Final report

PDS - Managing trace element deficiencies in sheep

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Prepared by: Lisa Warn
Lisa Warn Ag Consulting Pty Ltd

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Meat & Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

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1 Abstract

The Bairnsdale Bestwool/Bestlamb group in East Gippsland in Victoria set out to demonstrate best practice for the diagnosis of trace element deficiencies in sheep flocks and conduct cost-benefit analysis of preventative treatment options. The trace element status of 10 flocks was determined from a blood testing program that occurred in spring 2020. Marginal blood selenium levels (GSHPx between 20 and 50 U/gHb) were found in composite, first-cross and Merino lambs on 5 farms and deficient levels (less than 20 U/gHb) in Merino lambs on 1 farm. Marginal blood vitamin B12 levels (between 200 and 400 pmol/L) were found in lambs on 1 farm. Following weaning, five producer demonstration sites were established to assess the effect of selenium and cobalt/vitamin B12 supplementation on sheep live-weight gains, wool production and reproductive rate. Four farms compared a "Control" group of lambs (no trace elements), a "Farm practice" group (occasional use of short acting products) and a "Long acting" group (rumen pellets). The fifth farm compared 2 different short-acting injection regimes and a long-acting treatment, and did not have a Control group (as was very deficient in selenium and cobalt). Trial sheep were blood sampled 3 months and 12 months post treatments. The demo sites were monitored until June 2022, which covered 2 springs and by which time sheep were nearly 2 years old.

On the four farms with a Control group, no major production responses were measured from administering selenium or cobalt. The fifth farm, with no Control group, found that the 2 different regimes of short-acting injections used regularly were able to maintain adequate blood selenium and vitamin B12 like the long-acting rumen pellets, but they were a more expensive option and involved more labour for the yarding and injection of sheep. The response trials highlighted that where sheep tested marginal or at the low end of the normal range for selenium or vitamin B12, there were no production benefits from supplementing selenium or vitamin B12. Although the east Gippsland region has soils that are low in trace elements, deficiencies in sheep do not occur every year and different farms will have different risk factors. Blood testing is an important diagnostic tool to determine the trace element status of young sheep and whether they are at risk.

2 Executive summary

Background

Soils of the coastal and red-gum plains of East Gippsland are known to be marginal or deficient in the trace elements selenium (Se), cobalt (Co) and copper (Cu), which can affect livestock production. Most producers in the region are treating stock with Se and vitamin B12/Co contained in various animal health products but they are not confident that they are implementing the most appropriate and cost-effective preventative program for their individual farms. Most are not making use of diagnostic tests and expertise to determine if they have/at risk of one or more trace element deficiencies and they have not undertaken trials to measure the response/s.

The project aimed to demonstrate best practice for the diagnosis of trace element deficiencies in sheep flocks and conduct cost-benefit analysis of preventative treatment options. The project and results will be used to promote to producers the use of appropriate diagnostic tests, along with expert advice, to diagnose if selenium or vitamin B12, or both, is an issue or not and if so then work out which product/s will supply the required trace elements to cover their main risk period, most efficiently and at lowest cost. This will reduce their cost of production of meat and wool.

Objectives

By June 2023, in the East Gippsland region of Victoria:

1. Ascertain the trace element status of 10 flocks in east Gippsland
2. (In flocks identified to be deficient in one or more trace elements) Demonstrate and assess the effect of different trace element treatment options on live-weight gains of Merino and Composite/Cross-bred lambs, wool production of hoggets and scanning percentage of the maiden ewes.
3. Conduct a cost-benefit analysis to determine the relative economics of the different treatment options used on each farm.
4. Conduct an annual field day and other activities to showcase the demonstration site results and encourage adoption of key practices by the group and other regional producers.

The objectives of the project were achieved. No major production responses were measured in the response trials so the cost-benefit analysis focussed on determining what production benefit would be required to recover cost (break-even) of trace element supplementation.

Methodology

Lambs (x 7) from 10 flocks in east Gippsland were blood-tested by Agriculture Victoria and private veterinarians to determine trace element status. Blood tests were taken from 2020 drop lambs just prior to marking, before they received any trace element treatments in vaccines. The lambs were tested again just before weaning, before they received any trace element treatment in vaccines or drenches. Blood was analysed for selenium (GSHPx activity), vitamin B12 and copper levels.

From this sampling, 5 properties with marginal blood test results were selected to establish treatment response demonstrations. Fifty lambs (replacement ewe lambs or wether lambs) were randomly allocated to each treatment group (a total of 150 lambs/property).

The Bairnsdale Bestwool/Bestlamb group members met regularly to discuss results and a regional workshop was held to share results with other district producers and veterinarians

Results/key findings

- Marginal blood selenium levels (GSHPx activity) were found on 5 farms, and deficient levels found on 1 farm, at either the pre-marking or pre-weaning sampling.
- Low blood vitamin B12 levels were found on 3 or 4 lambs on 2 farms at the pre-marking sampling and did not appear to be an issue at the pre-weaning sampling.
- For the 4 farms that had marginal blood test results for selenium and included a nil/Control treatment, no production responses to selenium or vitamin B12 were measured in the response trials.
  On these farms, the risk of low selenium appeared to be higher than low vitamin B12, during the seasonal conditions when the project was conducted. This could allow vitamin B12 to be dropped out of vaccines which would save money. These farms had marginal Se in the lamb blood tests, but most weaners in nil/Control treatments maintained "low normal" levels and some had marginal blood Se levels, during the trial period. This would indicate a selenium supplement to cover the risk period from pre-lamb (vaccine/injection to late pregnant ewe) to lamb marking to weaning may be adequate and long-acting products at marking/weaning may not be required.
- The fifth farm did not include a nil/Control treatment, due to severe deficiency of selenium and cobalt in the lamb blood tests. The producer found that 2 different regimes of frequent treatment with short-acting Se and vitamin B12 injections were able to maintain adequate blood Se and B12 levels in the weaners as did the long-acting rumen pellets. The use of long-acting products would reduce product costs and labour.
- Although the east Gippsland region has soils that are low in trace elements, deficiencies in sheep do not occur every year and different farms will have different risk factors. Blood testing is an important diagnostic tool to determine the trace element status of young sheep and whether they are at risk. The response trials found that there were no production benefits from administering selenium supplements where sheep tested marginal or at the low end of the normal range for selenium. This is consistent with the findings of experiments conducted in the 1970s and 1980s in Victoria, where responses were only obtained in flocks with very low selenium nutrition (blood GSHPx < 20 U/gHb).
- Both the Core and Observer producers increased their knowledge on the PDS topic (scores lifted from 68% to 88% Core and from 54% to 84% Observer) but it was the core producers who dramatically increased their confidence in managing the issue due to their active participation in running the trials on their own farms. All producers were highly satisfied with the PDS project and the value to their enterprise.

Benefits to industry

This project is relevant to all sheep and cattle producers in east Gippsland as well as producers in other regions known to be marginal for trace elements such as south Gippsland, parts of north-east Victoria, south-east South Australia and King Island.

If not treated, trace element deficiencies cause major reductions in livestock production. Sub-optimum growth rates in lambs reduces the efficiency of pasture utilization, delays sales, increases risk and may lead to higher mortality. Poor mineral nutrition of ewes could affect their reproductive performance and longevity. Conversely, treating sheep that are not deficient increases the cost of production of meat and wool and in the case of Cu could be toxic to sheep.

Correct diagnosis and information on likely response is required to help producers, in all districts known to be marginal for trace elements, plan the most cost-effective preventative treatment program.

Future research and recommendations

Product gaps:

For producers with severe deficiency of selenium or cobalt, long-acting rumen pellets (3 years) are what have been used traditionally. The pellets are slow/labour intensive to administer but prevent the need to come back with repeated injections as per the short-acting products. For producers with a severe selenium deficiency, the availability of a long-acting selenium injection (18 months) can be a more labour and cost-effective option than pellets. The product gap in Australia is in the availability of a long-acting vitamin B12 injection (12 months) which is available in New Zealand and produced by Virbac (called SMARTShot B12). There are currently no plans by the company to make it available in Australia. Perhaps future response trials could include this product to evaluate against the other options.

Information gaps/too many products:

Animal health products containing selenium and vitamin B12 are readily available in rural merchandise stores in all districts and are widely promoted to sheep producers. Inclusion of trace elements significantly increases the cost and in many districts they are not needed.

More independent testing/evaluation and information about products is required to help producers in different regions make more informed decisions about whether to use a product and the cost-benefit. These evaluations could be supported by producer groups to customise them to the region.

3 PDS key data summary table

Project Aim:
The project aimed to demonstrate best practice for the diagnosis of trace element deficiencies in sheep flocks and conduct cost-benefit analysis of preventative treatment options.

	Comments		Unit
Production efficiency benefit (impact) Lamb growth rate (kg) Reproductive efficiency – scanning % Mortality rate (%)	**Long-acting vs Control** 0 - 1 .5 kg weight gain (after weaning) No diff in scan % No diff in mortality rate.	0 -1.5 kg LWT @ $2.50/kg	Per head
Reduction in expenditure Reduction in labour Reduction in other expenditure	Nil	0	
Increase in income	Liveweight gain	$ 0.00 – 3.75	Per head
Additional costs (to achieve benefits) **Pellets (Se + grinder, or Co + grinder, or Se + Co)** **Additional labour to administer pellets (2 mins/sheep@$50/hr = $1.70)**	$ 0.92 – 1.49 $1.70	$ 2.62- 3.19	Per head
Net $ benefit (impact)		**($3.19) - $ 0.56**	**/head**
Number of core participants engaged in project	5 farms - demos site hosts	8	
Number of observer participants engaged in project	Rest of BWBL group (6 farms)	7	
Core group no. ha		6,600	Ha
Observer group no. ha		10,500	Ha
Core group no. sheep		37,000	hd sheep
Observer group no. sheep		33,900	hd sheep
Core group no. cattle		1850	hd cattle
Observer group no. cattle		2200	hd cattle
% change in knowledge, skill & confidence – core *(managing trace element deficiencies in your sheep)*	*Knowledge- Pre 5.4/8* *Post 7.0/8* *Confidence- Pre 5.2/10* *Post 8.0/10*	K: 68% to 88% C: 52% to 80%	
% change in knowledge, skill & confidence – observer	*Knowledge- Pre 4.2* *Post 6.7* *Confidence- Pre 5.2* *Post 5.7*	K: 53% to 84% C: 52% to 57%	
% practice change adoption – core	**Blood test lambs at weaning (if unsure of trace element status)* **Changes made to animal health program*	100% 100%	
% practice change adoption – observers	**Blood test lambs* **Changes to An Health*	67% 67%	
% of total ha managed that the benefit applies to **% of total head of sheep managed that the benefit applies to** (based on % adoption)	*13,635 Ha/ 17,100 ha* *59,713 / 70,900 head*	80% 84%	
Key impact data			
Net $ benefit /ha (impacted ha) (59,713 hd /13,635 Ha = 4.3 sheep/ha)	**$ (13.72) – $ 2.41/ha**		
Net $ benefit /ha (total ha managed) (70,900 hd /17,100 Ha = 4.1 sheep/ha)	**$ (13.08) – $ 2.30/ha**		

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1. Background

1.1 The problem

Soils of the coastal and red-gum plains of East Gippsland are known to be deficient in the trace elements copper (Cu), selenium (Se), cobalt (Co) and molybdenum (Mo). Some areas may also be deficient in Zinc (Zn). Cu and Mo deficiencies affect legume/pasture production while Cu, Se and Co deficiencies affect livestock production. This project focuses on trace element deficiencies in livestock. Areas where responses to trace elements were obtained were documented in "Trace elements Victoria" by Hosking *et al.* (1986) based on available experimental data at the time. It is possible that in high production systems, trace element deficiencies may have been created on farms/districts not previously thought to have problems.

Most producers in the region are treating stock with various trace elements but are not making use of diagnostic tests and expertise to determine if they have one or more trace element deficiencies and they have not undertaken trials to measure the response/s. Many producers are using short-acting products (eg. Se and vitamin B12 combined 6 in1 vaccines or Se /Co in drenches) which may not be necessary or may not be giving adequate protection at the right time of year. One member of the Bestwool/Bestlamb group performed a sheep Se response trial 15 years ago and while blood Se was low they did not measure a production response. However, their production system has intensified since then and the situation needs to be reviewed. No sheep Cu or Co response trials have been conducted in the region recently.

Correct diagnosis and information on likely response is required to help regional producers plan the most cost-effective preventative treatment program.

1.2 Impact

If not treated, trace element deficiencies cause major reductions in livestock production. Sub-optimum growth rates in lambs reduces the efficiency of pasture utilization, delays sales, increases risk and may lead to higher mortality. Poor mineral nutrition of ewes could affect their reproductive performance and longevity.

Conversely, treating sheep that are not deficient increases the cost of production of meat and wool and in the case of Cu could be toxic to sheep.

