Proceedings of the New Zealand Grassland Association 50: 109-l 15 (1989)

COBALT DEFICIENCY IN THE KAIWERA DISTRICT, EASTERN SOUTHLAND

C.G. Sherrell[1], P.D. McIntosh* and P. Brunsden[3]
[1]MAFTech, Ruakura Agricultural Centre, Hamilton
[2]Division of Land and Soil Sciences, DSIR, Dunedin
[3]MAFQual, Gore

Abstract

Soils and pastures were sampled at 96 sites in the Kaiwera district, a" area having 12 soil types typical of eastern Southland and South Otago. Analyses indicated that W-thrift" in lambs could be due to low cobalt (Co) intake. Upland (>300 m a.s.l.) topsoils had lower EDTA-extractable Co than lowland topsoils and analysis of soil profile samples indicated that Co had been leached from upper horizons of upland soils. Upland pastures contained much less Co than lowland pastures and Co concentration was much lower in February than in October. Sheep grazing on upland pasture had very low vitamin B_{12} status from October to June and this coincided with low pasture Co concentration Sheep grazing on lowland pasture had adequate vitamin B_{12}, although pasture Co concentration fell to below 0.06 mg/kg for a short period in summer. We conclude that sheep grazed on upland pastures for long periods need supplementary Co or vitamin B_{12} or need to be rotationally grazed on lowland pasture to build up adequate reserves of vitamin B_{12}.

Keywords: ill-thrift, sheep, vitamin B_{12}, pasture cobalt, seasonal variation

INTRODUCTION

Traditionally, stock in eastern Southland and South Otago have suffered from an "ill-thrift" problem. Lambs fail to gain weight and fatten despite adequate available pasture. A mineral deficiency has been suspected and some improvement in health of sheep has been noted after cobalt (Co) dosing or vitamin B_{12} injection, but there has been no clear explanation of why the problem occurs intermittently and not on all farms.

In this paper we report an investigation of soils and pastures of a typical area of the eastern Southland-South Otago region and describe a major difference in available Co between upland and lowland soils and in Co concentration between upland and lowland pastures. We show how this difference affects the vitamin B_{12} status of grazing sheep.

METHODS

Soil and pasture survey

Soil and pasture samples were collected in October 1984 from 96 sites within the area shown in Fig. 1. There were 8 sites on each of 12 soil types which are of agricultural importance in the district. Four of the soils classified as upland yellow-brown earths occur above 300 m altitude (average of sampled sites was 41 Om). The other 8 soils, classified as lowland yellow-brown earths and a recent soil, occur below 300 m altitude (average of sampled sites was 200 m). Pastures were resampled at the same sites in February 1985.

Topsoils (O-l 5 cm) were analysed by MAF Quick Tests (Cornforth 1982a) and EDT&extractable Co was determined by the method of Forbes (1976). Pasture

samples were analysed for the complete range of major and minor nutrient elements (Cornforth 1982b) and Co (Poole 1980).

