NORTHLAND NATURALLY
FIRST REGION OF NEW ZEALAND

# Northland Pastoral Extension Research Stocktake

# Animal Health – Mineral Responses in Northland

## Summary Comments

Northland has had an exhaustive history of trace element research. The Agricultural Research Division of the Ministry of Agriculture and Fisheries ran almost 200 trials looking to establish trace element responses. Despite trial sites having low soil, plant or blood levels of some trace elements, there have been remarkably few trace element responses to supplementation.

Copper supplementation is proven to reduce the incidence of post parturient haemoglobinuria (PPH), a condition seen in dairy cows shortly after calving. Despite the dramatic symptoms of PPH, cows still showed a relatively small milk production response to copper supplementation. This condition is relatively uncommon today.

The immense efforts of scientists and technicians should reassure Northland farmers that trace element deficiencies are unlikely to be limiting livestock performance on their farms.

# Contents

# 1.0 An Assessment of the Copper Status of Dairy Herds in the Waikato, Taranaki and Northland in Spring and the Effects of Daily Supplementation with Copper Sulphate

Author: HF Dewes, MD Lowe, and CE McKay
NZ Veterinary Journal 38 (1990), 98-101

## Overview

Pasture, blood and liver results from a number of herds were analysed to determine copper status. Some herds were supplemented with copper sulphate. Northland herds had the lowest blood copper levels. Herds supplemented with copper sulphate had higher blood copper levels than herds not supplemented

## Method

This project reviewed the copper status of 327 dairy herds based on serum copper levels, liver biopsy and pasture analysis. The herds were located across the North Island:

- 214 Waikato herds.
- 82 Taranaki herds.
- 31 Northland herds

Herds were categorised into two groups:

- As Received – for this group the history of copper supplementation in the preceding 6 months was not known.

- Supplemented – this group received between 2 – 6 g/head/day of copper sulphate for at least 2 months before collection.

Each herd was analysed for copper, looking at serum copper, liver biopsy and pasture analysis with samples collected between the 1$^{st}$ August and the 30$^{th}$ September over a period of years.

## Results – pasture analysis

Table 1: Results of pasture analysis

| Area | Herds | Copper (µmol/kg) | Sulphur (mmol/kg) | Molybdenum (µmol/kg) | DACu[1] (µmol/kg) |
|---|---|---|---|---|---|
| Taranaki | 56 | 173±19 | 93±1 | 15±8 | 3.1±1.6 |
| Northland | 10 | 134±24 | 80±1 | 24±19 | 3.3±1.6 |
| Waitako | | | | | |
| Organic | 94 | 141±26 | 89±2 | 31±23 | 1.9±1.3 |
| Mineral | 107 | 141±29 | 89±1 | 9±6 | 4.4±1.7 |
| Alluvial | 111 | 143±29 | 89±2 | 11±10 | 3.1±1.3 |

[1] *DACu, Dietary Availability of copper based on Suttle & MaLachlan formula*

## Comments – pasture results

- Similar results between years.
- Northland pasture had the lowest copper levels, although the difference between them and Waikato pastures was probably not statistically significant.
- Sulphur levels were similar across soil types.
- Molybdenum levels were highly variable across soil types.
- Much of the variation in dietary availability of copper (DACu) is due to molybdenum:
  - Higher molybdenum levels in Waikato organic soils reduce copper availability
  - Availability of copper in Northland appeared to be relatively good

## Results - serum copper analysis

Table 2: Serum copper levels

| | | As Received | | Supplemented | |
|---|---|---|---|---|---|
| Area | Period | Herds | Serum Copper *(µmol/l)* | Herds | Serum Copper *(µmol/l)* |
| Waikato | 1986-1989 | 109 | 9.3±1.6 | 105 | 11.7±1.6 |
| Taranaki | 1987-1989 | 49 | 9.9±1.2 | 33 | 11.5±1.6 |
| Northland | 1988-1989 | 31 | 7.3±2.5 | - | - |

- As received samples varied in copper level across regions:
  - Waikato – marginal
  - Taranaki – lower range of normal
  - Northland – low

- Large variation in copper status within regions.
- Any copper treatment within the ‘as received’ herds does not seem to have maintained copper levels.

- Serum copper levels in ‘supplemented’ herds were within the normal range.

- Although not shown here, paired liver biopsy and blood results showed a correlation coefficient of 0.64.

- A large proportion of cattle in Northland are low in copper during August/September.

## Summary

- Pasture analysis has limited use for diagnosing deficiencies.

- Oral supplementation of copper sulphate has been shown to raise copper status and maintain them within the normal range.

- Low copper levels are relatively common in Northland dairy cows.