This issue impacts on all sheep and cattle producers in East Gippsland. Producers in other regions such as South Gippsland, north-east Victoria, south-east South Australia and King Island, are also impacted but are not the focus of this project.

1.3 How issue currently being addressed currently

Mo and Cu deficiencies in pastures are treated with occasional (every 6-7 years) applications of Mo and Cu in with the fertiliser. Most of the group members have been doing this but not all producers in the region have kept up with this program due to the additional cost of the fertiliser. Copper applied in fertiliser can provide a supply of copper to livestock which may or may not be adequate. Se, Co and Cu deficiencies can occur in livestock in the region, with many farms at risk of Se and Co issues, while other farms can have all 3 deficiencies (particularly if haven't applied Cu in fertiliser). Producers are aware of the need to preventatively treat sheep with trace elements and they do have programs in place but they are not confident that they are implementing the most appropriate and cost-effective program for their individual farms. A small number of producers administer ruminal Se

and Co pellets to young sheep (the most at risk group) which can give them 2-3 years protection. Other producers are supplying Se in multiple applications via drenches and vaccines or using B12 injections (instead of Co), which may or may not be giving adequate protection of stock and may add to the cost of production of meat and wool. Hence, there is a need to establish the more precise nature of the trace element deficiency on individual farms and demonstrate which preventative treatment options are the best for their situation. The project will also demonstrate appropriate practices for diagnosis of trace element deficiencies (i.e. blood tests, liver samples/biopsies for Cu) and use leaf analysis to highlight seasonal variation in clover and grass mineral status.

The benefits of using the RFID ear tags and eID technology to collect and collate data will also be demonstrated.

This project addresses the national RD&A priority to "*optimise production from the feedbase"* in order to reduce the cost of on-farm production of sheepmeat.

2. Objectives

By June 2023, in the East Gippsland region of Victoria:

1. Ascertain the trace element status of 10 flocks in east Gippsland
2. (In flocks identified to be deficient in one or more trace elements) Demonstrate and assess the effect of different trace element treatment options on:
    a. Live-weight gains of Merino and Composite/Cross-bred lambs
    b. Wool production of lambs at their lamb shearing plus hogget shearing for self-replacing flocks
    c. The reproductive rate (Scanning % and marking %) of Merino and Composite ewes
3. Conduct a cost-benefit analysis to determine the relative economics of the different treatment options used on each farm.
4. Conduct an annual field day and other activities to showcase the demonstration site results and encourage adoption of key practices by the group and other regional producers.

The objectives of the project were achieved. No major production responses were measured in the response trials so the cost-benefit analysis focussed on determining what production benefit would be required to recover cost (break-even) of trace element supplementation.

3. Demonstration Site Design

3.1 Methodology

3.1.1 Farm selection

The project was undertaken in the Bairnsdale district in east Gippsland from July 2020 to June 2022. Ten flocks in the Bairnsdale Bestwool/Bestlamb group were blood-tested. Trace elements of interest were selenium, cobalt (vitamin B12), and copper.

Blood test were taken from 2020 drop lambs just prior to marking, before they received any trace element treatments in vaccines. The lambs were tested again just before weaning, before they received any further trace element treatment in vaccines or drenches.

Sheep (x 7) from the 10 flocks were blood-tested by Agriculture Victoria veterinarians to determine trace element status. Samples were sent to Dr David Paynter, at the Regional Lab Services in Benalla, for analysis.

The original protocol was to only test lambs at weaning to identify any trace element deficiencies for farm demo site selection. However, further advice from Dr David Paynter was to also test lambs pre-marking in case the effect of marking vaccines (ie. 6 in 1), containing selenium and vitamin B12, was still apparent at weaning. This earlier testing (at marking) also highlighted potentially deficient flocks earlier and gave more time to select and prepare producers for setting up demo sites at weaning.

On all farms, pregnant ewes received a 6 in 1 vaccine in the month pre-lambing. Some of the producers used a 6 in 1 vaccine that included selenium or vitamin B12. Producers were reluctant to omit the trace elements from the pre-lamb vaccine in case there was deficiency that might affect the new born lambs. However, advice from the project's veterinarian consultant Dr Helen McGregor, was that by the time the lambs were marked any effect from the ewe's pre-lamb treatment would have waned, so blood testing lambs at marking would still give a good indication of the lamb's trace element status.

From this sampling, 5 properties with marginal blood test results were selected to establish treatment response demonstrations. Fifty lambs (replacement ewe lambs or wether lambs) were randomly allocated to each treatment group (a total of 150 lambs/property). All lambs were tagged with a RFID tag so they could be individually identified. They were also tagged with an additional coloured tag, supplied by Shearwell Australia, for easy identification in the drafting race and paddock. Treatments began at lamb weaning in 2020.

On two farms, a sample of 3 and 4 year old ewes that had received rumen pellets containing trace element as lambs, were also blood tested to study if the effect was waning. This additional testing was sponsored by Coopers Animal Health.

Blood tests were taken 3 months post treatment (over the period January to March 2021) from a sample of sheep in each treatment group on the 5 farms and again at 12-months post treatment (over the period November 2021 to March 2022).

3.1.2 Treatments

Treatments began at lamb weaning in 2020.

Treatments were:

(i) **Control** (no trace elements)
(ii) **Normal Farm Practice** - Short-term trace element products applied as part of the producers normal drenching and vaccination program (eg. selenium and vitamin B12 in vaccines or injections; selenium and cobalt sometimes in drenches).
(iii) **Long-acting products** - Rumen pellets (Selenium and Cobalt).

One farm, was extremely deficient in selenium and vitamin B12 and had a history of clinical deficiency symptoms in sheep, so the producer chose not to have a Control/Nil treatment. Instead, they compared two different regimes of short-acting products against the long-acting products.

All demo lambs on each farm were run together as one mob.

No supplementary feeding occurred during the period the response trials were run over as there was adequate summer rainfall to provide some pasture growth and green feed for weaner sheep. Hence, there were no trace elements supplied to sheep via any supplementary feed which if had occurred may have confounded results from applied treatments.

3.1.3 Sheep measurements

Ewe or wether lambs (2020 drop) were monitored from weaning through to hogget shearing and the ewes lambs until joining/scanning. Measurements included: Live-weights, growth rate, fleece weights, fibre diameter, and pregnancy scanning. Any mortalities were also recorded.

Lambs were blood tested in late summer/autumn 2021, around 3 months after treatments were applied to show changes in trace element concentration. These sheep were blood tested again in spring 2021 to compare blood Se, vitaminB12(Co) and Cu status in the treatment groups.

The benefits of using the eID technology to collect and collate data was also able to be demonstrated. All demo farms had RFID tag reader equipment and weigh scales.

3.1.4 Pasture measurements

On each of the 5 demo farms, herbage samples were cut and collected from paddocks where lambs were weaned into in spring 2020. Samples were collected again in winter and spring in 2021 from paddocks where the lambs were grazing. Herbage samples were sent to the Nutrient Advantage laboratory (Incitec Pivot) at Werribee for analysis of Se, Co, Cu content. The samples submitted for each farm were a bulk sample of all species present and were not sorted into species components. Pasture composition (% dry matter basis) was also assessed when herbage samples were collected.

This information was used to demonstrate to producers changes in herbage trace element status that can occur during the year and any differences in different pastures/crops being grazed.

3.2 Economic analysis

A cost-benefit analysis was conducted based on the cost of the treatment and the value of the response (if any) in terms of extra meat or wool produced. In the PDS Key Data Summary table (page 6), the additional costs and range in liveweight benefits of treating sheep with the long-acting rumen pellets (selenium and cobalt) was compared with Control treatment group. As no major liveweight (or other production) responses were obtained, another series of calculations were done to determine what liveweight gain would be required to recover cost (break-even) of different trace element supplementation options.

3.3 Extension and communication

The primary audience for extension and communication activities were the Bairnsdale Bestwool/Bestlamb group and other sheep producers in Gippsland, Victoria. The secondary audience were regional Agriculture Victoria veterinarians and extension staff, private vets and representatives from Animal health companies/Rural merchandise outlets.

The Bairnsdale Bestwool/Bestlamb group met every second month and were kept up to date with PDS results from the 5 local farms by reports from the PDS hosts and the group co-ordinator.

An annual event (field day/workshop) was planned to be held to promote the project and results to the wider community. This plan was disrupted by Covid-19 restrictions during 2021 as group/public events could not be held. One public event was held in July 2022.

It was planned to consult with organisers to present results at the Bestwool/Bestlamb co-ordinators conference in 2021 (for consultants/advisers) but this event was disrupted by Covid-19 restrictions.

Project updates appeared in the SALRC newsletters and on the MLA PDS website page.
An article about the project was written for MLA's Feedback magazine and an article/fact sheet was written for Agriculture Victoria's SheepNotes newsletter which is mailed to all sheep producers in Victoria. A copy of these documents are in the Appendix.

3.4 Monitoring and evaluation

The main methods used for monitoring and evaluating the project, and assessing the success of the communication activities were as follows:

- Pre and Post survey of core group members, and observers, showing knowledge and skill change and practice change
- Numbers of people attending events
- Evaluation of events (ie. aim for 70% satisfaction)

4 Results

4.1 Demonstration site results

4.1.1 Group survey - lamb blood test results

The 10 farms received blood test results from a sample of 7 lambs/property taken pre-marking and pre-weaning. The location of the farms and sheep details is summarised in Table 1.

Table 1. Farm location, sheep details and geology/soil type

Farm	Location	Sheep breed	Start of lambing	Lamb marking	Wean	Soil type
1	Walpa	Composite	Mid June	5 Aug	Mid Sept	Pleistocene alluvial deposits - sandy loams & sands
2	Bengworden	Merino	Early July	17 Aug	End Sept	Pleistocene alluvial deposits - sandy loams
3	Meerlieu	Merino	Early July	18 Aug	End Sept	Pleistocene alluvial deposits - sandy loams
4	Seacombe	Merino	Early Aug	7 Sept	End Oct	Pleistocene alluvial/aeolian deposits -sands
5	Bengworden	Merino & Crossbred	Early Aug	14 Sept	End Oct	Pleistocene alluvial deposits - sandy loams
6	Lindenow Sth	Merino	Early Aug	16 Sept	End Oct	Pleistocene alluvial deposits - sandy loams
7	Meerlieu	Merino	Late Aug	1 Oct	Mid Nov	Pleistocene alluvial deposits - sandy loams
8	Hillside	Merino & Crossbred	Early Aug	20 Sept	End Oct	Pleistocene alluvial deposits - sandy loams
9	Nicholson	Merino	Early Sept	25 Oct	Late Dec	Pliocene marine deposits – sandy loams
10	Stratford	Merino	Late Aug	15 Oct	Late Nov	Pleistocene alluvial deposits - sandy loams

The key findings from the blood testing were:

Selenium

Marginal blood selenium levels were found on 5 farms and deficient levels were found on 1 farm (Figure 1) at either the pre-marking or pre-weaning sampling. All farms, except Farm 3, used a 6 in 1 vaccine with selenium included as their standard marking vaccine.

Farm 3 selenium levels were lower pre-weaning, than pre-marking, while most of the other farms had higher levels pre-weaning. On Farm 3, the lambs tested pre-weaning were from a mob of 3 and 4 year-old ewes who had been treated with Se rumen pellets as hoggets. This would explain the higher blood selenium levels in the lambs pre-marking.

Farm 5 had low selenium levels at both sampling times and Farm 10 had low selenium levels pre-weaning even though they both used selenium in the marking vaccine (NB: Farm 10 missed the pre-mark blood sampling).

Provision of Se to the ewe during pregnancy will transfer Se through the placenta into the foetal tissue and into colostrum and milk (Erdogan *et al*. 2017). Colostrum contains more selenium than milk (Meneses *et al.* 1994). However, a continual supply of selenium to the ewe during lactation can increase selenium in the milk. This has been shown to occur with a long-acting product given during pregnancy (Wojcik *et al*. 2021) or several short-acting injections (sodium selenite) given to the ewe at lambing and during lactation (Meneses *et al* .1994). An injection to ewes with the short-acting selenium at lambing was shown to lift milk selenium for only 14 days (Meneses *et al* .1994). From this, it could be assumed that on the farms were ewes were treated in the last month of pregnancy with a short-acting form of selenium contained in vaccines, you could expect the impact to have waned by the time the lambs were blood tested pre-marking.

Despite the fact that 9 out of the 10 producers used vaccines with Se, the blood test results indicated that lambs on some farms were still low/marginal and that these farms were worthwhile conducting Se response trials on.

Copper

Low blood copper levels were only found on 1 or 2 lambs on 2 farms at the pre-marking sampling and did not appear to be an issue at the pre-weaning sampling (Figure 2). Copper was not included in standard treatments given to lambs at marking.