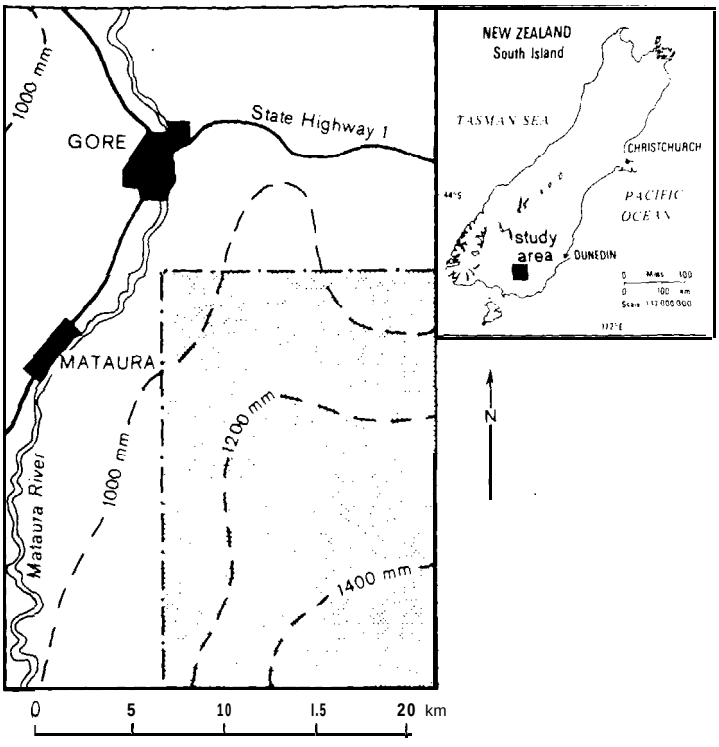

Figure 1: Location of the study area.

Animal grazing trials

Two trials began in August 1985 when 12 pregnant Romney ewes were set stocked on enclosed areas at an upland (375 mm a.s.l.) and a lowland site (195 m a.s.l.). Lambs were born in September 1985 and were kept on the sites till September 1986. Ewes were retained on the upland site but removed from the lowland site after weaning (January).

Blood samples were taken monthly by jugular puncture and collection in evacuated tubes, Liver samples were taken from lowland ewes when they were slaughtered in January 1986, from 3 lowland lambs slaughtered in March 1986, from 2 ewes and 2 lambs on the upland site slaughtered in February 1986, and from all animals remaining in the trial in September 1986. Serum and liver vitamin B_{12} were determined by a radioassay method (Millar et al. 1984).

Duplicate pasture samples were collected from the animal trial sites at the same time as blood samples were obtained. In addition, pasture samples were collected from neighbouring sites on different soils (pasture monitoring sites). These were analysed to determine if the trial sites were typical upland and lowland pastures with regard to Co concentration.

RESULTS

Soil and pasture survey

Soil Quick Test values were similar for all soils with satisfactory pH and medium fertility for pasture growth. Extractable soil Co was closely related to altitude. The upland soils had only about one-third of the available Co of lowland soils (Fig. 2). The difference between upland and lowland soils is attributed to leaching of Co from the upper horizons of the more acid upland soils (McIntosh *et* al. 1986).

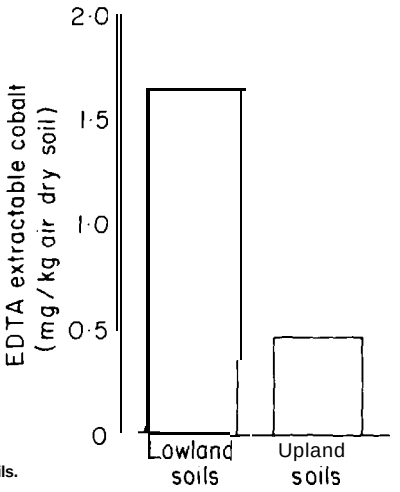

Figure 2: EOTA-extractable Co in upland and lowland soils.

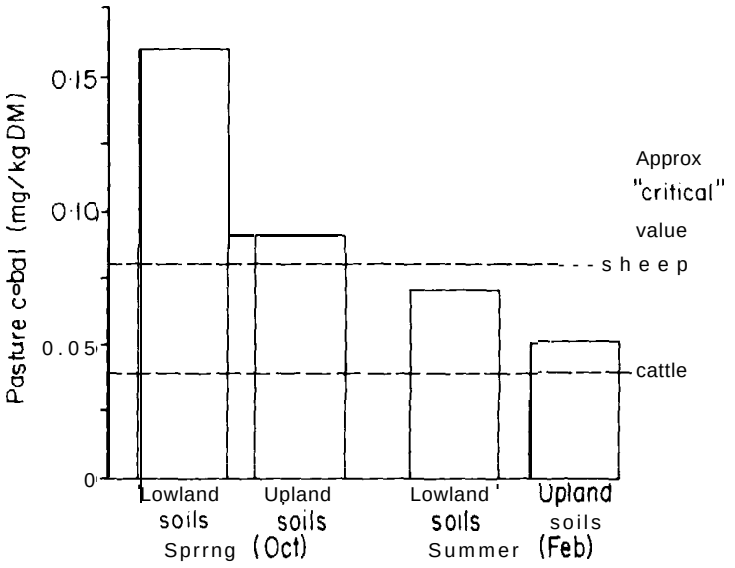

Figure 3: Pasture Co concentration in spring and summer.