# 2.0 The Effects of Copper Supplementation on Stock Health and Production

Part 1: Field Investigation into the effects of copper supplementation on stock health in dairy herds with a history of post-parturient haemoglobinuria
Author: Basil Smith
NZ Veterinary Journal 23 (1975), 73-77

## Overview

This project investigated the relationship between low copper status, the imbalance of copper and molybdenum in pasture and the incidence of post-parturient haemoglobinuria on Northland dairy farms. Post-parturient haemoglobinuria (PPH) is characterised by anaemia, poor milk production and haemoglobinuria (blood in the urine). The results showed supplementation with copper injection reduced the incidence of PPH and helped reduce the fall in haemoglobin. Copper fertiliser also proved to be an effective method of reducing the incidence of PPH.

## Method

**Injection:** This project involved farmers with a history of PPH giving half their herds copper injections (400mg copper glycinate – 120mg active copper) before calving and leaving the remainder untreated. Farmers recorded the incidence of PPH.

One property was selected to determine whether injections resulted in higher levels of haemoglobin after calving, cows were separated into three mobs; two treatments and a control:

- 120mg active copper within a few days of parturition.
- 240 mg active copper within a few days of parturition
- Untreated.

**Copper fertiliser:** Difficulties associated with copper injections initiated a further trial to look at the effect of applying copper as a fertiliser on the copper status of dairy cattle.

Nine farms were top-dressed with the equivalent of 1.3 kg copper/ha as either copper sulphate or copper oxide in late summer of 1972 (approximately 4 months before calving). Pasture samples were taken along with blood tests and liver biopsies from cull cows.

## Results – Incidence of PPH

Table 1: Effect of parenteral copper on incidence of PPH

| | ***Animals in Trial*** | | ***PPH Affected Animals*** | |
|---|---|---|---|---|
| *Farm* | *Untreated* | *Copper Inj* | *Untreated* | *Copper Inj* |
| A | 43 | 43 | 6 | 4 |
| B | 62 | 23 | 29 | 4 |
| C | 37 | 48 | 8 | 0 |
| D | 45 | 25 | 13 | 1 |
| E | 69 | 54 | 7 | 1 |
| **Total** | **256** | **193** | **73** | **10** |
| | | Affected (% of total) | 28.5% | 5.2% |

- Significant reduction in the incidence of PPH in the copper treated herds.
- Treating cows within 48 hours of calving gave the best results.

## Effect of supplementation on haemoglobin levels

Table 2: Effect of copper on the fall in mean haemoglobin levels of post parturient dairy cows (g/100ml)

| ***Treatment*** | **Differences in mean haemoglobin levels** | |
|---|---|---|
| | **30th Aug – 20th Sept** | **30th Aug – 13th Oct** |
| Untreated | $1.76_{a}$ | $2.20_{aA}$ |
| 120mg[1] | $1.09_{a}$ | $0.60_{bB}$ |
| 240mg[2] | $1.11_{a}$ | $0.87_{bAB}$ |
| SE | 0.89 | 1.16 |

*[1] 120 mg available copper as copper glycinate within a few days of calving*
*[2] 240 mg available copper as copper glycinate within a few days of calving*
*Levels with a letter in common do not differ significantly (a,b = 5%, A,B = 1%)*

- Cows receiving  copper injections showed a smaller drop in haemoglobin levels

## Copper fertiliser

Table 3: Levels of pasture, blood and liver on farms before and after application of copper in fertiliser:

| | **1971*** | **1972*** |
|---|---|---|
| Pasture copper (ppm) | 5.45 | 7.83 |
| Pasture Molybdenumm (ppm) | 5.36 | 3.02 |
| Blood Copper (mg/l) | 0.24 | 0.68 |
| Liver Copper (DM) | 4.4 | 26.8 |

**1971 is the year before the copper was applied, the 1972 results are taken approximately 3 months after copper fertiliser application*

- There was a slight increase in herbage copper between years
    - Seasonal effects are probably responsible for the difference in molybdenum levels (Table 3)

- 1972 was associated with much higher blood and liver copper levels, although there was no statistical analysis.

- There was a noticeable drop in the incidence of PPH following topdressing with copper (Table 4).

- Many farmers reported high milk production and better oestrus activity following top dressing with copper.

Table 4: Effect of copper topdressing on the incidence of PPH

| **Farm** | **Cows** | **Copper Type**[1] | **Incidence of PPH** | | | | **Production Increase**[2] | **Oestral Activity** |
|---|---|---|---|---|---|---|---|---|
| | | | **1969** | **1970** | **1971** | **1972** | | |
| A | 86 | CS | 2 | 60 | 3 | 2 | 45% | Intense |
| B | 105 | CS | 16 | 25 | 29 | 0 | 10% | Good |
| C | 170 | CS | 10 | 6 | 26 | 0 | 30% | Average |
| D | 190 | CS | 50 | 30 | 35 | 4 | 25% | Good |
| E | 125 | CuO | 20 | 25 | 14 | 0 | NA | Good |
| F | 130 | CuO | 6 | 25 | 11 | 0 | NA | Good |
| G | 135 | CuO | 5 | 40 | 8 | 0 | 50% | Intense |
| H | 126 | CS | 24 | 15 | 0 | 0 | 20% | Intense |
| I | 130 | CS | 25 | 30 | 10 | 0 | NA | Good |
| **Total** | **1196** | | **158** | **256** | **136** | **6** | | |

[1] *CS = Copper Sulphate, CuO = Copper Oxide*
[2] *Production increase per farm over the months of Jul – Sept -adjusted for seasonal factors*

## Summary

- Supplementing dairy cows with copper using an injection or top-dressing reduced the incidence of PPH.