Vitamin B12

Low blood vitamin B12 levels were found in 3 or 4 lambs on 2 farms at the pre-marking sampling and did not appear to be an issue at the pre-weaning sampling (Figure 3). Eight of the 10 farms used a 6 in 1 vaccine, with vitamin B12 included, as their standard marking and weaning vaccine. Farms 6 and 10 did not. However, lambs on Farm 6 had adequate vitamin B12 when tested pre-weaning and the levels had increased markedly from the pre-marking tests. Farm 10 had adequate vitamin B12 when lambs were tested pre-weaning.

For the other 8 farms, it is difficult to conclude whether the use of the marking vaccine with vitamin B12 was maintaining adequate blood vitamin B12 levels at the pre-wean testing or whether lambs obtained adequate levels anyway, once they started grazing and ingesting herbage and soil.

The trend observed for vitamin B12 to be lower in the pre-marking blood tests than the pre-weaning blood tests is a consistent with data from Halpin and Caple (reported in Hosking et al 1986). They demonstrated that in non-supplemented sheep, plasma vitamin B12 concentrations are normally lowest in pre-ruminant lambs and then increase as the lamb develops. Ewes can transfer some vitamin B12 to the lamb in utero and in the colostrum but there is very little vitamin B12 supplied in milk.

Figure 1. Blood selenium results (from 7 lambs) for each property taken pre-marking (M) and pre-weaning (W). *Low Normal* for blood selenium is GSHPx 50 U/gHb. The blue line indicates results that are below 50 U/gHb. *Marginal* is between 20-50 U/gHb and *Deficient* is below 20 U/gHb.

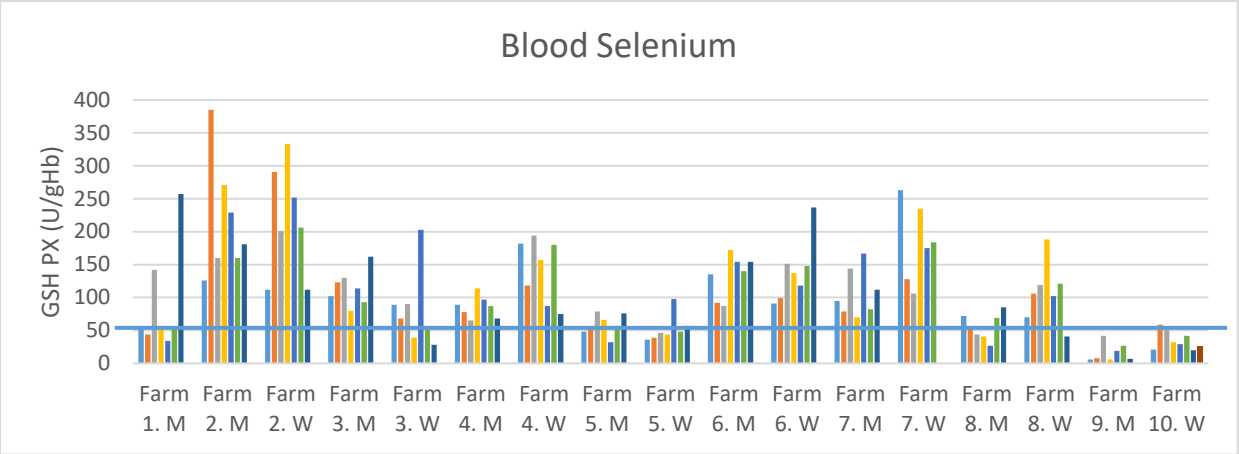


Figure 2. Blood copper results (from 7 lambs) for each property taken pre-marking (M) and pre-weaning (W). *Low normal* for blood copper is 7.5 um/L. The blue line indicates results that are below 7.5 um/L.

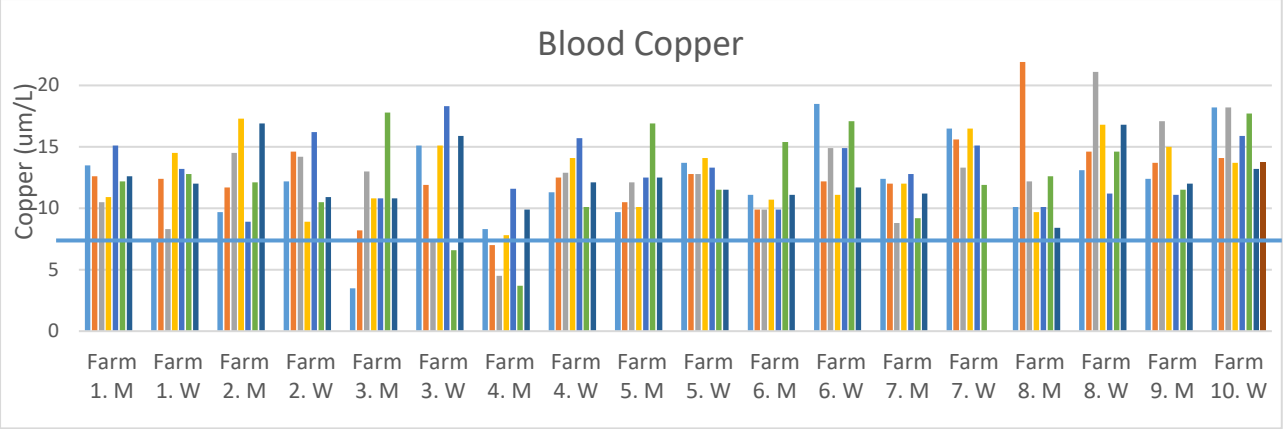
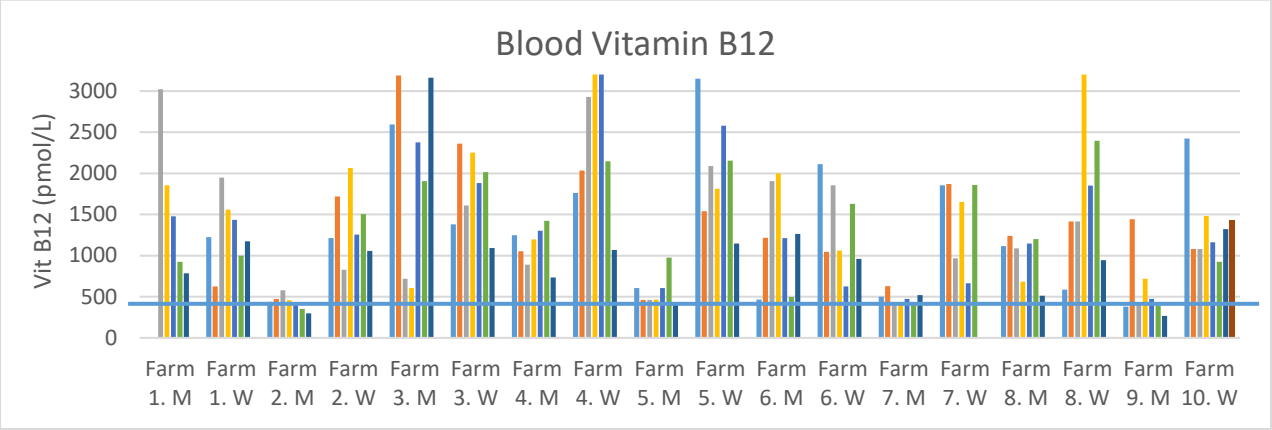


Figure 3. Blood Vitamin B12 results (from 7 lambs) for each property taken pre-marking (M) and pre-weaning (W). *Low normal* for blood Vitamin B12 is 400 pmol/L. The blue line indicates results that are below 400 pmol/L. *Marginal* is between 200- 400 pmol/L and *Deficient* is below 200 pmol/L.



4.1.2 Selection of producers for demo farms

Five producers were selected to run a trace element response trial. This was based on the blood test results (Figures 1,2 and 3) and extensive consultation with the project's Veterinarian consultant. Farms selected were Farms 1, 3, 5, 8 and 9. Farm 10 missed the pre-marking blood testing so the deficiency was only identified pre-weaning and by that time the five demo sites had already been selected.

The trials were established in late spring/early summer 2020 (Figure 4). While selenium appeared to be the main deficiency to investigate, the effect of cobalt supplementation (for vitamin B12) was also studied. For the farms that had some low results for copper, it was recommended that the weaner sheep be run on pastures that had a history of being top-dressed with copper in the fertiliser to ensure they were not deficient.

The following sheep were studied in the demonstrations.

- Farm 1: Composite ewe lambs
- Farm 3: Merino ewe lambs
- Farm 5: Merino wether lambs
- Farm 8: Merino ewe lambs and first-cross ewe lambs
- Farm 9: Merino ewe lambs

Figure 4. Group members setting up their PDS on their properties. This involved randomly drafting off 150 weaners and allocating 50 to 3 different treatment groups, tagging, administering Se and Co rumen pellets and weighing. *(photo on left - John Alexander, top right - John and Ken Alexander, bottom right Andrew Sheridan and Ben Belcher)*

4.1.3 Blood test results - 3 months and 12 months post treatment for demo farms

Blood tests were taken 3 months post treatment (over the period January to March 2021) and again at 12-months post treatment (over the period November 2021 to March 2022). Results for post-treatment blood tests for selenium and vitamin B12 are shown in Figures 5 and 6.

No supplementary feeding of grain/pellets/hay occurred during the trial period as there was some green pasture available to weaner sheep over their first summer/autumn, so there was no additional sources of trace elements in the feed supply other than that in the grazed pasture/soil.

4.1.3.1 Selenium

The selenium rumen pellets were effective at increasing blood selenium in weaner sheep from the deficient/bottom of the normal range (GSH PX <50 U/gHb) to the top of the normal range (550 U/gHb) (Figure 5).

Farm 1

Farm 1 had not administered any trace element to the Farm Practice group as at the 3-month blood sampling, so the Control and the Farm Practice were essentially the same treatment. Blood selenium levels were adequate for the Control sheep at the 3 month sampling in autumn 2021 but were closer to the Low Normal end of the range at the 12 months sampling in late spring 2021, indicating there was no Se deficiency.

Farm 1 gave the "Farm Practice" sheep a long-acting selenium injection (Selovin) in winter 2021 pre-lambing, and 4 months later (at the 12 months blood sampling) this was still having a similar impact on blood selenium to the long-acting rumen pellet that was administered 12 months prior.

Farm 3.

Farm 3 had not administered any trace element to the Farm Practice group as at the 3-month blood sampling, so the Control and the Farm Practice were the same treatment. Blood selenium levels were adequate for the Control sheep at the 3 month sampling in autumn 2021 but some sheep were in the marginal range at the 12 months sampling in early summer 2021, indicating there was a risk of a deficiency. Farm 3 did not use Se in the vaccine at marking or weaning and some lambs tested pre-marking had blood Se levels in the marginal range but levels had improved at 3-month blood sampling without any Se supplementation.

Farm 3 gave "Farm Practice" sheep a short-acting (SA) selenium injection (Multimin) in late November 2021 when the sheep were weighed. The blood test results were taken in December 2021. The SA selenium increased the Se in the blood relative to the Control when measured a month later. The LA Se pellet treatment continued to maintain higher blood Se levels.

Farm 5

Farm 5 had not administered any trace elements to the "Farm Practice" group at the time of the 3 or 12-month blood tests so that treatment was the same as the Control, hence the blood test results are similar. Blood selenium levels were in the marginal range for the Control sheep at the 3 month sampling in autumn 2021 which indicated the Se injection at weaning was not maintaining adequate blood selenium for this duration. This finding is consistent with general recommendations that selenium incorporated in vaccines will be effective in providing adequate selenium levels only for about 6-8 weeks.

Blood selenium levels for the Control sheep were at the low normal end of the range the 12 month sampling in late spring 2021, indicating there was no deficiency in spring. The LA pellet treatment continued to maintain high blood selenium levels at the 12 month testing.

Farm 8

Farm 8 had not administered any trace elements to the "Farm Practice" group at the time of the 3 or 12-month blood tests so that treatment was the same as the Control, hence the blood test results are similar. Blood selenium levels were in the marginal range for some of the Control sheep while some had adequate levels at the 3 month sampling in autumn 2021, but all were above the low normal end of the range the 12 month sampling in late spring 2021, indicating there was no deficiency in spring. The LA pellet treatment continued to maintain high blood selenium levels at the 12 month testing.

