

COBALT DEFICIENCY IN SHEEP

In Otago/Southland



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Introduction

Since approximately 1979 the incidence and severity of cobalt deficiency has gradually become worse and worse until it has become a hot topic amongst nearly all sheep farmers. This publication represents an attempt to bring together the available information on cobalt (especially preventative treatment) into one source. Bear in mind that there are some unknowns especially when it comes to soil and pasture factors. Also adding to the confusion is the natural variation from farm to farm and season to season which makes it impossible to give a nice simple specific recipe.

Requirement For Cobalt

Cobalt deficiency results in a deficiency of vitamin B12 because vitamin B12 contains cobalt. Rumen micro-organisms make vitamin B12 from cobalt. Absorption occurs mostly in the small intestine. Lack of vitamin B12 blocks a major metabolic pathway in the ruminant animal which would normally produce glucose (energy). Hence the classical description of cobalt deficiency — 'Starving in the midst of plenty'.

Vitamin B12 manufactured in the rumen is stored in the liver so that an animal with adequate levels of B12 in its liver can withstand a period (perhaps up to 2-3 months) of grazing on deficient pasture without showing signs. This length of time is dependent on:

- Level of storage in the liver.
- Health of the liver.
- Animal species.

The reason cattle are less susceptible to cobalt deficiency is that cattle's metabolic requirement for cobalt is less and hence liver storage lasts longer through any deficient period.

Symptoms Of Cobalt Deficiency

There are actually no specific signs characteristic of cobalt deficiency, hence caution should be applied when interpreting the following clinical signs as they could equally well apply to several other problems, most notable of these being internal parasitism.

The classical clinical sign is that of lambs in summer showing signs of illthrift where they are grazing adequate green pasture. Over the last 15 or so years though this classic 'narrow window' of cobalt deficiency has gradually and progressively become wider in that:

- Cobalt deficiency can occur in lambs by tailing and last the entire growing season.
- Other classes of stock (hoggets and ewes) may also be affected as well as lambs on some farms.
- Farms which prior to the 1980s have never had a cobalt deficiency have now experienced it.

If weaner lambs are healthy, cobalt deficiency is unlikely in older sheep, cattle or deer. Obviously the incidence and severity vary markedly from farm to farm. Signs of cobalt deficiency in lambs that may be noticed by farmers are:

- Loss of appetite resulting in poor growth rates and unhealthy appearance.
- A watery discharge from the eyes.
- Wool is white or washy and has a reduced growth rate.
- Scaly ears.
- Anaemia (pale mucous membranes) may develop.

In more marginal cases of deficiency the only sign may be reduced weight gain after weaning resulting in the development of a tail end of unthrifty lambs. The tail end develops because not all lambs are affected equally by low cobalt levels in pasture.

Note: The above signs can equally well apply to other conditions most notably pasture deficiency and internal parasitism.

Signs of cobalt deficiency in ewes are less obvious but may include:

- Fewer lambs, more stillbirths and lamb deaths around lambing.
- A syndrome of inappetence, resultant wasting and deaths after 2-3 weeks in mid winter has been reported in Southland.
- Ewes deficient pre-lamb produce less milk and pass less B12 onto their offspring so their lambs in turn will be lighter and develop B12 deficiency earlier. Newborn lambs are dependent on initial liver stores and good colostrum intake of vitamin B12 to maintain their levels for 4-6 weeks as manufacture of their own vitamin B12 from cobalt in the rumen is minimal in the first month since their rumen has not developed properly.

Factors Influencing Low B12 Levels

a) Soil Factors:

Cobalt is less available to plants from some soils than others due to:

- Inherent low cobalt level i.e. primary cobalt deficiency. Such soils do not appear to have any great geological similarity, varying from wind blown shell sands to soils derived from pumice and granite.

In general acid soils such as granite lack cobalt, while basaltic soils are usually adequate.

In most of Otago/Southland primary cobalt deficiency is not the reason for low cobalt levels — other factors resulting in secondary cobalt deficiency are more important:

- Loss of cobalt through weathering, leaching and intensive cropping.
- Soil drainage — plants growing on water logged soil appear to have cobalt levels many times higher than the same soil types with good drainage.
- Liming by reducing soil acidity reduces cobalt uptake.
- Other minerals can reduce cobalt uptake, these include manganese, iron, and nickel. High manganese concentrations in the soil can result in cobalt becoming unavailable to plants when soil moisture is low e.g. dry summer.

