

Trace element status on sheep–beef farms in the Raglan–Franklin districts

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Abstract

During spring 1995, pastoral farms in the Raglan–Franklin districts were surveyed to establish their trace element status. The major soil groups of the area were identified and a geographically representative sample of farms within these soil groups sampled for soil and pasture trace element concentrations. In total, 82 sites on 40 farms were sampled. In addition, liver samples from 80 lambs on 20 of these properties were analysed for trace elements during summer of 1995/96. Soil samples were analysed for Mn, Cu and Co; pastures were analysed for Mn, Fe, Zn, Cu, B, Mo, Co, Se and I. Lamb livers were analysed for Cu, Se and vitamin B₁₂. Survey findings indicated that the Co concentrations in soils, pastures and vitamin B₁₂ in lamb livers throughout much of the district were marginal, particularly in the southern area. The two soil groups most at risk were the yellow-brown loams and yellow-brown earths. Farmers are advised to closely monitor their Co status during late spring and to consider their grazing management strategies. Generally, the status of other trace elements was satisfactory.

Keywords: lambs, liver vitamin B₁₂, pasture cobalt, soil cobalt, soil contamination, soil group, titanium, trace elements

Introduction

An adequate and balanced trace element status in soils and pastures is essential for maintaining pasture production and animal health in New Zealand. Where a trace element deficiency has been identified on farms and corrective steps taken to remedy the deficiency using drenches, injections, licks or fertiliser, spectacular responses have occurred in the grazing ruminant. Cobalt deficiency, variously described as “Mairoa dopiness” in the King Country (Wright & Taylor 1931), “bush-sickness” in Nelson (Askew & Dixon 1936) and “Morton Mains disease” in Southland (Dixon 1936) were classic examples.

Conducting a survey can be an effective method of obtaining bench-mark data about the status of soil

fertility and animal health. This method has been employed in other areas of the central North Island for identifying the cobalt status of soils and pastures. Cobalt surveys were carried out in the Central Plateau–Bay of Plenty during 1978–80 (Sherrell *et al.* 1980) and again in 1991 (Hawke *et al.* 1994) and in the King Country (Hawke *et al.* 1994).

This survey of Raglan–Franklin districts was commissioned to determine the trace element status of soil, pasture and animals (lambs) on sheep–beef farms over a range of major soil groups in these districts. The only previous information was from a detailed cobalt study on one farm in the south Raglan area (Chapman 1983).

Methods

Soil type has been identified as an important factor influencing the occurrence of some trace element deficiencies in grazing animals (Fraser 1984). The major soil groups of the area were identified (Bruce 1978) and the relative importance of each ranked. Sheep and beef farmers were contacted with the aim of obtaining a proportionate distribution of soil groups throughout the districts.

The survey was conducted over 40 farms in the Raglan–Franklin districts during September and October 1995. The area covered was from the north-side of Kawhia Harbour to the south-side of Waikato Heads. Field samples were collected from more than one soil group on most farms owing to variability in topography and soil groups; in total, 82 sites were sampled. The soil groups and number of each sampled were: brown granular loam (BGL) 14; brown loam (BL) 5; recent 7; yellow-brown earth (YBE) 27, yellow-brown loam (YBL) 25 and yellow-brown sand (YBS) 4.

Soil and pasture samples were collected along transects at each site. Soil samples (0–7.5 cm) were analysed for Mn, Cu and Co using EDTA–extractable methods described by Forbes (1976). Pasture samples were washed in clean water and analysed for Mn, Fe, Zn, Cu, B, Mo, Co, Se, and I. All pasture samples were analysed for titanium (Ti) to check on soil contamination, as Ti is not absorbed by the plant (M. Sutton, pers. comm.). Soil and pasture analyses were conducted by the Soil Fertility Service, Ruakura.

Twenty farmers sent lambs to the meatworks from which four random liver samples were forwarded to the Ruakura Animal Health Laboratory for trace element analysis. Copper was determined in 4 livers and Se and vitamin B₁₂ were determined in 3 livers from each farm.

Soil and pasture data were statistically analysed using ANOVA. The data were log transformed for statistical analysis with back-transformed means (for soils) or medians (for pastures) reported in tables. The animal data was not analysed.

Results

Soils (Table 1)

Soil Mn concentrations were widely distributed, with 20% of sites above 500 mg/kg. Cu levels were significantly lower on YBE soils than all other soil groups except the YBL. EDTA-extractable Co was below an adequate concentration of 1 mg/kg air dry soil on 52%, 48% and 36% of the YBE, YBL and BGL sites respectively.

Pasture (Table 2)

Pasture Fe concentrations were high, even after washing the herbage, which indicated possible soil contamination. Soil contamination was later confirmed when analyses for Ti showed a highly significant correlation with Fe.