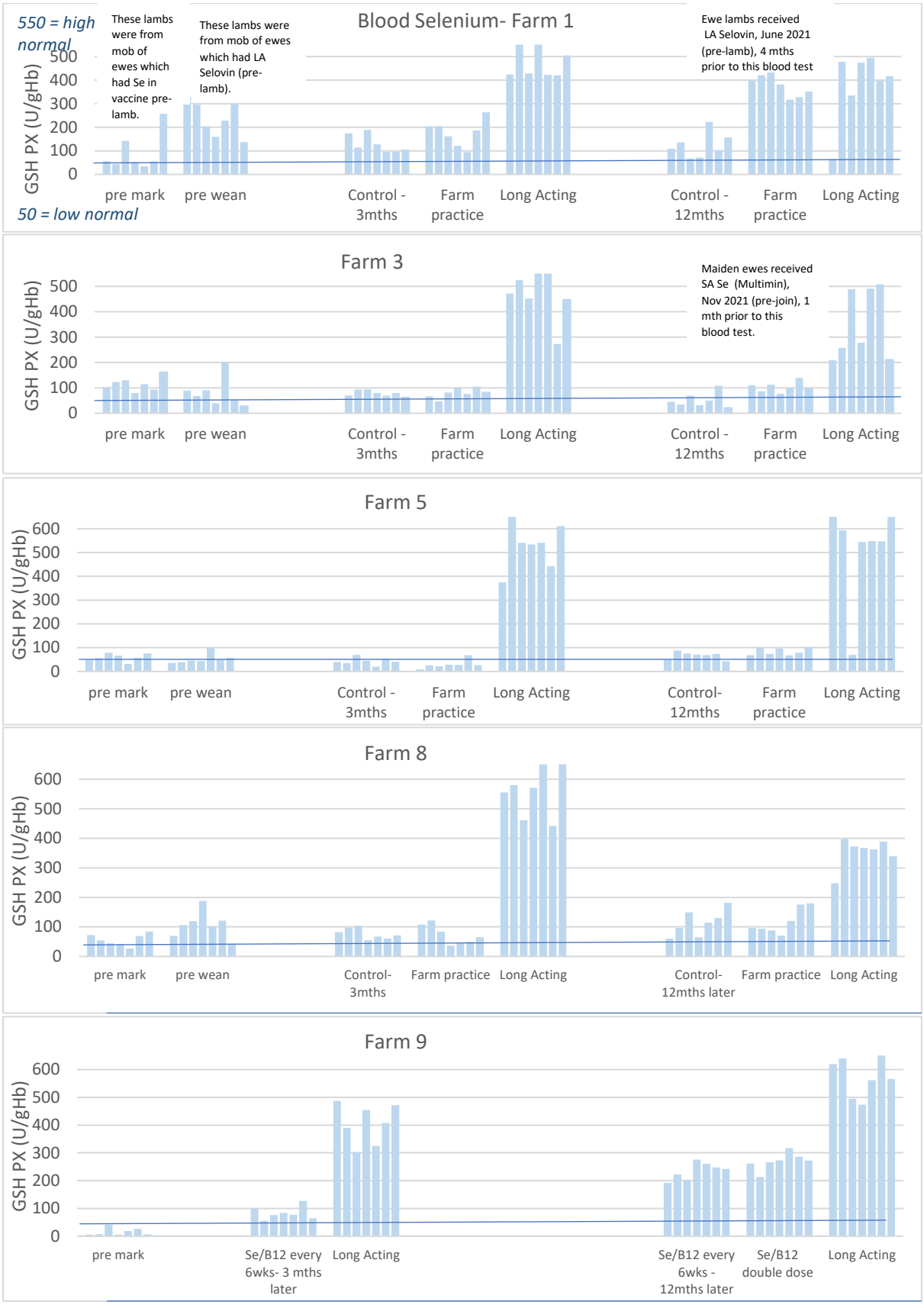
Farm 9

Farm 9 did not leave a "Control" group due to the producers concerns about the property's very low selenium levels. The "Farm Practice" group on Farm 9 received selenium and vitamin B12 injections every 6 weeks (1ml each) which is the manufacturers guidelines for treating a severe deficiency. At the 3 month testing, even at this frequency, the selenium injections did not raise blood selenium to a high level like the rumen pellets, but maintained the levels at the bottom end of the Low Normal range.

After the first 3 months of the trial the second short-acting treatment commenced. This involved a double dose of Se (& vitamin B12) every 12 weeks instead of a single dose every 6 weeks. This alternative short acting treatment was investigated to save labour and time spent yarding sheep.

The results indicate that 2 short acting Se injection regimes maintained a similar and adequate blood Se level. The LA rumen pellets maintained a higher blood Se level.

Figure 5. Blood selenium results (from 7 lambs) for the five PDS farms, 3 months and 12 months post-treatment. Low normal for blood selenium is 50 U/gHb. The blue line indicates results that are below 50 U/gHb. *Marginal* is between 20-50 U/gHb and *Deficient* is below 20 U/gHb.



4.1.3.2 Vitamin B12/Cobalt

There was no major concern about vitamin B12/cobalt deficiency except for Farm 9. On Farms 1, 3, 5 and 8, lambs tested pre-marking all had blood cobalt levels in the normal range. On Farm 9, 4 out of the 7 lambs tested were in the marginal range pre-marking (Figure 6).

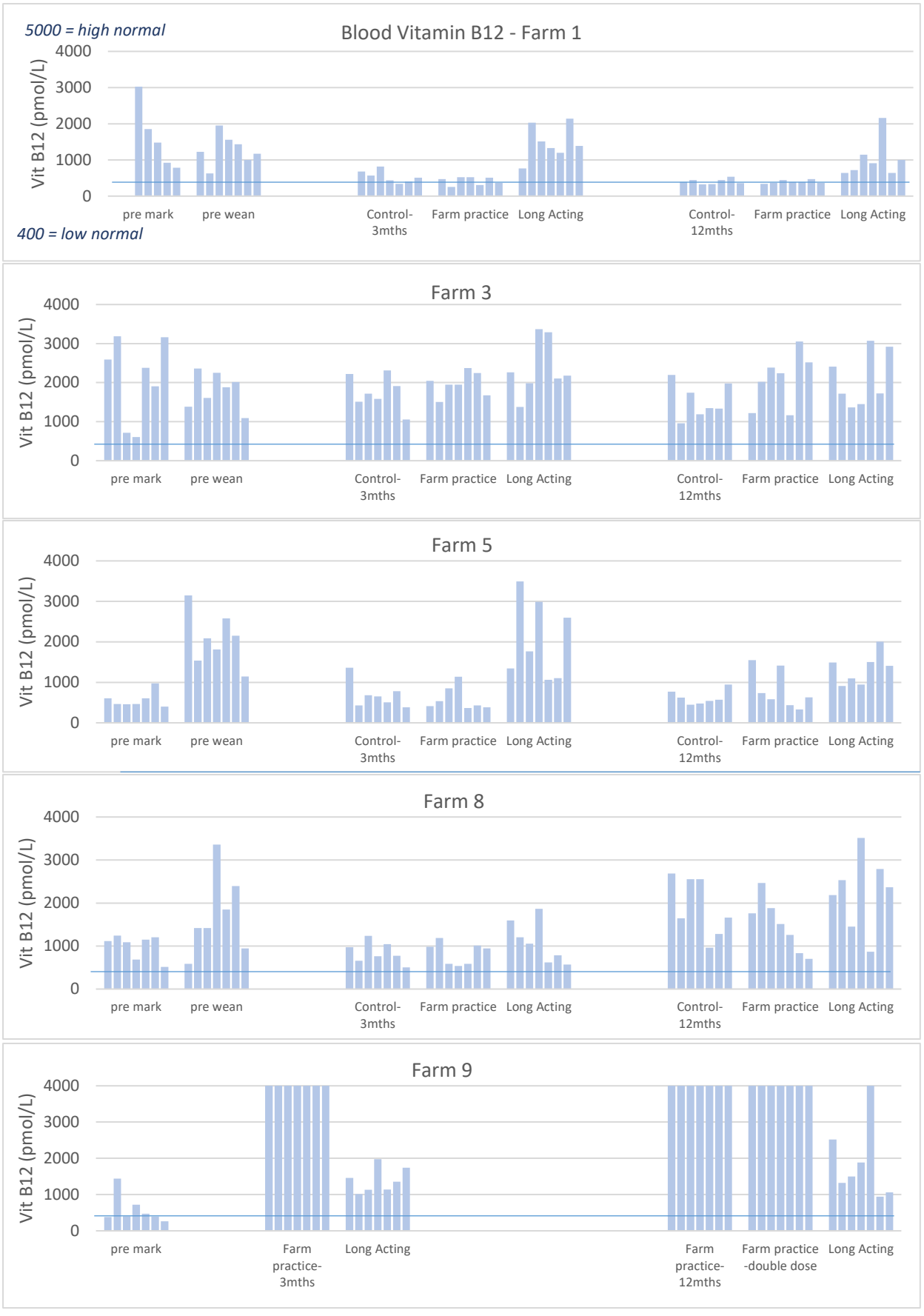
The 5 demo farms did give lambs vitamin B12 in the marking and weaning vaccine, except Farm 5 did not include vitamin B12 in the vaccine given to the Control sheep.

Farms 1, 3, 5 and 8, did not give the lambs in the Control or Farm Practice groups any other vitamin B12/cobalt supplements post-weaning, so these 2 treatments were same from that point. Farm 9 gave the Farm Practice group vitamin B12 injections every 6 weeks after weaning and after the 3-month blood testing occurred, they started up the other short-acting regime of a double dose every 12 weeks.

On Farms 3 and 8, three months after the injection of vitamin B12 at weaning, blood vitamin B12 levels were still well above the low normal benchmark even without any top-up treatments in the Control/FP groups. This did not necessarily mean the injection was still having an impact but sheep could have been picking up cobalt from the herbage/soil. In comparison, on Farm 1 at the 3-month blood testing some sheep in the Control/FP groups were in the marginal range. Similarly, on Farm 5 although they did not give vitamin B12 to the Control group at weaning, this did not appear to make any difference in blood levels between the Control and Farm Practice by the time of the 3-month testing. There was one sheep in each group that had vitamin B12 levels just below the low normal range. On Farm 9 the blood vitamin B12 levels in the Farm Practice group were at the top of the normal range due to regular injections. General recommendations are that a single injection of vitamin B12 will prevent the development of deficiency for 6-8 weeks in lambs. Hence, you would not expect to see an impact of the weaning injection 3-months later in the blood tests for Farms 1,3,5 and 8.

On all five farms, the long-acting cobalt treatment with rumen pellets was effective at increasing and maintaining blood cobalt in weaner sheep in the middle of the normal range (400-5000 pmol/l). On Farm 9, the 2 short-acting B12 injection regimes kept blood vitamin B12 at a higher level than the cobalt rumen pellets.

Figure 6. Blood Vitamin B12 results (from 7 lambs) for the five PDS farms, 3 months and 12 months post-treatment. Low normal for blood Vitamin B12 is 400 pmol/L. The blue line indicates results that are below 400 pmol/L. *Marginal* is between 200- 400 pmol/L and *Deficient* is below 200 pmol/L.



4.1.4 Pasture assessments

An estimate of herbage mass (feed on offer) was taken in each paddock where trial lambs were to be weaned into. Pasture composition (on a % dry matter basis) was also assessed. Results are summarised in Table 2. Paddocks grazed by weaners all had low clover contents.

Table 2. Herbage mass and Pasture composition (% dry matter basis) of paddocks where trial lambs were to be run after weaning.

FARM	1. Short-term rye (K2)	1. Short-term rye (P 3 sth)	3	5	8 Brassica (Centre Scots)	8 Brassica (Bush)	9
Date	7/10/20	7/10/20	25/11/20	25/11/20	11/12/20	11/12/20	26/11/20
Herbage mass (kg DM/ha)	2000 green	2500 green	1000 green & 500 dead	500 green & 1500 dead	2500 green	2500 green	2500 green
Legume %	10	0	5	10	-	-	10
Sown species %	90 (biennial ryegrass)	100 (biennial ryegrass)	75 (kikuyu)	5 (cocksfoot)	100 (brassica)	100 (brassica)	10 (kikuyu)
Native grass %	-	-	-	10	-	-	70
Annual grass weeds %	-	-	15	50	-	-	-
Peren. grass weeds %(couch)	-	-	-	5	-	-	-
Broadleaf Weeds %	-	-	5	20	-	-	10

4.1.5 Leaf analysis results

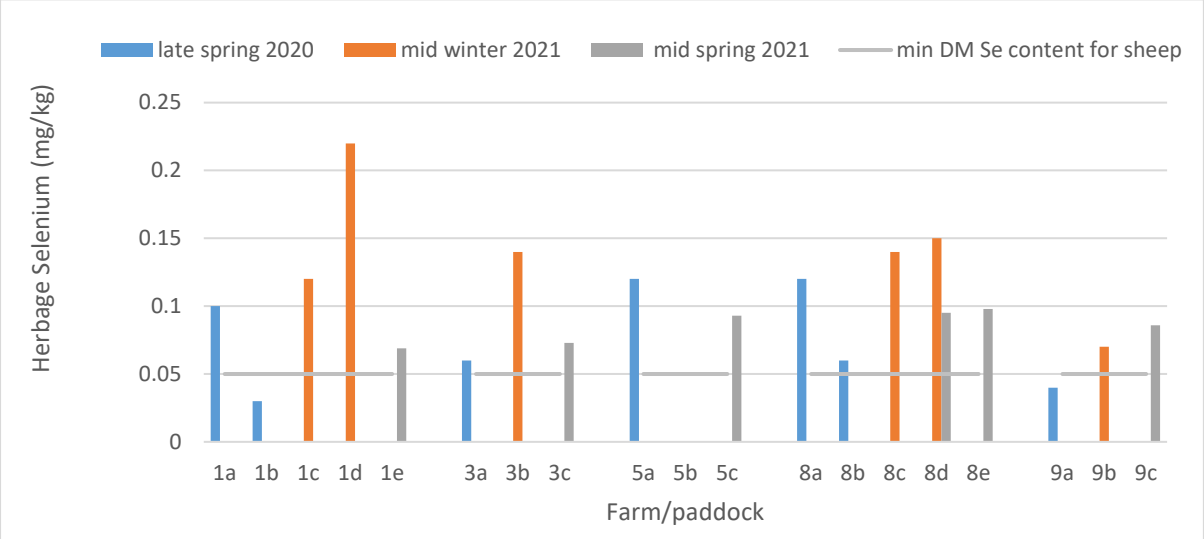
From each of the paddocks listed in Table 2, pasture cuts were taken and the samples submitted to the Nutrient Advantage laboratory (IPL) for nutrient analysis. Results for the bulk samples (not sorted into species) are summarised in Table 3. The results for all the herbage samples taken during the project (spring 2020, winter 2021 and spring 2021) are shown in Figure 7.