- Poor soil aeration as a result of soil compaction may result in lower availability providing this is not associated with higher soil moisture. Working up ground and as a result improving soil aeration (and renewing pasture with clover and pasture grasses of higher cobalt content — see table below) will improve cobalt availability.

b) Plant Factors

- Plant species differ in their ability to accumulate cobalt, with legumes tending to have a greater uptake than grasses. (See table.)

Cobalt Content In Different Pasture Plants Grown Under The Same Conditions

PLANT	COBALT mg/kg DM
Timothy	0.09
Cocksfoot	0.11
Meadow Fescue	0.12
Short Rotation Ryegrass	0.13
Perennial Ryegrass	0.16
Red Clover	0.23
White Clover	0.24

- Seasonal variation — Pasture levels of cobalt are higher in autumn and winter and lower in spring and summer, probably because of the dilution effect on cobalt concentrations of rapid pasture growth in spring and the higher levels of soil contamination (containing readily available cobalt) of pasture in the late autumn/winter.
- Seeded mature pasture has lower cobalt levels than vegetative growing pasture.

The above soil and plant factors can combine to create seasonal differences in cobalt availability in pasture so cobalt deficiency signs may appear more/less severe in some seasons and some years than others.

c) Animal Factors

- Age — younger animals have higher requirements.
- Sex — ram and wether lambs have a slightly higher requirement than ewe lambs.
- Scouring — any cause of scouring will result in less absorption of cobalt from the gut because of increased speed of stomach contents through the gut. This applies especially to internal parasitism but also any other cause e.g. coccidiosis, nutritional scour.
- Intestinal parasitism reduces cobalt absorption also by damaging the gut lining.

Why Is Cobalt Deficiency Becoming Worse?

Over the last 10-15 years in South Otago and Southland there has been a widening area of cobalt deficiency particularly in areas not previously recognised as having a problem. Also there has been a trend for farms, which had a problem initially only with lambs in summer, to have noticed a widening of the problem time of the year; and also other classes of stock (hoggets and ewes) sometimes being affected. Cases in Central Otago have appeared in the last season or two for the first time. Why?? Below is a list of known reasons - there may well be other as yet unknown factors as well.

- Declining fertiliser use through the 1980s. This will have an influence through:
 - * Less cobaltised super applied.
 - * Poorer quality pastures.With clovers having higher cobalt levels than grasses and weeds and seeded pasture having lower levels than vegetative pasture it is obvious that less fertile pastures that are poorly maintained will produce more cobalt deficiency problems than a highly fertile pasture managed to maintain vegetative growth.
- The recent rise in the amount of lime being applied will help reduce pasture cobalt levels. Soil pH should be kept within the optimal range of 5.8-6.0. Any increase above this will result in lowered cobalt availability.
- Improving drainage on farms will reduce available cobalt.
- The trend to growing out heavier lambs e.g. 18kg instead of 13-14kg will put more demand on cobalt requirements.
- Climate changes — these may affect cobalt levels in ways not yet fully understood. Any trend to drier summers will result in manganese interfering with cobalt uptake and making it less available to pasture.
- Reference range changes. The levels accepted as normal or adequate have been revised upwards over the years so that what used to be accepted as adequate may now be marginal etc.
- Farmers (and vets) are more aware of cobalt deficiency and are more inquisitive. The use of electronic weighing scales has enabled easy monitoring of growth rates — the more you look the more you'll find!

Diagnosis:

Of all the trace element deficiencies the diagnosis of cobalt deficiency, especially marginal situations, can be the most difficult to resolve. Your veterinarian when faced with a potential cobalt deficiency problem will take into account:

- The location of the farm in relation to known areas of cobalt deficiency.
- History of the property with respect to top dressing, pasture species, season, any previous cobalt analyses, etc.
- The appearance and symptoms of the stock in question bearing in mind that symptoms are not specific.
- Any other apparent problems — parasitism, scouring etc.

Chemical Analysis

— liver or blood samples are the best samples to take to diagnose cobalt deficiency. (See later section on monitoring for further detail.)

Liver B12 — indicates B12 reserves and likely response to treatment. Samples from a minimum of three animals are required.

Serum B12 — indicates recent (24-48 hours) daily intake of cobalt and likely response to treatment. A minimum of 10 samples are required. Stock should be yarded less than four hours prior to sampling.