A wide range of values was found for the various elements with the exception of Cu. Generally, there were no significant differences in trace element concentrations between soil groups. However, Se

concentrations on recent soils were significantly lower than on the other soil groups. Pasture Se concentrations of 0.03 mg/kg DM (the minimum level) were found on 12% of sites. The YBL and YBE soils had median pasture Co concentrations of 0.08 mg/kg DM (the minimum level for sheep). This value was computed after adjustment for Ti concentration to allow for soil contamination.

Generally, pasture concentrations for Mn, Zn, B, Mo and I were adequate. However, 21% of sites had Mo concentrations above 1.5 mg/kg and 5% of sites had I concentrations below 0.25 mg/kg (the minimum level for sheep). Pasture Zn concentrations on BL soils were significantly lower than for other soil groups.

Table 1 Mean Mn, Cu and Co content of soils (mg/kg EDTA-extractable air dry).

	Mn	Cu	Co
Mean	303	3.9	1.7
Range	19–1680	1.0–9.9	0.2–7.7
<i>Soil Group</i>			
BGL	217	3.8	1.4
BL	295	4.2	1.7
Recent	458	5.0	3.3
YBS	367	5.6	1.8
YBE	116	2.2	0.9
YBL	168	3.7	1.0
	ns	***	ns
LSR (5%) ¹	1.63	1.29	1.40

¹ LSR = Least significant ratio between YBE and YBL soils

Table 2 The median Mn, Fe, Zn, Cu, B, Mo, Co, Se and I pasture concentrations (mg/kg DM).¹

	Mn	Fe	Zn	Cu	B	Mo	Co	Se	I
Minimum ²	25	30	25	5	NK ³	0.05	0.08	0.03	0.25 ⁴
<i>Soil Group</i>									
BGL	138	209	32	10.3	9	0.85	0.09	0.05	0.40
BL	190	217	26	9.8	8	0.72	0.11	0.05	0.51
Recent	225	200	37	10.1	9	1.22	0.14	0.03	0.42
YBS	178	313	36	9.6	8	0.76	0.14	0.06	0.55
YBE	160	222	38	10.5	9	1.01	0.08	0.06	0.41
YBL	178	231	36	10.2	8	0.91	0.08	0.06	0.57
	ns	*	*	ns	ns	ns	*	*	ns
LSD (5%)	70			1.8	2				
LSR (5%) ⁵		1.30	1.19			2.72	1.54	1.27	1.81

¹ Adjusted for soil contamination using titanium concentration of 20 mg/kg DM.

² Minimum = minimum dietary requirements for sheep (MAF, 1988)

³ NK = not known

⁴ Minimum = minimum dietary iodine requirement for sheep (Grace, 1994)

⁵ LSR = least significant ratio between YBE and YBL soils

Animal – lamb livers (Table 3)

Although the Cu and Se concentrations were adequate, 22% and 5% of vitamin B₁₂ samples were in the marginal (< 375 nmol/kg) and low (< 280 nmol/kg) ranges respectively (MAF 1988). Only 8% of the farmers gave their lambs vitamin B₁₂ injections.

Table 3 Trace element status of lamb livers (% of total sampled).

	Copper	Selenium	Vitamin B ₁₂
Low	1	0	27
Adequate ¹	94	100	70
High	5	0	3

¹ Adequate range is 95-3000 µmol/kg for Cu; 450–10 000 nmol/kg for Se; 375-1000 nmol/kg for vitamin B₁₂ (MAF 1988).

Discussion

Iron and titanium

Survey results showed that pasture Fe concentrations were very high (104-3674 mg/kg DM). Similar concentrations (1 I I-3850 mg/kg) had been found (but on unwashed pasture) between May and August during studies at Ruakura (Campbell *et al.* 1974). Because seasonal variation studies have shown elevated Fe levels in late winter-early spring (Metson *et al.* 1979; Grace & Clark 1991), it was important to determine whether the high Fe concentrations were peculiar to this district with an iron-sand coastline or due, despite washing, to soil contamination. There are also stock health implications, for example, high Fe intakes in diets can reduce the absorption of Cu in sheep and cattle (Grace 1994). The Ti analyses clearly confirmed that pasture samples were contaminated with soil. Because soil usually contains higher concentrations than pasture there is an enrichment factor associated with soil contamination. Healy *et al.* (1973) found that pasture (especially clover) concentrations of Co, Se and I to be greatly enriched by soil contamination.

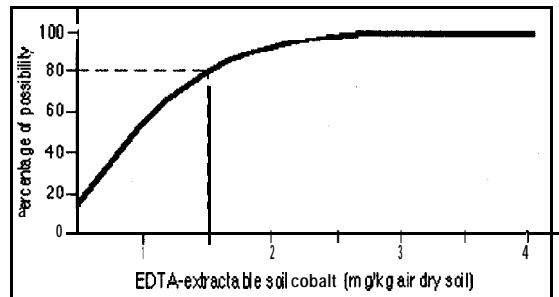
Copper

Results showed that both soil and pasture Cu concentrations were adequate. Copper was topdressed on 5% of farms while 40% of farmers treated their stock with some form of Cu supplement (through injections or bolus applications). Overall, the Cu status of the district appears to be adequate; however, caution would be required on some farms as high pasture Mo concentrations in the presence of sulphur can decrease Cu absorption (Cornforth 1980).