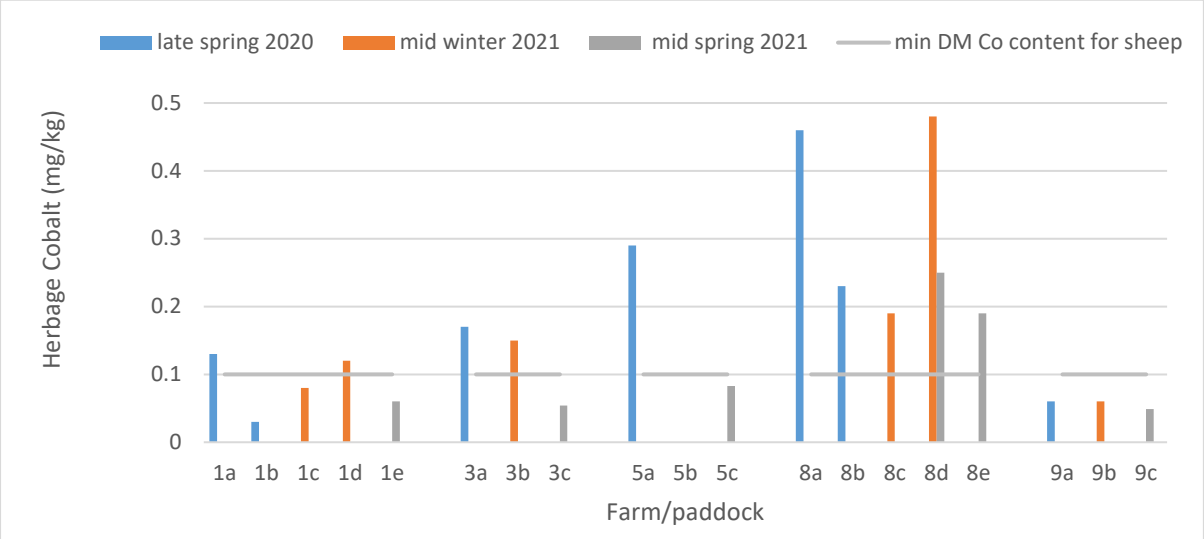
Table 3. Trace element concentration in herbage samples taken from weaning paddocks, spring 2020.

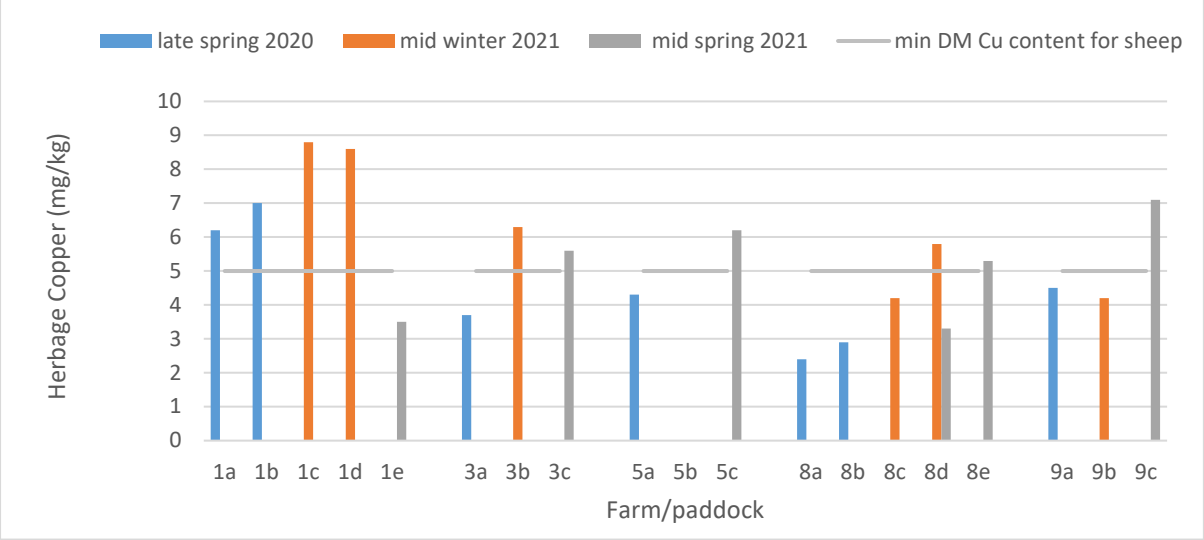
FARM	1. Short-term rye (K2)	1. Short-term rye (P 3 sth)	3 Kikuyu	5 Annual grasses	8 Brassica (Centre Scots)	8 Brassica (Bush)	9 Native grasses	*Minimum nutrient content for sheep*[1]
Date	7/10/20	7/10/20	25/11/20	25/11/20	11/12/20	11/12/20	26/11/20	
Selenium (mg/kg)	0.10	0.03	0.06	0.12	0.12	0.06	0.04	***0.05***
Copper (mg/kg)	6.2	7.0	3.7	4.3	2.4	2.9	4.5	***5.0***
Cobalt (mg/kg)	0.13	0.03	0.17	0.29	0.46	0.23	0.06	***0.10***

[1] Trace elements for Pastures & Animals in Victoria (1986).

Figure 7. Herbage trace element content, from samples collected on each farm paddock where trial sheep were grazing. The grey line indicates the minimum content of the trace element in the dry matter required for sheep.







Blood testing for Selenium and vitamin B12 (Cobalt) is the more definitive method of diagnosing possible trace element deficiencies rather than leaf or soil analysis. However, the herbage was analysed to provide additional information about likely seasonal availability of these nutrients from the pasture and perhaps be able to help producers identify high risk paddocks.

Herbage samples highlighted the variation that occurs in trace element content between seasons and paddocks/soil types. In general, herbage selenium, cobalt and copper content were all lower in spring than in winter. Herbage selenium concentrations were at or above the minimum required for sheep nutrition in most paddocks at each sampling time. Herbage cobalt was below the minimum required for sheep nutrition for the paddocks sampled on 4 farms at weaning in spring 2020.

Where more than one paddock was sampled per farm (Farms 1 and 8) at each time, the results also highlight the variation between paddocks on the same farm. For example, paddock 1b herbage was low in selenium and cobalt in spring 2020. Paddock 1b had a very sandy ridge that had previously grown bracken before the pasture improvement, whereas Paddock 1a was a sandy clay loam soil. Hence, as sheep are rotated around different paddocks, they will have access to different amounts of trace elements in herbage and soil.

The very sandy, leached soils on Farm 9 gave rise to the lowest herbage selenium and cobalt results measured for the 5 demo farms, which corresponded with the lowest levels measured in the sheep blood samples.

Herbage copper concentrations were below the minimum content desired for sheep in some paddocks the lambs were weaned onto in spring 2020. Herbage copper was generally adequate in 2021 samples. Producers do apply copper (and molybdenum) in fertiliser to improve pasture production. Copper content in herbage is less a guide to whether sheep are getting adequate copper intake at a point in time as they are able to regulate blood copper from copper stored in the liver.

The literature highlights that in districts/soils known to be marginal for Se and Co, trace element deficiencies may not occur every year (especially clinical symptoms) but the risk would be higher in good seasons/big springs where the trace elements are diluted in lush feed and when stock are not grazing close to the soil surface to ingest soil. Seasonal conditions had been good during the trial period with good rainfall and spring pasture growth in 2020 and 2021 and high summer rainfall in 2021/22. The trial sheep had not been fed any supplementary feed during winter, spring, summer of 2021 (eg. no pellets, grain) that might have contained trace elements. The seasonal conditions would have increased the risk of inducing trace element deficiencies yet we were still not able to detect any responses.

4.1.6 Sheep measurements

On the four farms (1,3,5,8) with Control treatments, there were no major responses in sheep liveweight (Figure 8) or wool cut or scanning percentage (where these were measured). The standard errors around the liveweights are around 0.7 kg so a much larger gain would be required to be significant (or a much larger sample size). A summary of the key production measurements taken during the trial are shown in Table 4. The weight gain data in Table 4 (in brackets) has been adjusted to allow for any starting weight differences. The actual weights of the trial sheep are shown in Figure 8.

Farm 1 – there were no significant differences in liveweight gain or pregnancy scanning between the treatments. Liveweight gains, shown in Table 4, are divided up for the Farm Practice treatment from the time before and after the long-acting selenium injection (Selovin) was used pre-lambing in 2021, as the Farm Practice treatment was the same as the Control before that.

Farm 3 - there were no significant differences in liveweight gain between the treatments. Liveweight gains are divided up for the Farm Practice treatment from the time before and after the short-acting selenium injection was used, as the Farm Practice treatment was the same as the Control before that. Farm 3 recorded a slightly higher pregnancy scanning % in the Farm Practice ewes that received the short-acting Se injection (which also included Zn and Mn) in November 2021 prior to joining. This injection occurred 1 month before the 12-month blood samples were taken. The Control and LA groups had similar scanning results. This result is difficult to explain as a selenium response as the Control group had marginal blood Se but both the LA and Farm Practice groups had adequate blood Se pre-joining. The number of sheep per treatment may need to increase to accurately capture this scanning difference. There were 2 sheep scanned empty in the Farm Practice group compared with 4 in the LA group. As there were only 50 sheep per treatment this would give rise to large errors around this measurement.

Farm 5 recorded no significant differences in liveweight gain or wool cut in the wethers with the LA rumen pellet compared with Control sheep over the whole trial period.

Farm 8 recorded no major differences in liveweight gain or scanning percentage in the ewes with the LA rumen pellet compared with Control sheep over the whole trial period. However, the liveweight gain from the LA treatment (+1.5 kg) was higher than observed on the other farms.

On Farm 9, there were no major differences recorded for the production measures between the 3 different trace element programs evaluated. There did appear to be a small weight gain benefit (+1.2kg) from the LA pellets and the short acting injection every 6 weeks compared with the double dose every 12 weeks over the time the sheep weights were monitored.

The trials highlighted that there were no production benefits from administering Se supplements where sheep tested marginal or around the low end of the normal range for Se. This is consistent with the findings of experiments conducted in the 1970s and 1980s in Victoria, where responses were only obtained in flocks with very low selenium nutrition (blood GSHPx less than 20 units).

Table 4. Effect of trace element treatment on key production measures.

(x = no significant response, - = not measured, ? = not sure)

Farm (lambs in trial)	Liveweight gain *(gain/loss relative to Control)* (kg)		Greasy fleece weight (kg)	Pregnancy scan (%)
	Farm Practice	Long acting		
1 (Composite ewes)	x *(0 to June 2021, + 0.4 June 2021 to May 2022)*	x *(-0.7)*	-	x 2021 x 2022
3 (Merino ewes)	x *(0 to Nov 2021, -0.2 Nov to May 2022)*	x *(-0.6 to Nov 2021, -0.3 to May 2022)*	-	? 2022 (119% control, 128% FP, 121% LA)
5 (Merino wethers)	x *(0)*	x *(+0.8)*	x *(+ 0.09 kg LA)*	-
8 (Merino & Xbd ewes)	x *(0)*	*(+1.5)*	-	x
9* (Merino ewes)	*(+1.2)*	*(+1.2)*	x	x

**Farm 9 didn't have a Control/Nil – Farm Practice & LA compared with "double dose every 12 weeks" treatment*

Figure 8. Effect of trace element treatment on weaner liveweights

5.2 Economic analysis

The costs of a range of options for supplementing lambs with selenium or vitamin B12, if they are deficient or at risk of a deficiency, are summarised in Table 5. In addition to options shown, ewes can be treated pre-lambing with short or long-acting products. If ewes are treated with a long-acting product this may eliminate the need to use that trace element in the lamb marking vaccine.
Note: there will variation in the prices of these products depending on the brand and quantity purchased.