Interpretation of these results, especially serum, requires an extensive knowledge of the pattern and development of cobalt deficiency in a particular area. It is not possible to look at the B12 levels received from the laboratory in isolation and use a single cut off level. For example a 'just' adequate level in lambs going into a known cobalt deficient time and/or area may well be interpreted by your veterinarian differently to the same level in lambs in another area or later in the season.

Controlled response trials — can be used to diagnose cobalt deficiency. They may fail to diagnose marginal deficiencies, for example if the trial is not conducted at the right time of the year. Commonly a weight gain trial using 50 control and 50 B12 injected lambs is used. Regular weighing is required and lambs must be identified by ear tag.

Soil And Pasture Sampling

For the diagnosis of cobalt deficiency, soil sampling is of no value because the relationships between soil—plant—animal are complex, and the cobalt content of the soil may bear little relationship to the grazing animals level.

Pasture sampling is of very limited use unless performed on a regular basis during spring (monthly). This is because sheep can survive for considerable periods (3 months) on cobalt deficient pasture due to liver storage of Vitamin B12. Any soil contamination of the pasture sample will give a false high result. Soil contamination of pasture though, is a source of cobalt to livestock.

Low pasture cobalt levels can be used as a guide to the likelihood of deficiency occurring in stock.

For growing sheep pasture concentrations of less than 0.08mg/kg DM are deficient and 0.08-0.1 mg/kg DM marginal.

Treatment

For treatment of an existing cobalt deficiency (as distinct from prevention of a potential problem) injection of vitamin B12 is the treatment of choice. This is because cobalt deficient animals have markedly reduced appetites and so take in less feed even if the feed has had cobalt applied to it. Immediate response can only be obtained from the more direct Vitamin B12 injection — 1 to 2 mg depending on the stock being treated. Farmers report visible signs of improvement within three days of injecting cobalt deficient lambs.

Prevention

As with most animal health problems prevention is better than cure. The poor growth rates and ill thrift accompanying cobalt deficiency can affect lifetime performance so it is best to prevent the problem rather than attempt a cure after production has been lost.

The best approach to preventing cobalt deficiency is going to vary from farm to farm depending on many factors, soil types, timing and degree of problem etc. so most importantly a preventative approach needs to run alongside a monitoring programme (see next section) to achieve the best approach for you individually.

The different approaches that can be taken to prevention are:

- Cobalt sulphate top dressing (usually with superphosphate).
- Cobalt sulphate pasture spraying.
- Cobalt prill/chip pasture application.
- Vitamin B12 injection.
- Cobalt sulphate oral drenching.
- Combination of some of the above.

a) Cobalt Sulphate Top Dressing

The effectiveness of fertiliser top dressing with cobalt sulphate depends on the soil type. The soils of Otago and Southland are such that application of cobalt fertiliser will only boost levels for as little as six weeks up to a maximum of around 12 weeks. Hence application must be made at strategic times to best meet the needs of the animals rather than just tagged to the annual fertiliser programme. The best time to apply cobaltised fertiliser is in late spring just prior to weaning. Recommended rates are from 175-350 gm/ha of cobalt sulphate.

There is some evidence to suggest that long term topdressing (10-20 years) of cobalt sulphate at the higher rate of 350gms/ha/year may on *some* soil types build soil reserves to high enough levels to maintain pasture at an adequate cobalt level throughout the year and that after this period the rate of application can be reduced.

Factors to consider with this approach are:

- Initially other cobalt supplementation methods may be needed as well, which increases the cost.
- The price of cobalt sulphate can fluctuate dramatically due to overseas factors such as wars (cobalt sulphate is used to harden metal in gun barrels), meaning in some years the annual application could be extremely expensive. In 1991 the price nearly reached \$1000/25 kg which at 350gms/ha works out at \$14/ha.
- While long term application has been shown to be effective on some North Island soils especially pumice soils I am unaware of any evidence as to the effectiveness of this approach in Otago/Southland.

b) Cobalt Sulphate Pasture Spraying

As a means of applying cobalt to pasture this method is preferable to top dressing. Liquid application gives a more rapid elevation of pasture cobalt and to higher levels (2-3 times) than that achieved with top dressing — probably because of the more even spread and more immediate availability. The duration of elevation will vary with soil type as does top dressing. It will last, as long as top dressing on the same soil type.