- The low copper levels and high molybdenum levels probably contribute to the incidence of PPH.

- Some farmers reported problems with injection sites and preferred to use copperised fertiliser.

- Blood copper levels rise quickly following injection, but if initial copper levels are low an injection may not maintain levels over long periods

# 3.0 The Effects of Copper Supplementation on Stock Health and Production Part 2: The Effects of Parenteral Copper on Incidence of Disease, Haematological Changes and Blood Copper Levels in a Dairy Herd with Hypocuprosis.

Author B Smith, DA Woodhouse, and AJ Fraser
NZ Veterinary Journal 23, 109-112, 1975

This project provided a detailed investigation of blood chemistry following supplementation with parenteral copper.

A farm milking 120 cows, on Waikare clay, a moderately podzolised yellow brown earth, with a history of Post-parturient haemoglobinuria was selected for the project. 85 cows were divided into 2 groups; one group received 240mg of available copper (as copper glycinate) within 48 hours of parturition, the remaining group was left untreated. Blood samples were analysed for serum copper, haemoglobin and the incidence of Heinz bodies.

## Results

- Copper Injection reduced incidence of PPH
  - Untreated group had 53% incidence of PPH
  - Injected group had no incidence
- Haemoglobin levels remained significantly ($p<0.05$) higher in the treated group until February.
- Heinz bodies (a feature associated with PPH) were lower in the treated group.
- Blood copper levels remained significantly higher in the treated group than the untreated group through the sampling period.
- The untreated group showed a trend of increasing blood copper levels from winter – summer (Table 1)
  - Possibly related to falling molybdenum levels in pasture

Table 1: Changes in mean blood copper levels (mg/litre)

| | **Start 19 Aug** | **19 Sept** | **19 Nov** | **4 Feb** |
|---|---|---|---|---|
| Untreated | 0.33*a* | 0.33*b* | 0.41*b* | 0.57*b* |
| Copper | 0.33*a* | 0.97*a* | 0.68*a* | 0.69*a* |
| SE | 0.11 | .12 | 0.16 | 0.10 |

*Means in the same column with different letters vary are significantly different ($P\leq0.05$).*

## Summary

- Injection of copper within 48 hours of calving
  - Reduces the incidence of PPH
  - Maintains higher haemoglobin levels
  - Increases blood copper levels

# 4.0 The Effects of Copper Supplementation on Stock Health and Production Part 3: The Effects of Parenteral Copper on the Milk Yield Characteristics of a Dairy Herd with Hypocuprosis.

Author: GJ Goold and B Smith
NZ Veterinary Journal 23, 233-236, 1975

## Introduction

This project investigated changes in milk yield characteristics following supplementation with parenteral copper and the impact of Post-parturient haemoglobinuria (PPH) on milk production. PPH depresses milk production, supplementation with copper increased milk fat production in the first 3 months of lactation.

## Design

85 cows were divided into 2 groups, in one group cows received 240mg of available copper (as copper glycinate) within 48 hours of parturition. The remaining group were left untreated. The cows were herd-tested with analysis of butterfat and milk yield fortnightly from 16th August to 15th November, then at monthly intervals until the cows were dried off. The results are presented in three periods:

- Period 1: August 24th – November 30th.
- Period 2: December 1st – April 25th.
- Period 3: August 24th – April 25th.

## Results

The production information is outlined in Table 1.

Table 1 Production response from cows supplemented with copper compared with unsupplemented cows

| | Period 1 | | Period 2 | | Period 3 | |
|---|---|---|---|---|---|---|
| Effect | Milk Yield (kg/cow) | Fat Yield (kg/cow) | Milk Yield (kg/cow) | Fat Yield (kg/cow) | Milk Yield (kg/cow) | Fat Yield (kg/cow) |
| Control | 1370*a* | 65*bA* | 960*a* | 48*a* | 2330*a* | 113*a* |
| Copper | 1440*a* | 70*aA* | 990*a* | 52*a* | 2440*a* | 122*a* |
| SD 5% | 110 | - | 170 | 8 | 260 | 12 |
| SD 10% | 90 | - | 140 | 7 | 220 | 10 |
| CV% | 18 | 17 | 39 | 36 | 25 | 24 |

*Means with different letter vary are significantly different. a,b =10% A,B =5%*

## Key points

- 29% of the control group showed clinical symptoms of PPH compared with none in the treatment group
    - Cows affected by PPH had lower milk yield (12%) and butter fat (13%) across the whole season, although the results were not statistically significant

- Milk production from cows treated with copper was consistently higher than milk production from cows not treated with copper, although the results did not reach statistical significance.

- Butter fat yield was significantly higher ($P<0.1$) in the first period from August to November.