Cobalt

Survey results indicate that Co is the trace element that deserves the most attention in this district. The critical concentration of Co in pasture for sheep dietary requirements is 0.08 mg/kg DM (Clark & Millar 1983). Findings from previous Co surveys have found plant Co to be positively correlated to EDTA-extractable soil Co (Hawke *et al.* 1994). Recent data from 560 sheep-beef farms throughout NZ showed that for an 80% probability of achieving 0.08 mg/kg Co in pasture, the EDTA-extractable Co concentration required was between 0.75 and 1.7 mg/kg, depending on the soil group (O'Connor *et al.* 1997). In the present survey, analyses suggest that for an 80% probability of pasture achieving a Co concentration of 0.08 mg/kg DM, EDTA-extractable soil Co needs to be at least 1.5 mg/kg air dried soil (Figure 1). This concentration is necessary where the soil Mn was 190 mg/kg (the mean). Higher soil Mn levels would require higher soil Co status (Adams *et al.* 1969).

Figure 1 Percentage probability that pasture Co exceeds 0.08 mg/kg DM for a given soil Co value and a soil Mn value of 190 mg/kg.



Cobalt problems are most likely to be experienced on the YBL and YBE soils particularly in the southern area of the district. The YBL soils are derived from Mairoa ash which was classified as severely Co deficient (Andrews 1971). Also, Chapman (1983) reported Co as deficient in a YBL soil in the south Raglan area. However, BL soils in this area have higher Co levels than YBL soils as found by Chapman (1983) and this survey (Table 1). A management strategy for alleviating Co shortages during the critical spring and summer months suggested by Chapman (1983) could be to rotate grazing stock between YBL and BL areas where the two soil groups occur on the same property. Other proven methods of control include applying Co in the fertiliser (long term) or using vitamin B₁₂ injections (short term).

Pasture Co studies on seasonal variation have indicated lower values going into the summer period

(Grace & Clark 1991), while plant species and stage of growth (Mitchell 1945; Andrews 1971) can also contribute to yearly fluctuations. This survey highlights the difficulty of determining the "true" Co content of pasture during early spring. The unadjusted median concentrations for the YBL and YBE soils were 0.12 and 0.23 mg/kg DM respectively, compared with medians of 0.08 mg/kg DM adjusted for soil contamination. Soil contamination of pasture is recognised as a source of Co to grazing stock and can occur as a result of animal treading or soil splash on short pasture during heavy rain. Pasture height becomes a crucial factor in determining Co concentrations: the shorter the pasture the more likely it is to have soil contamination. Andrews *et al.* (1958) induced Co deficiency in weaned lambs at low grazing intensity on marginally deficient pasture compared with heavy grazing intensity. Pasture samples for Co should also include Fe to indicate possible soil contamination. Pasture Fe concentrations above 250 mg/kg are considered to be contaminated by soil (G. Renshaw, pers. comm.) The most conclusive test for farmers to undertake on lambs is vitamin B₁₂ analysis on serum and/or liver samples.

Topdressing pasture with Co is the most effective long-term strategy for raising pasture Co. However, relatively few farmers in this survey applied Co fertiliser, some 15% and 13% of farms receiving regular and occasional topdressings respectively. The EDTA-extractable Co soil test could be used to determine the quantity of Co fertiliser required to raise soil Co reserves to the required level (O'Connor *et al.* 1997).

Selenium

The Se concentrations of lamb livers were all in the adequate range. However, Se pasture concentrations on recent soils (river flats) were at the minimum dietary Se requirement for sheep. As the recent soils comprise such a small area on farms in the district, rotating livestock between river flats and rolling paddocks would normally overcome any potential Se problems.

Summary

Survey findings indicated that the Co status throughout much of the district was marginal, particularly in the southern area. This was shown in soil, pasture and lamb liver samples. The two soil groups most at risk were the yellow-brown loams (ash soils) and yellow-brown earths (mudstone, sandstone soils). Farmers on suspect soils are advised to monitor their Co status in late spring to identify whether Co supplementation of animals is necessary. Iron analyses should be included to determine likely soil contamination. A further management practice

of some farmers would be to ensure that livestock, particularly the young, are grazed alternately between soil groups with high/low Co status.

Generally, the status of the other trace elements analysed was satisfactory. The high Fe status of the district should be recognised.

ACKNOWLEDGEMENTS

The authors wish to thank the following for their assistance: the participating farmers for their co-operation; the veterinarians at the Raglan, Northern Waikato and Franklin practices; Richard Chapman, University of Waikato; John Waller for statistical analysis and Tom Gee for field assistance. BOP Fertiliser Ltd and the C Alma Baker Trust for funding the survey.

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