Application can be made strategically to parts of the farm where stock will be grazing and will remain in the treated pasture up to the time of consumption provided the pasture does not go to seed.

To be effective cobalt sulphate spray should be:

- Applied to actively growing pasture.
- Applied 2-3 weeks prior to the pasture being grazed to allow time for uptake into the pasture. Spraying closer than this prior to grazing will result in less uptake and any cobalt coating the pasture is effectively a 'drench' with the benefits lasting a much shorter time (approximately one week). If the cobalt sulphate was washed off by rain and pasture was then grazed say a week after application, stock would receive virtually no extra cobalt.

This means that forward planning is necessary and spraying of pastures should be done 1-2 weeks after grazing to be ready for the next grazing rotation in 2-3 weeks.

- Applied to a minimum of $\frac{1}{3}$ of the paddock(s) area to be grazed but at the effective rate/ha i.e. three times as much on $\frac{1}{3}$ the area or 2 x on $\frac{1}{2}$ the area, etc.
- Applied little and often will be more effective than more less often. Spraying pasture every 5-6 weeks at a rate of 50-60 gms/ha is better than 120-140gms/ha every 10-12 weeks.

Hence a spray unit on the farm four wheel bike or ute and used regularly 2-3 weeks in front of the lambs will be far more effective than a single application over the whole farm once.

c) Cobalt Prill/Chip Application

These products have a similar effect to cobalt sulphate top dressing but often at a cost of up to 2½ times greater for the same area. Their only advantage is that they are easy to apply via prill spreaders.

d) Vitamin B12 Injection

B12 given by injection is stored in the liver and is available immediately. Vitamin B12 is a very effective metabolic stimulant even when cobalt levels are reasonable. Production responses sustained for 3-6 weeks have been achieved when cobalt levels were already adequate. The length of time the injection lasts varies depending on the liver levels at time of application and how deficient the dietary cobalt will be over the forthcoming weeks. As a *rough guide only* it would appear that:

- 1mg (1000mcg) given to lambs at tailing lasts up to 12 weeks.
- 2mg (2000mcg), given to lambs from weaning onwards when there is a reasonable cobalt deficiency, lasts 6-8 weeks.
- 2mg given to ewes prelamb would appear to last in the lambs through to about the same time as 1mg given to lambs at tailing does i.e. through until about 12 weeks after tailing. Ewes should milk much better (vitamin B12 is needed to make lactose (sugar) in milk) which will result in better fed lambs needing less pasture which may be cobalt deficient to supplement their diets hence the lambs will require less stored liver B12 and so use less of its B12 reserves. Lambs cannot manufacture their own vitamin B12 until their rumen is developed (1-2 months of age).

e) Cobalt Sulphate Oral Drench

Cobalt sulphate given orally e.g. in mineralised anthelmintics is ineffective in preventing cobalt deficiency because a regular dietary intake is required. The usual dose of 35mg of cobalt sulphate would need to be given at least weekly to prevent cobalt deficiency which is impractical. However in areas of cobalt deficiency where other means of prevention are being employed, (B12 injection, pasture spraying) when stock are being drenched anyway, cobalt sulphate may as well be given orally as this will provide an additional source which will help extend the effective life of the injection or pasture spray.

f) Combination Of Above

It is likely that most farms experiencing cobalt deficiency will use a combination of methods. The combination of vitamin B12 injections and pasture spraying would appear to be the most effective on the majority of farm situations. A typical situation would be a B12 injection either to the ewes pre-lamb or lambs at tailing followed by pasture spraying commencing round weaning for the lambs. This pasture spraying will be most effective in actively growing pasture. As summer progresses if pastures either go to seed or ground conditions become dry (and hence soil manganese will tie up the applied cobalt) then B12 injections should be reverted to. Either way, towards the end of autumn when hopefully the bulk of works lambs have gone, any tail enders can simply be injected if necessary as can ewe lamb replacements.

Some farmers have found that pasture application is ineffective and use all B12 injections, others have found that a solitary pasture application round weaning is all that is needed. As stated earlier, because of all the factors involved there is no one simple recipe. This is where monitoring comes in.

Cobalt/B12 Monitoring Programme

The judicious monitoring of B12 levels will help:

- Avoid unnecessary expenditure on cobalt/B12 supplementation.
- Prevent economic losses through poor growth rates resulting from undiagnosed cobalt deficiency.

