reference ranges for mineral deficiencies are detailed by Grace (1983). An exception is the salivary sodium test, which requires further evaluation and is not routinely offered by MAF Animal Health Laboratories.

Sample numbers

There are probably minor differences between animals in requirements for minerals. This biological variation plus variation in intake due to selective grazing and soil ingestion results in variation in tissue concentrations of the element. The adviser and farmer are generally interested in the mineral status of the herd, not the individual animal. Testing all animals provides the most accurate estimate of the herd mineral status but is extremely costly in time and resources. Fortunately the number of animals required to be sampled to provide a mean close to the true herd mean can be calculated (Pringle, 1982). Where only small variation exists in tissue mineral levels within a herd e.g., selenium, only 3 samples are required, whereas when larger variation exists e.g., serum vitamin B_{12} in sheep, 10 samples are required. Naturally, the samples should be selected from the group (e.g., age group) of animals suspected of being deficient. However, within this group of animals, samples should be selected at random because reference ranges are based on random sampling.

Interpretation of results

Given the appropriate tissue and sample numbers, the mean result is compared with reference ranges derived from production response trials.

The likelihood of animal response is predicted from these ranges, animal status being classified as responsive to treatment, marginal or adequate. In the responsive range, response to supplementation is likely; in the adequate range a response is not likely; and in the marginal range a response may or may not occur. This is rather imprecise and it would be more meaningful if reference ranges were related more closely to the probability of a response occurring and the likely amount of response— a subject discussed by Wright *et al.* (1984).

Reference values should be provided or verified by the laboratory doing the test because its staff are best qualified to compare the analytical methods with those in the literature. Changes in analytical methodology can cause changes in the absolute result and the reference ranges. Information on reference ranges for a number of mineral deficiencies is lacking because many tests have only recently been developed. Thus production response trials need to be repeated using these new tests to establish the relationship between the analytical result and the likelihood of a production response.

Formulation of advice

The final step is the formulation of advice given to the farmer. This requires knowledge of epidemiological factors influencing the deficiency. For instance, if a mineral deficiency is known to become more severe during a certain period, animals with a result in the low end of the 'adequate' range at the start of this period may later become deficient, indicating need for a further test in 1 or 2 months time. Treatment by the most cost effective method should be recommended. This requires knowledge of the economic loss produced by the deficiency and the cost and effectiveness of the treatment or control measures.

Preventive Medicine

This applies mostly to marginal areas, in which deficiency may or may not occur every year, or as a check on control measures. The rationale is that some deficiencies (e.g., cobalt) have a seasonal occurrence and animal samples taken early in the period may allow prediction of whether or not a deficiency will occur. If necessary, preventive measures can then be introduced to minimise production loss.

Role of Plant Mineral Analysis

Following diagnosis with animal tests, plant analysis has an important role in explaining the cause of some deficiencies (e.g., whether copper deficiency is the result simply of low copper intake or is induced by high molybdenum, sulphur or iron levels). Plant analysis can also be used to determine treatment or control measures or to monitor the effectiveness of top-dressing fertilisers containing mineral additives.

CONCLUSION

The diagnosis of a mineral deficiency depends on describing the problem, deducing the likely cause(s) and confirming the diagnosis with the most appropriate test or tests. In general this involves animal tissue analysis or production response trials.

Problems in which mineral deficiencies may be involved are often compounded and confused with associated problems of management and other diseases. Therefore success is most likely when farm adviser and veterinarian work together with the farmer.

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