- Although not statistically significant, cows treated with copper produced 4% more milk and 7% more butterfat.

## Summary

- Cows with PPH tended to produce less milk than cows not affected with PPH

- Cows treated with parenteral copper produced significantly more butterfat in the first 3 months after calving, but the increase over the whole season was not statistically significant

- The copper response was ascribed to the reduction in incidence of PPH

# 5.0 Hypocuprosis: The effects of Administration of Copper Sulphate to Cattle Through the Water Supply

Author: B Smith and GH Moon
NZ Veterinary Journal 24, 132-134, 1976

## Introduction

This project investigated whether copper sulphate in the water supply of dairy cattle is an effective method of raising blood and liver copper concentrations.

Injecting copper and top-dressing copper have been shown to reduce the incidence of Post-parturient haemoglobinuria (PPH). Injections of copper are associated with some practical problems, while topdressing is a relatively expensive method of supplying copper. Medicating the water supply would present farmers with an alternative delivery system to provide supplementary copper.

Cows supplemented with copper in the water supply had greater liver copper levels and similar blood levels.

## Design

A herd of 180 predominantly Jersey dairy cows was split into three groups of 60 and 19 cows from each group were selected for the trial. During the winter the herd was held under cover in a wintering barn with unlimited access to hay and some grazing when weather permitted. The wintering barn had three separate water supplies:

- Group A were not dosed.
- Group B received an injection of 120mg of active copper as copper glycinate on 11th June.
- Group C was given a daily ration of copper sulphate added to the water trough twice daily (0.7g copper sulphate/cow/day or 178mg copper) from 14th June to 10th August.

Blood tests were taken at 3 weekly intervals and 5 cows were selected for liver biopsy from each group, with biopsy sampled in October to assess degree of copper retention by the liver.

## Results

- Both injection and copper in the water increased copper status of the cows (Table 1).

- The liver results indicate copper in the water provided greater amounts of copper which replenished liver copper reserves (Table 2).

Table 1: Effect of copper supplementation on blood copper levels (mg/litre)

| Date | Control (A) | Cu Injection (B) | Cu in Water (C) |
|---|---|---|---|
| June 11 | 0.32 | 0.37 | 0.33 |
| July 2 | 0.40 | 0.76 | 0.71 |
| July 24 | 0.46 | 0.78 | 0.82 |

Table 2: Mean liver levels of copper (mg/kgDM)

| Date | Control (A) | Cu Injection (B) | Cu in Water (C) |
|---|---|---|---|
| Oct 16 | 43.2*b* | 44.4*b* | 143.4*a* |

*Means with different letter vary are significantly different. (P≤0.05)*

## Summary

- Copper in the water supply increased blood copper levels to a similar level as injections.

- Copper in the water supply increased in liver copper levels whereas than copper injection did not.

- The author cautions that extended periods of copper supplementation in the water may result in copper toxicity.

- Availability of copper can be affected by iron and chloride levels, water must be tested to determine whether it is compatible with copper supplementation.

- The proportion of hay in the diet and restricting access to pasture would have increased water consumption, this level of water consumption may not have occurred in an all-grass wintering system.

# 6.0 Phosphorus Supplementation of Lactating Dairy Cattle on a Northland Farm

Author: K Betteridge, DA Haynes, and WJ Killen
NZ Veterinary Journal 37:107-111,1989

## Introduction

This project examined the impact of providing supplementing phosphate to dairy cows with low phosphate levels. Supplementation increased serum phosphate levels but did not increase milk production.

## Background

Phosphorus deficiency has only been recorded once in dairy cows in New Zealand. A survey of 200 cows across ten farms in Northland showed average serum Pi (inorganic phosphate) to be 1.3 mmol/l at peak lactation. The suggested normal range is 1.3 – 2.8 mmol/l. Animals with a level below 1.1 mmol/l may show clinical signs of P deficiency and may respond to phosphate supplementation. Given the low blood phosphate levels, a milk production response was considered possible.

A farm near Okaihau with a mixture of free draining basaltic soils and winter wet podzol was selected for the trial, Olsen P ranged from 37 – 67 mg P/kg soil. 48 Friesian or Friesian X cows were divided into two groups, one group receiving 25g phosphate/head/day as sodium tripolyphosphate (TPP) and the control group receiving sodium chloride. After four weeks the serum response to TPP was small, so the control group were given dicalcium phosphate to compare phosphate availability. Serum phosphate, bodyweight, condition score and milk production were monitored through the trial. The supplementation used in the trial is outlined in Table 1 below:

Table 1: Experimental design

| | Period | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Group | 0-2 weeks | 2-6 weeks | 6-8 weeks | 8-10 weeks |
| 1 | Nil | TPP[1] | TPP | Nil |
| 2 | Nil | NaCl[2] | DCP[3] | Nil |

*[1] TPP - sodium tripolyphosphate (25g P, 25g NaCl/cow/day)*
*[2] NaCl – sodium chloride (25g NaCl/cow/day)*
*[3] DCP – dicalcium phosphate (25g P, 38g Ca/cow/day)*

## Results

- Liveweight did not vary between groups during the trial.