Pasture Co concentration showed the same pattern as extractable Co in soils. In October, upland pastures had only half the Co concentration of lowland pastures (Fig. 3) and some of the upland pastures were marginal or below the Co requirement for sheep (0.08 mg/kg, Agricultural Research Council 1980). In February, Co values in all samples were much lower than in October and 91% of upland pastures and 61% of lowland pastures were below 0.06 mg/kg.

Other trace elements and major elements were similar in all pasture samples and were adequate for optimum pasture growth and animal requirements (Sherrell & McIntosh 1987).

Grazing trial

Pasture cobalt concentration Pasture Co concentration at the upland animal trial site was adequate for sheep when the trial began but fell quickly to below 0.08 mg/kg and remained at approximately 0.05 mg/kg from October to April (Fig. 4a). Values increased slightly in May and June and were adequate from July to September. Similar changes occurred in pasture Co concentration at the upland monitoring site (Fig. 4b).

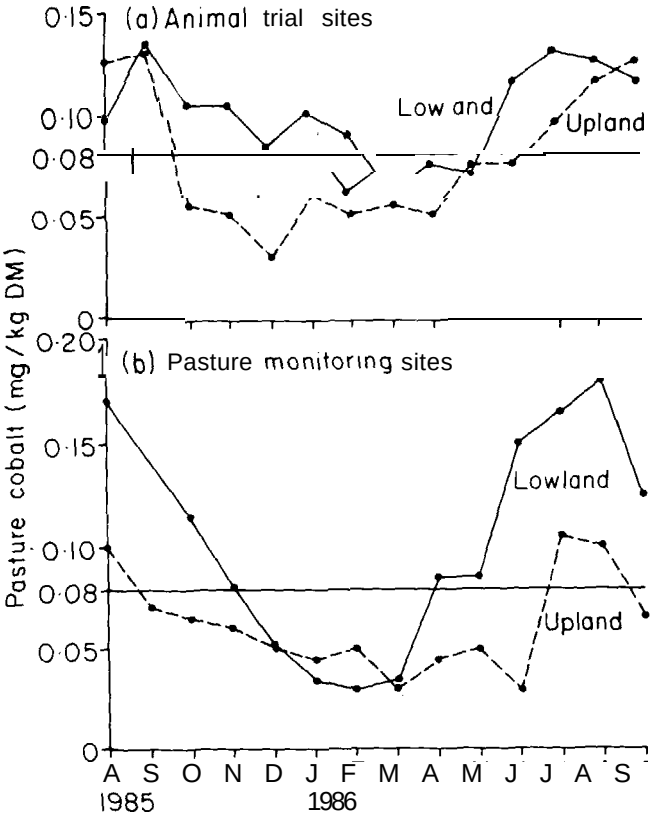

Figure 4: Pasture Co concentration in upland and lowland Pastures (a) animal trial site, (b) Pasture monitoring sites.

Pasture Co concentration at the lowland animal trial site also decreased from adequate values in spring and early summer but did not drop below 0.08 mg/kg until March (Fig. 4a). Values remained slightly below 0.08 mg/kg till May and then increased to 0.1 1 ▪ 0.13 mg/kg for the remainder of the trial. Pasture on the lowland monitoring site was below 0.08 mg/kg from December to March (Fig. 4b).