Table 5. Cost of treatment options ($/head) not including labour.

Product	Timing			
	Lambs @ marking	**Lambs @Weaning**	**Annual booster**	**Every 6-8 weeks post wean to 18 months of age (1ml dose)**
6 in 1 vaccine (250ml pack/1ml dose)	$0.46	$0.46	$0.46	
6 in 1 vaccine +Se (250ml pack/1ml dose)	$0.50	$0.50	$0.50	
6 in 1 vaccine + B12 (250ml pack/1ml dose)	$0.84	$0.84	$0.84	
6 in 1 vaccine +Se & B12 (250ml pack/1ml dose)	$0.85	$0.85	$0.85	
B12 Injection - short acting (500ml pack/0.5 -1.5 ml dose)	$0.08 (lamb dose 0.5 ml)	$0.08 (lamb dose 0.5 ml)		$0.17 x 8 -10 treatments =$1.36 -$1.70
Se/B12 injection- short acting (500ml pack/0.5 -1.5 ml dose)	$0.10 (lamb dose 0.5 ml)	$0.10 (lamb dose 0.5 ml)		$0.20 x 8-10 treatments =$1.60 - $2.00
Long-acting Se injection (500ml pack/0.5 -1.0 ml dose) (lasts 18 months – can be given at marking)		$0.31 Lamb dose 0.5ml $ 0.62 Adult dose 1ml *(may need this follow up dose)*		
Long-acting Se pellet +grinder (500 pack) (last 3 years - lambs must be 3 months of age)		$ 0.92		
Long acting Co pellet +grinder (500 pack)		$1.01		
Long acting Se + Co pellets (500 pack)		$1.49		

There were no major production responses measured in the demo sites from administering trace elements post-weaning. However, to illustrate an example for the cost-benefit analysis, the additional costs and range in liveweight gain of treating sheep with the long-acting rumen pellets (selenium and cobalt) was compared with Control treatment group. Product costs are taken from Table 5.

The example cost-benefit analysis is shown in Table 6 (and the PDS Key Data Summary table on page 6).

Table 6. Example Cost-benefit analysis

Parameter	Comment	Value	Unit
Production efficiency benefit (impact) Lamb growth rate (kg) Reproductive efficiency – scanning % Mortality rate (%)	**Long-acting vs Control** 0 - 1 .5 kg weight gain (after weaning) No diff in scan %. No diff in mortality rate.	0 -1.5 kg LWT @ $2.50/kg	Per head
Reduction in expenditure **Reduction in labour**	Nil Nil	0	
Increase in income	Liveweight gain	$ 0.00 – 3.75	Per head
Additional costs (to achieve benefits) Pellets (Se + grinder, or Co + grinder, or Se + Co) Additional labour to administer pellets (2 mins/sheep@ $50/hr = $1.70)	 $ 0.92 – 1.49 $ 1.70	$ 2.62 - 3.19	Per head
Net $ benefit (impact)		**($3.19) - $ 0.56**	**Per head**

As no major liveweight (or other production) responses were obtained, another series of calculations were done to determine what liveweight gain benefit would be required to recover the cost (break-even) of different trace element supplementation options (Table 7). Where extra labour /yarding sheep is required a labour cost has been added. Liveweight is valued at $2.50 kg. While the cost of using trace element supplements in the example programs, increases the costs per head significantly, relatively minor weight gains are required to break-even.

Table 7. Liveweight gain required (from weaning to 18 months of age) for treatment costs to break-even with Nil treatment.

Treatment option	Comment	Cost $/head	Extra cost $/head	Break-even live-weight required kg
Standard 6 in1 vaccine with no trace elements	4 doses @ $0.46 (ewe -pre-lamb; lamb -mark, wean, 12 mth booster)	$1.84	-	-
Vaccine with Se	4 doses @ $ 0.50	$2.00	$0.16	0.06
Vaccine with Se & B12	4 doses @ $ 0.50	$3.40	$1.56	0.62
Vaccine with Se - ewe pre-lamb + Standard vaccine – lamb at mark & wean &12 mths + Long-acting selenium – lamb at marking + labour (10 secs/sheep)	1 x vaccine @ $0.50 3 x vaccine @ $0.46 1 x LA Se @ $0.31 Labour @ $ 0.14	$2.33	$0.49	0.20
Vaccine with Se/B12 - ewe pre-lamb & lamb at marking + Standard vaccine – lamb wean & 12 months + Long-acting Se & Co pellets at wean + labour (2mins/sheep)	2 x vaccine @ $0.50 2 x vaccine @ $0.46 Se & Co pellets @ $1.49 Labour @ $ 1.70	$ 5.11	$3.27	1.31

5.3 Extension and communication

The Bairnsdale Bestwool/Bestlamb group met every second month and were regularly kept up to date with PDS results from the 5 local farms by reports from the PDS hosts and the group co-ordinator. Results presented at Bestwool/Bestlamb group meetings by host producers and co-ordinator (March & May 2021, Mar 2022). Presentations on various aspects of managing trace element in sheep were made to the BWBL group by guest speakers, Dr Helen McGregor (project vet consultant), Dr Dianne Phillips (Agriculture Victoria) and Dr Jim Walsh (Coopers Animal Health).

Three of the PDS hosts also participated in the Lifetime Ewe Management course in 2021-22 which was delivered by Lisa Warn. This also created another opportunity to inspect the trial sheep and discuss the project progress with other local LTEM participants.

Local Agriculture Victoria veterinarians, and private veterinarians were involved in the project from the inception, undertook blood sampling of trial sheep, were briefed on results as they became available and attended the field day/workshop. Results were presented to AgVic and private veterinarians who had been providing in-kind support (taking blood samples) for the project (May 2021, July 2022).

A field day/workshop was held for the wider community in July 2022 at Lindenow. PDS results were presented by Lisa Warn and the PDS host producers contributed with their observations and conclusions. Dr Jim Walsh (Cooper Animal Health) presented information on symptoms of trace elements deficiencies, best practice diagnosis, implications of PDS results, and preventative treatment options/costs). Twenty-five people attended and brief evaluation was undertaken after the workshop. The results are shown in Table 8.

Table 8. Changes in knowledge and confidence measured from the workshop.

Question	Pre event	Post
Knowledge of how to diagnose if your sheep have (or at risk of) a Trace Element deficiency	5.5/10	7.6/10
Confidence with deciding what products to use if sheep have/at risk of Trace Element deficiency	5.8/10	7.8/10

From the July 2022 workshop evaluation, 80% of participants said they would do something different as a result of attending the workshop. Changes included:

- blood test sheep
- look for different symptoms/monitor more closely
- use LA Selovin
- consider a LA Se instead of short-acting multis
- use LA treatments
- test different products with own trials
- use Se at lamb marking as a standard
- give B12 to lambs & weaners
- consult with a vet before deciding on an action

Project updates appeared in the SALRC newsletters and on the MLA PDS website page.
An article about the project was written for MLA's Feedback magazine and an article/fact sheet was written for AgVic SheepNotes newsletter, which is mailed to all sheep producers in Victoria. A copy of these documents are in the Appendix.

5.4 Monitoring and evaluation

5.4.1 Changes in knowledge, skills and confidence.

Pre-project surveys were completed by all group members in July 2020. The producers who ended up hosting a PDS trial became the "core" producers. Post-project surveys were completed by the core and observer producers in the Bestwool/Bestlamb group in March 2023.

Changes in knowledge and confidence are summarised in Table 9. Their rating of the PDS project and its value is also shown.

Both the Core and Observer producers increased their knowledge on the PDS topic but it was the core producers who dramatically increased their confidence in managing the issue due to their active participation in running the trials on their own farms. All producers were highly satisfied with the PDS project and the value to their enterprise but the core producer gave it a higher rating most likely due to their more active involvement.

Table 9. Changes in knowledge and confidence amongst core group and value of PDS.

Producers	Survey	Knowledge score	Confidence score	Satisfaction with PDS	Value of PDS to your enterprise
Core	Pre project	68 %	5.2/10		
	Post project	88 %	8.0/10	8.8/10	8.5/10
Observers	Pre project	53 %	5.2/10		
	Post project	84 %	5.7/10	7/10	7/10

Some of the opportunities for group members to pick up knowledge and skills during the project included:

- 10 farms involving 13 group members were actively involved in getting mobs of lambs yarded and helping a veterinarian to take the blood samples. The members had their test results returned promptly along with individual feedback/interpretation from the project co-ordinator and veterinarian consultant to the project. They also had the benefit of discussing the issue with the visiting vet who took the samples. (Also and additional, 2 new group members were involved in other project extension activities but missed out on the blood testing program).
- The majority of the group members had never previously had sheep blood tests taken to ascertain trace element status. This activity alone improved their knowledge/skill in how to go about diagnosing potential deficiencies and improved their confidence about planning their animal health program. One group member said that when they saw the blood test results this was a real wake-up call as they thought their current animal health program was adequate.
- Group members had the opportunity to discuss the topic with several veterinarians, and each other, since the project commenced which improved their knowledge. They are now familiar with reading the laboratory report and what the normal range should be for blood selenium, copper and vitamin B12.

PDS program feedback from Core group.
100% of the core group would recommend MLA's PDS program to others. Some comments were:

- Great way to participate in an on-farm trial and see the results first hand. PDS trial allowed us to test if there was a selenium deficiency in the area and on each farm and see if there was any treatment response. This is great way to have some direct learning on farm through participating in the PDS trial.
- The demonstration project was a great opportunity to benchmark the trace mineral levels of our sheep and evaluate the effects of different treatments. It also allowed us to develop systems to weigh sheep and determine growth rates across the growing season. This was a worthwhile use of our time and resources & I recommend this program to other producers.
- A PDS study enables farmers to make more informed decisions.

PDS program feedback from Observer group.
100% of the observer group would recommend MLA's PDS program to others. Some comments were:

- A PDS study enables farmers to make more informed decisions
- I believe in the PDS method and find value in them

5.4.2 Practice change

During project

During the project the producers commented on various changes they were making or considering as result of involvement in the project. Some examples:

- Demo Farm 1 producer changed from using a 6in1 vaccine with Selenium added (1ml dose) at lamb marking/weaning to using separate products to be able to give more accurate dosages of Se according to weight of the lambs. They decided follow up with a long-acting Se injection (Selovin) on replacement ewe lambs rather than use rumen pellets due to lower cost and ease of administration. The need for Co/vitamin B12 will be monitored.
- Demo Farm 3 wanted to do a further evaluation on the use of short-acting Multimin pre-joining to see if it results in improved pregnancy scanning results to confirm if data from 2022 scanning was a real effect.
- Demo Farm 5 producer undertook additional blood testing in 2020, to determine trace element status on a mob of weaners on a second property they own, as a result of the PDS project. They administered rumen pellets to this mob pre-empting the results of this PDS on the first property.
- Demo Farm 8 is looking to use a long-acting injection (Selovin) if required instead of rumen pellets due to lower costs and ease of administration.
- Demo Farm 9 producer is undertaking an additional trace element response trial on a mob of 2021 drop wether weaners. They are confident they can move to 12-week injection of double dose Se & B12 instead of the standard 6 weekly recommendation to save time/labour. They could use Selovin for further labour savings if only concerned about Se but are also concerned about Co so will need to use a vitamin B12 product regularly too. Alternatively, they would have to stay with using Se and Co rumen pellets.
- All Demo producers were using eID technology to record data from trial sheep and had been improving their confidence and knowledge of how to apply this technology and manage the data. They had been able to help other members of the group with using this equipment.
- Only 1 of the Demo farms had ever taken blood samples before to look at trace element (Se, B12, Cu) levels in their weaner sheep and none had conducted a trace element response trial. They have now used some diagnostic tools and developed skills to evaluate treatments on their own sheep/properties which they can apply to evaluate any other animal health products.

After project

The post project survey asked core and observer producers about their intention to adopt key practices (if they weren't already doing it) such as:

- *Do you intend to blood test lamb/weaners to assess their trace element status and when/how would you decide when to do this ?*
- *Do you intend to blood test ewes to assess their trace element status and when/how would you decide when to do this ?*
- *Do you weigh weaner sheep -how often and what percentage of them?*

Practice change amongst Core group

- 85% of the core group will conduct blood testing of lambs/weaners to check their trace element status to help monitor their animal health program. (They will do this occasionally or if lambs looked unhealthy/showed possible signs of a deficiency).
- 100% of core group members were already weighing their weaners prior to the PDS, with the Merino producers weighing <25% of that age group, and the prime lamb producers weighing 100% of lambs. Several of the producers said they would weigh the weaners more regularly as a result of the PDS.