- Condition score showed a small, but significant ($P<0.05$) difference during the first and fourth period
    - Group 1 condition score averaged 4.7
    - Group 2 condition score averaged 4.4

- Condition score was not significantly different during the 2nd and 3rd periods.

- Sodium tripolyphosphate and dicalcium phosphate has a similar effect in raising serum Pi.

- Additional dietary calcium appeared to have no effect on availability of phosphate.

- Serum Pi levels were increased by supplementation
    - Period 2
        - Group 1 serum Pi averaged 1.43 mmol/l
        - Group 2 serum Pi averaged 1.30 mmol/l
    - Supplementation increased serum Pi by 10%, from a 33% increase in dietary P

- Despite the increase in serum Pi, there was no significant difference in milk production (milk, milk-fat or milk-protein) during the trial.

- Pasture analysis showed pasture averaged:
    - 73% ryegrass
    - 20% legume
    - 7% other species

- Phosphate in the pasture ranged from 0.39 – 0.55%DM and calcium ranged from 0.49 – 0.6%DM.

- Average phosphate intake from pasture was estimated at 79g/cow/day compared to a requirement of 44g/cow/day .

## Summary

- Other studies suggest a greater response in serum and milk production should have been expected following supplementation.

- Serum Pi is not the best indicator of P deficiency.

- Serum Pi levels fluctuate between weeks and make diagnosis of phosphate deficiency complex.

- Low serum phosphate levels did not affect milk production in this trial.

- P nutrition for most New Zealand dairy cattle should be adequate.

# 7.0 Animal Production – Trace Element Results (taken from the Annual Report 1982/83)

Author: TC Reid

This document reviews the research from trace element studies undertaken in Northland by trace element with summary data. There have been few production responses to trace element supplementation in Northland.

## Copper – Beef cattle

One trial on a volcanic soil near Kaikohe (Punakitere) examined the live weight response to copper supplementation (by injection) in weaner Angus steers over 11 months. The results (Table 1) indicated a **decrease** in growth rate with supplementation. Blood copper levels were adequate.

Table 1: Effect of copper supplementation on cattle liveweight gain over 11 months.

| | Liveweight (kg/head) | | |
|---|---|---|---|
| | April | November | March |
| Copper Dosed | 209 | 362 | 394 |
| Control | 211 | 366 | 406 |
| SED | 1.7 | 3.2 | 3.7 |
| Significance | NS | NS | ** |

** Highly Significant (P<0.001)

One trial looked at three east coast properties and another trial on 8 sandy west coast soils:

- No response was detected on liveweight gain on any of the properties.
- Copper supplementation raised blood copper concentration

Table 2: Effect of copper supplementation on final liveweights and blood copper concentrations of beef cattle (two trials)

| ***Trial*** | ***Soil type*** | ***Farms*** | ***Treatment*** | ***Final Liveweight (kg/head)*** | ***Blood Copper (µM/l)*** |
|---|---|---|---|---|---|
| 1 | Clay | 3 | Copper | 343 | 9.9 |
| | | | No Copper | 341 | 7.9 |
| 2 | Sand | 8 | Copper | 327 | - |
| | | | No Copper | 326 | - |

## Copper – Sheep

One trial involved 14 farms on two soil types (a heavy clay and a sand). Blood copper concentrations were all adequate.

- Copper supplementation had no effect on liveweight gain or blood copper concentrations.

Table 3: Effect of copper supplementation on liveweight gain and blood copper concentrations of growing lambs.

| ***Soil type*** | ***Period*** | ***Treatment Liveweight Gain (kg/head)*** | | ***Blood Copper (µM/l)*** |
|---|---|---|---|---|
| | | ***Copper*** | ***No Copper*** | |
| Clay | Dec-May | 5.45 | 5.60 | 14.3 |
| Sand | Dec-May | 3.63 | 3.80 | 13.4 |

## Copper – Dairy cattle

A trial on two farms on sandy peat soils showed no response in milk production, condition score or reproductive performance to copper supplementation.

## Cobalt – Beef

On three east coast properties and eight west coast properties, $B_{12}$ in the blood was founds to vary between sampling time and site. Only on one occasion did the concentration fall below adequate. No significant effect of supplementation was observed on blood $B_{12}$ levels or live weight.

## Cobalt – Sheep

Similar results were found with sheep on fourteen sites - eight on clay and six sandy soils. Only two sites had low serum $B_{12}$ levels. Small positive liveweight gains occurred following supplementation on these two sites and one other site. On nine sites liveweight gains were slightly lower after supplementation.

Local effects of cobalt deficiency were observed in one trial where some paddocks showed signs of cobalt deficiency. These effects may have been obscured by rotational grazing. There was a significant response in liveweight gain to rate of supplementation and stocking rate from the more responsive paddocks from June – November. There was a greater response at low stocking rates, with low stocked/unsupplemented animals losing weight.