Vitamin B_{12} in sheep Ewes on upland pasture had satifactory serum vitamin B_{12} status at the start of the trial (Fig. 5) but by October values had decreased to just above the marginal range (370 p mol/litre, Clark8 Millar 1983). Serum vitamin B_{12} of ewes and lambs remained marginal or in the deficient range from November to July and increased again in August and September to adequate values.

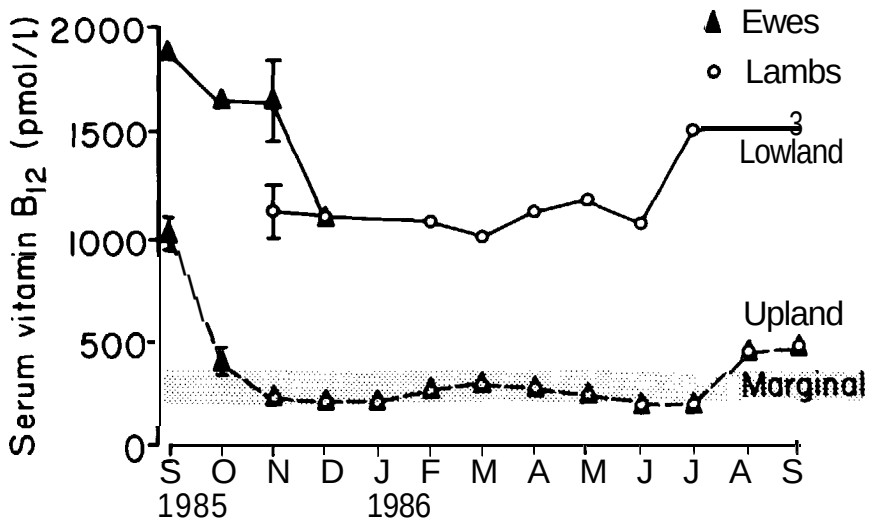

Figure 5: Serum vitamin B_{12} concentration of sheep grazing upland and lowland pasture.

Serum vitamin B_{12} in lowland sheep showed a similar seasonal pattern to that in upland sheep but values were much higher and well into the adequate range throughout the trial (Fig. 5).

The low vitamin B_{12} status of upland sheep was confirmed by liver analysis (Table 1). Upland sheep were deficient (<1 10 n mol/kg in February) and although values had increased by September, they were still not adequate. Lowland sheep had adequate liver vitamin B_{12} (>220 n mol/kg, Clark & Millar 1983) throughout the trial.

Table 1: Vitamin B_{12} concentration in liver of upland and lowland sheep (*n* mol/kg fresh tissue)

	Jan	Feb	Mar	Sept 1966
Upland		80(5.6)[1]		169(14)
Lowland	313(58)		250(32)	501(65)

[1] **SEM**

DISCUSSION

The results of the soil and pasture survey strongly suggest that lamb ill-thrift in the district is related to an inadequate Co intake, which in turn is related to soil type.

In the grazing trials, the patterns of changes in serum vitamin B_{12} closely followed pasture Co concentration. The patterns were identical on the upland site and they were very similar on the lowland site except that serum vitamin B_{12} did not decrease in the period March-May when pasture Co fell to below 0.08 mg/kg. The lowland sheep had adequate reserves of liver vitamin B_{12} and these were probably utilised to maintain serum vitamin B_{12} during the short period of low Co intake (Marston 1970). The upland sheep had inadequate liver reserves and serum vitamin B_{12} fell rapidly when pasture became low in Co.

Vitamin B_{12} in serum and liver can both be used to diagnose Co deficiency in sheep. Millar et al. (1987) reported that a worthwhile response to Co treatment would occur if serum vitamin B_{12} was less than 336 p mol/litre or liver vitamin B_{12} was less than 282 n mol/kg. In the current trial upland sheep had far lower values than these and were clearly Co deficient.