Practice change amongst Observer group

- 67% of the observer group will conduct blood testing of lambs/weaners to check their trace element status to help monitor their animal health program. (They will do this occasionally or if lambs looked unhealthy/showed possible signs of a deficiency).
- 100% of observer group members were already weighing their weaners prior to the PDS, with the Merino producers weighing 25-50% of that age group, and the prime lamb producers weighing 75-100% of lambs.

All producers – proposed changes

Proposed changes to the products/treatments used in your animal health program, as result of participating in this PDS include:

- Yes: Use long-acting selenium injection vs short acting. No extra work
- Yes: Use targeted injections of Se (Multimin) prior to joining/lambing to increase scanning and lambing percentages and lamb survival. Using targeted mineral drenches for young stock at key times of growth cycle. (Had sometimes used LA rumen bullets before the PDS but can't always get them).
- No change: Continue to use LA selenium (Selovin)
- Yes - give preventative injections of Se & vitamin B12 at 6 weeks (marking) & then a double dose at 12 weeks until the wethers are sold. Ewes retained to receive Se & Co bullets prior to first lambing.
- Yes- dropped the Se & B12 out of our 6 in1 vaccines & targeting actual deficiencies which vary from farm to farm. Using LA selenium (selovin) on one farm and bullets (Se & Co) on the other.

Other proposed changes to your business as result of participating in this PDS:

- Will also monitor weaners more closely.
- Feeling more in control of these identified deficiencies, the changes we outlined are actually addressing the problems rather than our previous inadequate 'shotgun' approach.

Despite seeing no major production response during this PDS, the core producers are reluctant to omit selenium (and cobalt/B12 for some) from their animal health program. Trace element deficiencies can occur sporadically and many of the farms had Se levels that were 'marginal' or 'low normal' or below in the weaner sheep. So, they feel using Se (&B12) is risk mitigation.

Most of the producers said they would move from short-acting treatments (which may give 6-8 weeks protection if a deficiency occurred) to longer acting products. Most farms were not following up with top up Se/B12 post weaning in a planned way so they were at risk if a deficiency was to occur. The longer acting products would be more labour efficient and would not necessarily cost anymore, possibly cost less.

The long-acting selenium injection on the market (Selovin -lasts up to 18 months in sheep) which some group members have used and more are intending to use. There is a long acting B12 injection (Virbac's Smartshot - lasts up to 6 months in sheep) but unfortunately it is only registered in New Zealand. So, for the producers who are concerned about both Se and Co/B12 deficiencies this leaves the long-acting rumen pellets (last up to 3 years) as the most cost-effective option. One company has had issues with supply of rumen pellets over the last few years, so in some years this treatment was not an option.

6 Conclusion

6.1 Key Findings

- The trace element status of 10 flocks in east Gippsland was determined from a lamb blood testing program that occurred in spring 2020.
    - Marginal blood selenium levels (between 20-50 GSHPx U/gHb) were found on 5 farms, and deficient levels on 1 farm (below GSHPx 20 U/gHb) at either the pre-marking or pre-weaning blood sampling.
    - Marginal blood vitamin B12 levels (between 200-400 pmol/l) were found on 2 farms pre-marking but this is not necessarily an indication of potential risk as pre-ruminant lambs normally have lower blood vitamin B12 and it can increase as they develop. All 10 farms had blood vitamin B12 levels in the normal range (between 400-5000 pmol/l) pre-weaning. It is uncertain whether this was due to any carryover effects of vitamin B12 in the marking vaccine that was used on 8 out of the 10 farms, or from lambs grazing herbage /soil containing cobalt.
    - Most lambs tested had blood copper in the normal range (7.5-20 umol/l) at both times.
- Although the farms are located in a region known to be marginal for selenium and cobalt the blood testing highlighted that for most of the farms in the study, the risk of selenium deficiency in sheep was potentially higher than vitamin B12 deficiency. The exception was one farm that was extremely deficient in both selenium and cobalt due to very different geology/soil type to the other 9 farms.
- The five producer demonstration sites (trace element response trials) that were established post weaning (based on the results of the initial blood testing program) highlighted that:
    - For the 4 farms (that included a Control/Nil trace element), there were no major responses in liveweight gain from supplementing with selenium and cobalt over the period of the trial. There were no major differences in wool production or scanning percentage where these parameters were also measured. Blood testing at 3 months and 12 months post treatment showed that for 2 of these farms the sheep blood

selenium levels were at the low normal end of the range, and 2 farms had one time period where they were in the marginal range, but none of the sheep were found to be deficient (ie. <20 GSH PX <50 U/gHb). Sheep blood vitamin B12 levels were found to be in the low normal range at both sampling times for 3 farms and marginal for some sheep on 1 farm. The blood test results would explain why no production responses were observed.

- For the more Se/Co deficient farm that compared short-acting Se/vitamin B12 injections given at 6 or 12 week intervals post-weaning with a long acting Se/Co rumen pellet treatment, they measured no difference in liveweight gain, wool production or pregnancy scanning percentage between the 3 treatments. This gave them confidence they could extend the interval of short-acting injections to 12 weeks for the wethers (that are sold at 18 months of age) to save on labour, and use the rumen pellets for the ewe portion that are kept.
- The selenium rumen pellets were effective at increasing blood selenium in weaner sheep from the deficient/bottom of the normal range (GSH PX <50 U/gHb) to the top of the normal range (550 U/gHb) and maintaining these levels during the trial period. The long-acting selenium injection, used in one trial, was as effective as the rumen pellet at increasing blood selenium to the top of the normal range. The selenium injections given at marking and weaning may only be providing adequate selenium levels for up to 6 weeks on the marginal/deficient farms.

- Managing the risk of a trace element deficiency in stock is not always straightforward. Even if a region has some soil types that are naturally low in selenium or cobalt, the occurrence of deficiencies in stock can be very sporadic, seasonal, and can be influenced by different pasture species/crops on the farm, fertiliser history or class of stock.
- Despite seeing no major production response during this PDS, the producers were reluctant to omit selenium (and cobalt/B12 for some) from their animal health program. Trace element deficiencies can occur sporadically and many of the farms had Se levels that were 'marginal' or 'low normal' in the weaner sheep. They feel using Se (&B12) is risk mitigation.
- As a result of the PDS:
  - Producers said they would be more targeted in which trace element/s they would use (eg. only use Se not B12 if not at risk) in future and would undertake blood testing of lambs occasionally to determine if at risk of Se or vitamin B12 deficiency or both.
  - Most of the producers said they would move from short-acting treatments (which may give 6-8 weeks protection if a deficiency occurred) to longer acting products, particularly in the case of selenium. Most farms were not following up with top up Se/B12 post weaning in a planned way so they were at risk if a deficiency was to occur. Longer acting products would be more labour efficient and would not necessarily cost anymore, possibly cost less. Using a long-acting Se injection or Se pellet in ewes also meant they could drop Se out of pre-lamb and marking vaccines.
- The cost benefit analysis showed that if no production response was obtained from treating sheep, with the rumen pellets option for example, this would cost $3.19/head whereas if a 1.5 kg liveweight gain occurred the net benefit would be $0.56/head. A further analysis, looked at range of preventative treatment options, and indicate that anything from a 0.06 kg to 1.31 kg weight gain was required to break-even with costs of a particular preventative treatment program.

6.2 Benefits to industry

This project is relevant to all sheep and cattle producers in east Gippsland as well as producers in other regions known to be marginal for trace elements such as south Gippsland, parts of north-east Victoria, south-east South Australia and King Island.

If not treated, trace element deficiencies cause major reductions in livestock production. Sub-optimum growth rates in lambs reduces the efficiency of pasture utilization, delays sales, increases risk and may lead to higher mortality. Poor mineral nutrition of ewes could affect their reproductive performance and longevity. Conversely, treating sheep that are not deficient increases the cost of production of meat and wool and in the case of Cu could be toxic to sheep.

Correct diagnosis and information on likely response is required to help producers, in all districts known to be marginal for trace elements, plan the most cost-effective preventative treatment program.

7 Acknowledgments

The Bairnsdale Bestwool /Bestlamb group would like to thank MLA for funding this PDS. The cost of laboratory testing of blood samples was a major cost in this project so without MLA support this project would not be possible.

Very generous in-kind support has been provided by Dr Dianne Phillips, Dr Jo Cunningham, Megan Filtness from Agriculture Victoria Bairnsdale, and Dr Michael Roberts, Agriculture Victoria, Maffra. They have visited the farms and taken the blood tests. Dr Alison Gunn from Herd Solutions has also provided support with blood testing.

Dr Helen McGregor (Redefining Agriculture) acted as the project's veterinary consultant and was involved with providing technical support at the project planning and set-up stage of the demo sites.

Sponsorship was obtained from Dr Jim Walsh, from Coopers Animal Health, for tubs of selenium and cobalt rumen pellets and applicators for each trial site. Coopers also sponsored some additional blood testing of older ewes on 2 farms, which is separate to the lamb demo sites.

Sponsorship was also obtained from Shearwell Australia for coloured ear tags and ear tag applicators for the PDS trials hosts.

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9 Appendix

9.1 Article prepared for MLA Feedback Magazine/MLA email newsletter

(draft - submitted to MLA Comms team for editing/approval July 2023)

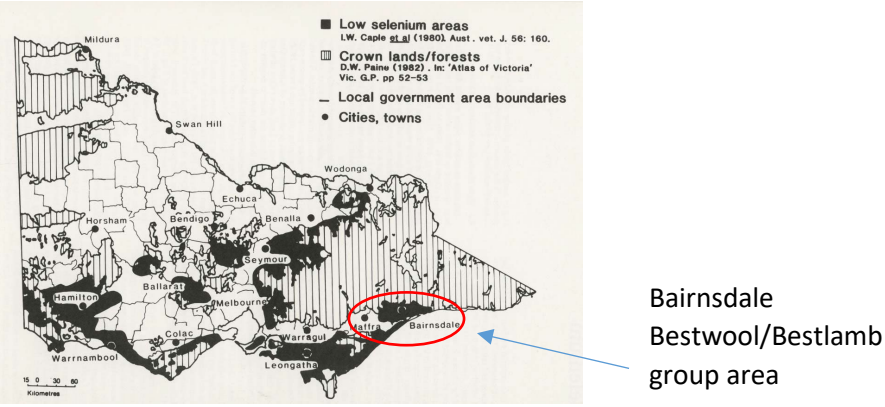
Managing trace element deficiencies in sheep

By Lisa Warn (Lisa Warn Ag Consulting)

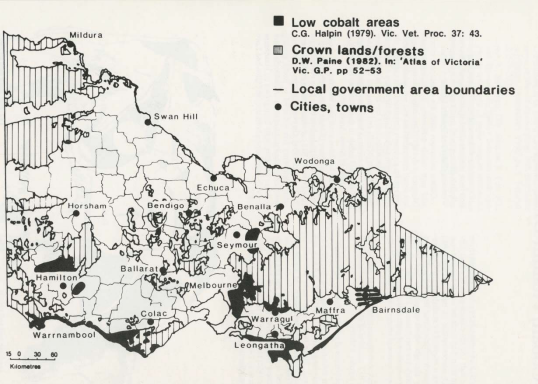
Sheep producers in east Gippsland, Victoria, have been investigating options to manage the risk of trace elements deficiencies in sheep in a Producer Demonstration Site project funded by MLA. The PDS was run by the Bairnsdale Bestwool /Bestlamb group and co-ordinated by Lisa Warn (Lisa Warn Ag Consulting).

The sandy soil types in the region are known to be low in the trace elements copper (Cu), cobalt (Co) and selenium (Se) which can lead to deficiencies in livestock. The soils are also deficient in the trace element molybdenum (Mo). Molybdenum and copper deficiencies affect legume/pasture production.

Areas in Victoria at risk of trace elements deficiencies in stock or pastures were documented and mapped by the Department of Agriculture in the book "Trace elements Victoria" by Hosking *et al.* (1986). Based on available experimental data at the time, the maps show areas where records of livestock blood tests indicated low levels for a trace element or where responses to trace elements had been obtained. From this work, laboratory tests and calibrations (critical levels) were developed to use as diagnostics tools. Animal tests are the preferred method to detect low trace element status in livestock and plant leaf analysis is the preferred method for pastures. Soil tests are not an appropriate method.



Map of Victorian showing marginal selenium areas based on original data by Caple *et. al.* (1980). Within the black shaded areas sheep may have blood glutathione peroxidase activities less than 50 units, cattle less than 40 units and blood selenium less than 0.5 umol/l in spring. (from Hosking et al. 1986).



Areas where cobalt deficiency has been detected in livestock in Victoria based on original data by Halpin (1979). (from Hosking et al. 1986).