Table 4: Effects of $B_{12}$ supplementation of lambs on liveweight gain, fleece weight and serum $B_{12}$ at two stocking rates.

| Response Jun - Nov | Stocking Rate | Supplementation Rate (µg hydroxycobalamin/head) | | | |
|---|---|---|---|---|---|
| | | 0 | 30 | 100 | 3000 |
| LWG (kg/head) | Low | -1.5 | 4.5 | 14.6 | 17.9 |
| | High | 4.5 | 6.4 | 8.3 | 8.0 |
| Fleece Wt (kg/head) | Low | 1.8 | 1.8 | 2.1 | 2.3 |
| | High | 1.3 | 1.4 | 1.5 | 1.5 |
| Serum $B_{12}$ (pmol/l) | Low | 111 | 117 | 141 | 480 |
| | High | 180 | 192 | 259 | 641 |

- Cobalt deficiency may be restricted to certain areas of a property and be obscured by rotational grazing.
- Abundant feed may be a factor in inducing deficiency. Soil ingestion is more common at high stocking rates than at low and this can assist in maintaining cobalt status in the animals as the soil concentrations of cobalt are considerably higher than those in pasture.

A trial looking at the efficacy of topdressing cobalt showed elevated blood cobalt levels in Friesian Bull calves grazing the area 3½ years after application. At a comparatively high stocking rate liveweight gains were lower among calves grazing the top-dressed area than the control area.

## Selenium – Beef cattle

A trial run on three farms situated on clay soils indicated no response to liveweight gains following selenium supplementation in the first year. A second trial on 8 sandy soils on the West Coast indicated a small but statistically significant response. On one property (Farm 5) the response was greater than on the others.

Table 5: Effect of selenium supplementation on growth of beef cattle

| Farm | Period | Liveweight gain (kg/head) | | Blood Test* |
|---|---|---|---|---|
| | | No Selenium | Selenium | |
| 1 | April - Mar | 106.5 | 116.2 | 7.2 |
| 2 | April - Mar | 131.4 | 127.6 | 31.9 |
| 3 | April - Mar | 118.3 | 121.4 | 28.8 |
| 4 | April - Mar | 73.8 | 74.3 | 21.1 |
| 5 | April - Mar | 126.9 | 151.5 | 10.0 |
| 6 | April - Mar | 102.1 | 106.4 | 19.3 |
| 7 | April - Mar | 111.3 | 111.1 | 9.0 |
| 8 | April - Mar | 94.1 | 98 | 9.0 |
| | | 108.3 | 111.3 | |

** Glutathione peroxidase activity (i.u./litre) collected in April before the trial as an indicator of selenium status*

## Selenium – Sheep

A trial looked at selenium responses on eight farms on clay soils and six on sandy soils. There was no evidence of a selenium response. Selenium supplementation increased blood glutathione activity on most farms.

Table 6: Effect of selenium supplementation on liveweight gain of sheep (Dec-Jun).

| Soil Type | Farms | Liveweight gain (kg/head) | | Blood Glutathione activity (i.u./l) | |
|---|---|---|---|---|---|
| | | **+ Se** | **No Se** | **+ Se** | **No Se** |
| Clay | 8 | 5.67 | 5.38 | 13.7 | 7.9 |
| Sand | 6 | 3.72 | 3.79 | 18.5 | 9.4 |

## Selenium – Dairy cows

The effect of selenium supplementation on dairy production was tested on two farms on sandy peat soils. There was no effect of selenium on milk production or on reproduction.

## Summary

- There are few animal production responses to trace element supplementation in Northland.

# 8.0 Situation Review Trace Element Deficiencies of Sheep & Cattle in Northland

Author: IPM McQueen
Internal ARD publication - NARL Ref 296, circa 1987

This document reviews the research from trace element studies undertaken with in Northland and presents a summary of the findings on cobalt with Cattle.

## Background

In the 1970's the Agricultural Research Division (ARD) of Ministry of Agriculture and Fisheries (MAF) was asked to identify situations in which animal performance was limited by trace element deficiencies. This was in response to gains in productivity gains in trials with trace elements:

- 1 with copper (published).
- 1 with cobalt (unpublished).
- 3 with selenium (unpublished).

Since 1979 the ARD has conducted many trials with trace elements in animals on sites which were reputed to be deficient, including:

- 47 with copper (no production gains).
- 57 with cobalt (4 responses to cobalt – three at one site).
- 44 with selenium (no production gains).

## Survey

An early part of the work was to establish the status quo of certain trace elements in soils, plants and animals and to determine the inter-relationship between them.

This work demonstrated the complex nature of trace element. It failed to demonstrate any widespread low levels of copper, cobalt or selenium in animals in Northland. Using soil type, parent material and leaching was shown to have very limited application in predicting likely trace element status. Notable features were:

- Selenium levels tended to be high on limestone or basaltic soils and low on certain types of peat.

- Podzols, which had assumed to be prone to trace element deficiency based on soil and herbage tests, often had adequate blood levels of copper and vitamin B12.

- There was virtually no relationship between copper in the diet and copper levels in the blood (even allowing for copper dietary availability).