Applicability of results

Soils formed from similar parent material to those in this study cover about 310,000 ha in eastern Southland and South Otago (N.Z. Soil Bureau 1968), and about 65,000 ha in the Hokonui Hills. The distribution of Co deficiency in these districts is likely to follow the deficiency pattern found here, i.e. deficiency will be most severe on pastures on strongly leached soils, particularly those above 300 m altitude and the degree of deficiency on both upland and lowland pastures will depend on soil type.

CONCLUSIONS

(1) The Co intake by sheep on upland pastures of the Kaiwera district is inadequate to replenish liver reserves of vitamin B_{12}. Lambs grazed for long periods on upland pastures should be supplemented with Co or vitamin B_{12} to ensure satisfactory liveweight gain. Alternatively, lambs could be grazed on lowland pastures for a period immediately after weaning to build up vitamin B_{12} reserves.

(2) The sporadic nature of Co deficiency in the district is related to the seasonal variation in pasture Co and the differences between upland and lowland pastures. Annual variation in Co availability may also be important. The occurrence of Co deficiency will depend on the soil type on which sheep are grazing and the length of time they graze pastures of inadequate Co content.

(3) The soil pattern of much of eastern Southland/South Otago and the Hokonui Hills is similar to that of the Kaiwera district so these results may have implication for an area totalling 375,000 ha. Co deficiency is likely to occur mostly on strongly leached soils, particularly those above 300 m altitude.

Acknowledgements

We are grateful to B 8 T Story and G. Sharp for their willing co-operation in the grazing trials; J. Gill and staff of Invermay Animal Health Laboratory for vitamin B_{12} determinations; Plant and Analytical Chemistry Group. Ruakura for soil quick tests and plant analyses.

REFERENCES

Agricultural Research Council. 1980. The nutrient requirements of ruminant livestock Farnham Royal: Commonwealth Agricultural Bureaux.

Clark, R.G.; Millar, K.R. 1983. Cobalt. pp 27-37, In Grace, N.D. (Ed) The mineral requirements of grazing ruminants *N.Z. Society of Animal Production occasional publication No. 9*

Cornforth, I.S. 1982a. Soil analysis interpretation. *AgLink 556.* Wellington: Ministry of Agriculture and Fisheries.

Cornforth, I.S. 1982b. Plant analysis methods and interpretation. *AgLink* 557. Wellington: Ministry of Agriculture and Fisheries.

Forbes, E.A. 1976. Cobalt, copper and zinc in yellow-brown pumice soils under grazed permanent pastures. N.Z *journal* of agricultural *research 19:* 153-64.

Marston, H.R. 1970. the requirement of sheep for cobalt or for vitamin B_{12}. *British journal of nutrition 2:* 615-33.

McIntosh. P.D., Sherrell, C.G., Prema PG. 1986. Distribution of cobalt, copper and zinc in upland and lowland soils of the Kaiwera District, Eastern Southland, New Zealand. N Z. *Soil Bureau scientific report 78*

Millar, K i?; Albyt, A.T.; Bond, G.C 1984. Measurement of vitamin B_{12} in the livers and sera of sheep and cattle and an investigation of factors influencing serum vitamin B_{12} levels in sheep. N.Z. *veterinary journal 32*: 65-70.

Miller, K.R.; Wright, D F.. Clark. R G 1987. Relationship between liveweight response and diagnostic parameters in young cobalt-deficient sheep. *Proceedmgs of* the 4th AAAP *Animal Science* Congress p. 431.

New Zealand Soil Bureau, 1968. Soils of South Island, New Zealand *N.Z Soil Bureau Bulletin 27.*

Poole, P R. 1980 Graphite furnace atomic absorption spectroscopic determination of cobalt and copper in herbage. *Proceedmgs of New Zealand Institute of Chemistry Conference, August* 1980, *Palmerston North*

Sherrell. CG.. McIntosh PD. 1987 Nutrient status of soils and pastures in the Kaiwera district, eastern Southland. New Zealand. *N.Z journal of agricultural research 30:* 261-68.