Previous experience on your farm situation will indicate the likely times you should be checking B12 levels. An outline of a broad monitoring programme is given below. Possible monitoring times are:

1. Ewes — pre-lamb.

Serum B12 levels indicate cobalt intake which is often high due to increased soil intake at this time of year. Ewe liver levels may be more useful in predicting the B12 levels of newborn lambs. Liver samples can be obtained by:

- Liver biopsy — see your vet.
- Obtaining liver samples from dead ewes over the pre-lambing period e.g. from ewes that have died from misadventure, bearings, etc. Avoid sampling the 'skin and bone' type death e.g. Johnes disease victims, unless this is a problem you haven't got to the bottom of. Samples from three livers are needed. The first ones can be frozen until the last one is obtained. Pack in three separate containers.

b) Lambs — pretailing.

Serum levels in lambs at this age are not considered so reliable, so liver sampling is the recommended test. The best way is to obtain livers (3) from dead lambs and freeze etc. as mentioned above. Lambs sampled as such should be old enough so that they will definitely have received colostrum since much B12 is passed to the lamb via the colostrum (far less through the milk).

c) Older lambs — Prewearing through to end of autumn.

Earlier in the season prior to lambs going to the works, blood sampling of 10 lambs will determine if a response to treatment is likely or not at the time of sampling. Vitamin B12 levels rapidly reflect dietary cobalt intake (1-2 days) so if you wish to determine the likely cobalt status of a new pasture then blood sample two days after commencement of grazing that pasture.

Avoid blood testing closer than 10-14 days after a mineralised drench containing cobalt as B12 levels will be elevated for a short period following this drench.

Lambs should be yarded only shortly prior to sampling (certainly less than four hours) as prolonged yarding elevates serum B12 levels. Results will be available in 3-4 working days.

As works lambs become available liver samples can be taken at the freezing works (this service has become known as Optigrow). A comment often heard is that it is no use checking the works lambs as they are the better ones. However, these still give a good indication of the on-farm situation as information from trial work has shown similar liver B12 levels in lambs with high body weights to those with low body weights; so that lambs when checked at the works give a good idea of the situation with the rest back on the farm.

To arrange liver sampling contact your local veterinary clinic with details of which works, number in the line, and the date of kill. The clinic will arrange the rest and results will be available in 4-6 working days. Monitoring of lambs B12 levels through the growing season, as well as seeing if supplementation is needed, can also be used to check on the success of supplementation. Experience has shown that supplementation, especially pasture application, is not always successful and just because you have applied cobalt sulphate to pasture it doesn't mean 'she'll be right'.

Your veterinarian will discuss the results of each monitoring with you and after taking into account such factors as the farm's location, how the lambs are doing, time of the season, any previous supplementation and if so, what and when, will recommend a course of action (or inaction as the case may be). As stated earlier simple recipes of: below a certain level — treat, above a certain level — OK, are not possible and if applied as such can lead to incorrect diagnosis and action.

Some works have had schemes (mainly to try and get one up in the procurement war) where a typed 'pre set' comment accompanies the result. These comments, because of a complete lack of knowledge of the history of the property as regards cobalt (previous supplementation for example), must be treated cautiously and results should be taken to your local veterinarian for interpretation. Farmers interpreting their own levels have got into trouble too, through using an over simplistic 'cut off level' approach.

There is no substitute for consultation between the farmer with knowledge of his property and his experienced local veterinarian with knowledge of the wider cobalt scene in his area to come up with the best interpretation of any monitoring carried out and the correct course of action to take.

Summary

Cobalt B12 deficiency, factors affecting it and its prevention is a complex subject and I hope this publication has answered some of your queries, and perhaps shown why cobalt deficiency has become more of a problem on your farm, and why maybe some of your cobalt supplementation methods have not given the desired results. Certainly, there are no doubt other unknown influences at play, some of which may be discovered with further research so that I am under no illusion that I have provided all the answers — I have simply tried to set out the information as it is known to date in a form for you to read and then apply the relevant 'pieces of the jigsaw' to your farm.

It is vital that each farmer sets up management practices to reduce the impact of cobalt deficiency on their own farming operation. An article like this can't cover every individual farming situation specifically so contact your local veterinarian for further advice for *your* situation and the partnership of farmer and veterinarian will come up with the best management practices to handle the cobalt problem on your property.