- Blood selenium was strongly related to that of the herbage (r= 0.64–0.77).

- The relationship between blood levels and animal production is unclear; often the reference standards for critical levels are conservative.

Grazing Management interacts with trace elements:

- Interaction between grazing intensity and responses to B12 supplement were investigated:
  - Serum $B_{12}$ was elevated as much by increased grazing pressure as by supplementation

- Rotational grazing helps to reduce the impact of low trace element levels on one part of the farm

## Cobalt deficiency in cattle in Northland

There have been anecdotal reports of cobalt deficiency in Northland. While an acute deficiency is unlikely, there may be fleeting periods of the year when a deficiency impacts on production.

In 1978/79 a survey was undertaken looking at the serum vitamin $B_{12}$ concentrations and their relationship to soil and pasture samples. The survey involved confining 6 yearling steers to an area for eight weeks on 131 farms. At the end of the eight week period (in October) blood samples were taken, along with soil and herbage tests.

Following this survey, between 1980 – 1984 a series of response trials were run on farms shown to have low or marginal serum $B_{12}$ levels in the survey. The trials were run at varying times of the year using young animals of both dairy and beef breeds. Cobalt treatment took the form of cobalt bullets or injections of hydroxycobalamin given at 2-3 monthly intervals. The results of the response trial are outlined in the Tables below.

Table 1: Cobalt bullets

| Farm No | Class | Period | Serum $B_{12}$ (µM/litre) | | | Liveweight Gain | |
|---|---|---|---|---|---|---|---|
| | | | Initial | Final | | | |
| | | | | -Co | +Co | -Co | +Co |
| 1 | Beef Yearling | Apr-Mar | 60 | 142 | 146 | 138 | 141 |
| 2 | Beef Yearling | Apr-Mar | 83 | 209 | 183 | 97 | 95 |
| 3 | Beef Yearling | Apr-Mar | 85 | 131 | 150 | 105 | 103 |
| 4 | Beef Yearling | Apr-Mar | 120 | 166 | 183 | 110 | 114 |
| 5 | Beef Yearling | Apr-Mar | 141 | 189 | 182 | 136 | 123 |
| 6 | Beef Yearling | Apr-Mar | 249 | 183 | 195 | 68 | 80 |
| 7 | Beef Yearling | Apr-Mar | 258 | 147 | 138 | 119 | 120 |
| 8 | Dairy Calves | Oct-Mar | 73 | 228 | 239 | 106 | 105 |
| 9 | Dairy Calves | Oct-Mar | 135 | 162 | 204* | 89 | 92 |
| 10 | Dairy Calves | Oct-Mar | 146 | 288 | 295 | 57 | 50 |
| 11 | Dairy Calves | Oct-Mar | 177 | 254 | 288 | 54 | 58 |
| 12 | Dairy Calves | Oct-Mar | 187 | 237 | 255 | 46 | 46 |
| 13 | Dairy Calves | Oct-Mar | 231 | 146 | 168 | 87 | 85 |

* $p<0.05$

- Poor correlation between initial B12 result and final result in the untreated mob.
- Only farm 9 had a significant increase in serum B12 level.
- No farms showed a significant increase in liveweight gain.

Table 2: Hydrocobalamine Injection (1000µg/50kg LW)

| Farm No | Class | Period | Serum $B_{12}$ (µM/litre) | | | Liveweight Gain | |
|---|---|---|---|---|---|---|---|
| | | | Initial | Final | | | |
| | | | | -Co | +Co | -Co | +Co |
| 1 | Beef (2 Year) | Mar-Aug | 83 | 166 | 186 | -2 | 3 |
| 2 | Beef (2 Year) | Mar-Aug | 85 | 180 | 200 | -31 | -30 |
| 3 | Beef (2 Year) | Mar-Aug | 120 | 148 | 199 | -34 | -35 |
| 4 | Beef (2 Year) | Jun-Jan | 178 | 120 | 121 | 138 | 131 |
| 5 | Beef (2 Year) | Jun-Jan | 210 | 276 | 327 | 130 | 133 |
| 6 | Beef (2 Year) | Mar-Aug | 258 | 125 | 123 | -12 | -18 |
| 7 | Beef (2 Year) | Jun-Jan | 308 | 186 | 197 | 135 | 135 |
| 8 | Friesian Yrlg | Oct-Mar | 144 | 121 | 178 | 26 | 26 |

- Poor correlation between initial B12 result and final result in the untreated mob.
- No farms had a significant increase in either serum B12 level or liveweight gain.

A further series of four trials was set-up from 1979-83, comparing topdressing cobalt (1.3 kg $CoSO_4$/ha) with monthly injections (5000µg hydroxycobalamin/head). Two of the four trials used yearling Angus steers, the other two trials used 3 month Friesian bull calves. The results are presented in Table 3 below:

Table 3: Comparison of Topdressing and Cobalt Injection*

| Trial | Stock | Period | Treatment | Serum $B_{12}$ | LWG | Liver $B_{12}$ |
|---|---|---|---|---|---|---|
| 1 | Angus | Jul-Apr | Topdress | 178 *A* | 147 *b* | 886 *A* |
| | | | Injection | 147 *A* | 151 *a* | 849 *A* |
| | | | Control | 61 *B* | 141 *c* | 366 *B* |
| | | | *p* | *<0.001* | *<0.1* | *<0.001* |
| 2 | Angus | Jul-Mar | Topdress | 174 *A* | 146 | 564 *A* |
| | | | Injection | 174 *A* | 152 | - |
| | | | Control | 70 *B* | 155 | 249 *B* |
| | | | *p* | *<0.001* | *NS* | *<0.001* |
| 3 | Friesian Calves | Nov-Apr | Topdress | 192 *A* | 82 | 410 *AB* |
| | | | Injection | 184 *A* | 87 | 409 *A* |
| | | | Control | 105 *B* | 88 | 303 *B* |
| | | | *p* | *<0.001* | *NS* | *<0.001* |
| 4 | Friesian Calves | Nov-Jan | Topdress | 221 | 22 *B* | |
| | | | Injection | 175 | 32 *A* | |
| | | | Control | 152 | 32 *A* | |
| | | | *p* | | *<0.01* | |

**Different lettering refers to differences between treatments at the level shown*

- Control (unsupplemented) animals are significantly lower in serum and liver B12 levels than supplemented animals in the first two trials.

- Both cobalt topdressing and injection increased serum and liver vitamin B12 levels in the first three trials.

- Cobalt injection resulted in the highest significant production advantage in the first trial, but topdressing also gave a production advantage.

- The subsequent two trials failed to produce a response.

- In the short term fourth trial, cattle on the top-dressed area grew less than the injection or control animals.

Another trial looked at rotation length. There was no significant difference of a long (63 day) or short (21 day) rotation on serum $B_{12}$ or liveweight gain.

## Summary

- Despite the large number of trials testing responses, there have been few production responses to trace elements in Northland.

- Trace elements nutrition is very complex:
    - There is low correlation between dietary copper and blood copper
    - Blood selenium is highly correlated with dietary selenium
    - Blood cobalt levels are influenced as much by grazing pressure as by supplementation

- Cobalt supplementation via injections and topdressing significantly increased serum levels in cattle, but failed to produce a response.

- The critical levels for deficiency may be conservative.

# 9.0 Summary of Results of Agricultural Research Division Work on Trace Elements for Advisor Services Division meeting 14th October 1983

Internal MAF publication - NARL Ref 356

This document reviews the research from trace element studies undertaken in Northland and presents a table summarising the results of ARD trial work to date.

Key findings include:

- Sheep and cattle blood tests have different thresholds for diagnosis of a deficiency.
- Soil types do not influence cobalt or copper in animals.
- Selenium may be partly determined by soil types:
  - Volcanic soils normally associated with high blood Selenium
  - Peaty soils <u>may</u> be associated with low blood selenium
- Testing soil, pasture and blood are diagnostic aids in assessing deficiency, they do not define deficiencies.
- Trace element deficiencies are rare in Northland.
  - Very few production responses from supplementation
  - Supplementation can be associated with depressed production
- The association between blood concentrations, soil types and animal production have been intensively researched.
- Blood tests tend to reflect the most recent area grazed by animals, not the whole property.
- Grazing Management is important:
  - Rotational grazing may help to reduce the impact of low trace element levels on one part of the farm
  - Heavy stocking or hard grazing may help prevent low vitamin B12 levels
  - Animals under lax grazing may be more prone to deficiency symptoms

Table 1: Summary of ARD Trace Element Trials

| Project | Subject* | Species | Sites | Response |
|---|---|---|---|---|
| RN 3 | Forms of Co | Sheep | 3 | 1 (positive) |
| RN 4 | Forms of Co & Se | Cattle | 3 | Nil |
| RN12 | Cu | Beef Cattle | 1 | 1 (Negative) |
| RN15 | Milk Response to Co | Dairy Cattle | 3 | Nil |
| RN17 | LW response to Co | Calves | 5 | Nil |
| RN17 | LW response to Co | Lambs | 1 | 1 Possible |
| RN20 | Milk response to Cu | Dairy Cattle | 6 | Nil |
| RN26 | Cu, Co & Se | Beef Cattle | 4 | Nil |
| RN29 | Co on Volcanic soils | Beef Cattle | 1 | Nil |
| RN30 | Milk response to Cu x Se | Dairy Cattle | 10 | Nil |
| RN34 | Cu, Co & Se | Beef Cattle | 12 | 1Se? 1Cu? |
| RN36 | Co | Goats | 1 | Ongoing |
| RN38 | Forms of Co & Stocking Rate | Bull Calves | 1 | Nil |
| RN59 | Cu, Co & Se | Sheep | 15 | Ongoing (1Se?) |
| RN64 | Co | Sheep | 1 | Underway |
| | | **Total** | **67** | |

**Co is Cobalt, Se is Selenium and Cu is Copper, LW is Liveweight*