Managing the risk of a trace element deficiency in stock is not always straightforward according to PDS co-ordinator Lisa Warn "Even though the region has some soil types that are naturally low in selenium, cobalt and copper, the occurrence of deficiencies in stock can be very sporadic, seasonal, and can be influenced by different pasture species/crops on the farm, fertiliser history or class of stock" she said.

Group members Andrew and Heather Sheridan, who hosted one of the demo sites at their Bengworden property, wanted to see if they could improve their decision making around the use of trace elements in their Merino flock.

"Use of trace elements in sheep is a topic that has come up frequently in our group discussions. We are all using vaccines and sometimes drenches that contain selenium and Vitamin B12/cobalt, but we didn't really know whether what we were doing was necessary or if these short-acting products were adequate if we did have a deficiency" Andrew said.

"The opportunity to run a PDS meant we could apply best practice diagnostics methods to identify if our lambs were likely to be deficient in Se, Co/Vit B12 or Cu and then evaluate the cost/benefit of short-acting versus long-acting products over several years" Andrew said.

Response trials

The PDS project started in spring 2020. A sample of 7 lambs from 10 group member's flocks were blood tested at marking, prior to receiving any trace elements in vaccines, and again at weaning. Dr Dianne Phillips, Senior Veterinarian with AgVic Bairnsdale, team members and private veterinarian consultant Dr Alison Gunn undertook the blood testing for the project. Blood samples were analysed for Se (glutathione peroxidase activity, GSHPx), Vitamin B12 (cobalt is required for rumen microbes to synthesize vitamin B12) and Cu concentrations.

"We needed to identify which lambs had relatively low levels of trace elements to select suitable farms to conduct response trials. A definitive diagnosis of a trace element deficiency can only be made from measured improvements in health and production of animals following supplementation compared with a "Control" group with no supplementation" Lisa said.

"Low blood selenium levels were found in 6 of the 10 flocks and low blood Vitamin B12 levels were found on a few lambs on 2 farms at the pre-marking test. Based on the results, 5 farms were selected to run response trials for Se and Co/Vitamin B12 supplementation in the weaned lambs. All flocks had adequate blood copper. Copper is stored in the liver and can release copper into the blood, so liver samples are actually a better diagnostic tool to detect a low copper status. However, we felt that Se and Co were the main concerns to evaluate" Lisa said.

According to Dr Dianne Phillips, many of the pastures in the copper deficient areas have been top-dressed with copper to improve pasture growth and the incidence and severity of copper deficiency in animals and pastures has been greatly reduced. “We don’t see or hear of many cases of copper deficiency in stock compared with 30-40 years ago. You have to be very careful about supplementing stock directly with copper as it can accumulate and become toxic.” she said.

On 4 of the 5 demo sites three treatment groups of lambs were run together from spring 2020 to winter 2022. Two farms ran Merino ewes in the demos, 1 ran Merino ewes and 1st cross ewes, 1 ran Merino wethers and 1 ran composite ewes. Treatments were Control (no trace elements), Normal Farm Practice (using short-acting Se and B12/Co treatments -in vaccines and drenches) and Long Acting (a Se and Co rumen pellet or a long-acting Se injection). On the fifth farm, a Control group wasn’t used due to concerns the property’s soil type was severely deficient in Se and Co and past experiences with clinical signs in stock. Farm 5 investigated 2 different short-acting treatment regimes against a long-acting treatment (Se & Co rumen pellets).

Despite the low initial blood test results in the lambs, on the 4 farms that included the control group, there was no response in liveweight gain, wool growth, or pregnancy scanning % from trace element supplementation over the trial period. Follow up blood testing 1 year after treatments began did show the long-acting treatments were maintaining higher blood Se and Vitamin B12 levels. The 2 years the trials ran over had favourable seasonal conditions with good spring growth (and no supplementary feeding) so would have increased the risk of inducing trace element deficiencies yet we were still not able to detect any responses.

Monitor and test

Group members said there were some important learnings from the PDS. They will conduct blood testing of lambs/weaners to assess trace element status if in doubt, and monitor stock more closely. They will also make changes to their animal health program, such as being more targeted with what products they use. They commented that they have now used some diagnostic tools and developed skills to evaluate treatments on their own sheep/properties which they can apply to evaluate any other animal health products.

Feedback from one group member was that the PDS was a great opportunity to benchmark the trace mineral levels of our sheep and evaluate the effects of different treatments. It also allowed them to develop systems to weigh sheep and determine growth rates across the growing season.

Despite seeing no production response during this PDS, group members are reluctant to omit Selenium (and Cobalt/B12 for some farms) from their animal health program. Trace element deficiencies can occur sporadically and many of the farms had Se levels that were at the low end of the normal range (‘low normal’) or below, in their weaner sheep. They feel using Se is risk mitigation.

Most of the group members said they would move from short-acting treatments (which may give 6-8 weeks protection) to longer acting products. Most farms were not following up with top up Se or Vitamin B12 (via short acting products) post weaning in a planned way so they were at risk if a deficiency was to occur. The longer acting products would be more labour efficient and would cost less. For example, treating ewe lambs from marking until 18 months of age with numerous short-acting selenium injections would cost $2.20 per head plus labour/yarding, treating them with a long-acting (18 months) Se injection would cost $0.65/head and treating with a long-acting (3 years) Se rumen pellet (& grinder) at weaning would cost $0.92/head.

“We are dropping Se and B12 out of our 6 in 1 vaccines and targeting actual deficiencies which vary from farm to farm. We will be using a long-acting Se injection on one farm and rumen bullets (Se and Co) on the other. I am feeling more in control of these identified possible deficiencies and the

changes we outlined are actually addressing the problems rather than our previous inadequate 'shotgun' approach. This targeted approach is risk management/cheap insurance against different seasons which can exacerbate the underlying deficiencies". Andrew said.

Another spin-off benefit of the PDS was making better use of eID technology. All Demo site producers used eID technology to record data from trial sheep and improved their confidence and knowledge of how to apply this technology and manage the data. They have been able to help other members of the group with using this equipment.

Diagnosis and preventative treatments

If you are uncertain about whether your stock may be at risk of certain trace element deficiencies it is important to seek expert advice from your veterinarian or animal health advisor. They can diagnose if selenium or cobalt/Vitamin B12, or both, is an issue or not and if so then work out which product/s will supply the required trace elements to cover your main risk period, most efficiently and at lowest cost.

Bairnsdale Bestwool/Bestlamb group members who hosted the 5 Producer Demonstration Sites.

From left to right: John Alexander, Rory Blandford, Andrew Sheridan, Doug Pemberton, Kane Stewart, and Nick Blandford.

PDS host Andrew Sheridan (right) and Ben Belcher setting up a trace element response trial in Merino wether weaners.

Dr Dianne Phillip, Senior Vet AgVic, Bairnsdale (left), Lisa Warn (centre), and Dr Jim Walsh, Coopers Animal Health (right) at a PDS field day in July 2022.

PDS hosts John (photo on left – John on left) and Ken Alexander recording RFID tags numbers of composite ewe weaners and linking them to treatment groups at the start of the trace element response trial.

Acknowledgments.

Thanks to project funders MLA, project collaborators Dr Dianne Phillips and team at AgVic, Dr Alison Gunn, and project sponsors Coopers and Shearwell who provided products.

Selenium deficiency

Symptoms

- Ill-thrift – reduced weight gain and wool growth in lambs.
- White muscle disease – can affect lambs and calves. Lesions occur in skeletal and/or heart muscle. Muscles affected in upper fore and hind limbs, and affected animals walk with a stiff-legged gait or are unable to stand. Lesions in heart muscle may produce sudden death, and in intercostal muscles may produce respiratory distress.

Risk factors

- Stock class - Young growing stock are most susceptible
- Soil type - sandy or granite soils
- Seasonal variation - lowest levels of selenium in pastures occur in spring and summer.
- Variation between years - white muscle disease in lambs and calves in spring is most prevalent in years when there is good autumn rainfall and abundant clover growth in spring
- Heavy or long-term applications of fertilisers containing sulphur (eg.superphosphate or gypsum) decrease the concentration of selenium in pastures and may also decrease the uptake of selenium by livestock.
- Pasture type - Clover dominant pastures – clovers have lower Se concentrations than grasses

Cobalt/ Vitamin B12 deficiency

Symptoms

- Poor appetite and growth rates
- Lethargy
- Diarrhoea
- Weeping ‘rheumy’ eyes
- Anaemia
- Decreased wool and milk production.
- Scaly ears (cobalt deficiency predisposes sheep to liver disease. Affected sheep show signs of photosensitization associated with the liver damage).

Risk factors

- Stock class - Young growing stock are most susceptible and lambs are more susceptible than calves.
- Soil type - Coastal calcareous sands.
- Seasonal variation - cobalt in pastures and plasma vitamin B12 in livestock is lowest in spring.
- Large fluctuations in available cobalt between years. Seasons favouring lush pasture growth favour development of cobalt deficiency. This is due to animals ingesting less soil when grazing lightly stocked, rapidly growing pastures. Soil provides a more concentrated source of cobalt to the ruminant than pastures.
- Pasture type - Grassy pastures – grasses have lower Co concentrations than clovers.

9.2 Article prepared for Agriculture Victoria's SheepNotes newsletter

(Draft submitted to Ag Vic, Aug 2023)

Do I need to give Selenium or Vitamin B12/cobalt to my sheep?

By Lisa Warn (Lisa Warn Ag Consulting)

Whether to supplement sheep with the trace elements selenium or Vitamin B12/cobalt is a frequently asked question by producers. Many producers are using vaccines and sometimes drenches that contain selenium and Vitamin B12/cobalt but are unsure of whether these additions are necessary for their sheep or if these short-acting products would be adequate if they did have a deficiency.

Managing the risk of a trace element deficiency in stock is not always straightforward. Even if a region has some soil types that are naturally low in selenium or cobalt, the occurrence of deficiencies in stock can be very sporadic, seasonal, and can be influenced by different pasture species/crops on the farm, fertiliser history or class of stock.

Role of selenium and Vitamin B12/cobalt

Selenium is an essential element for animals, but not plants. Selenium is required by sheep for growth and has a role in immune function.

Cobalt is required by rumen microbes to synthesise Vitamin B12. Without an adequate supply of cobalt from the soil or feed a Vitamin B12 deficiency can occur. Vitamin B12 is important for energy metabolism, protein synthesis and production of red blood cells.

Symptoms of Selenium and Vitamin B12 deficiency are summarised in the break-out boxes.

Marginal selenium and cobalt areas in Victoria

Areas in Victoria at risk of trace elements deficiencies in stock or pastures were documented and mapped by the Department of Agriculture in the book "Trace elements Victoria" by Hosking *et al.* (1986). Based on available experimental data at the time, the maps show areas where records of livestock blood tests indicated low levels for a trace element or where responses to trace elements had been obtained (Figures 1 and 2).

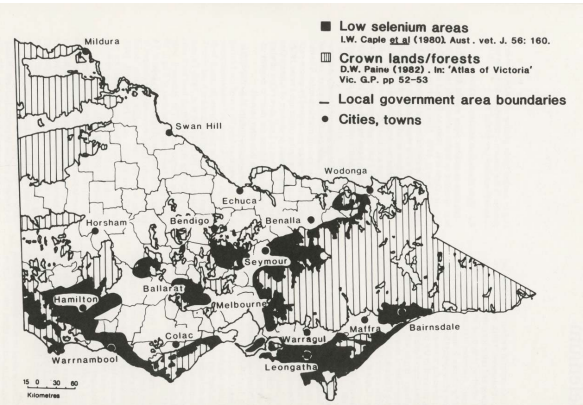


Figure 1. Map of Victorian showing marginal selenium areas based on original data by Caple *et. al.* (1980). Within the black shaded areas sheep may have blood glutathione peroxidase activities less than 50 units, cattle less than 40 units (from Hosking et al. 1986).

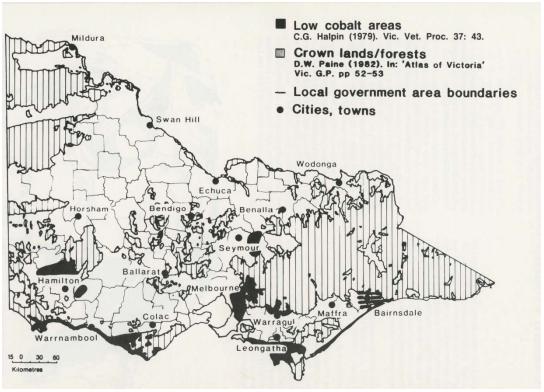


Figure 2. Areas where cobalt deficiency has been detected in livestock in Victoria based on original data by Halpin (1979). (from Hosking et al. 1986).

Risk factors

In the marginal Se and Co areas, it is rapidly growing lambs and weaner sheep that are most at risk. The conditions that can predispose sheep to selenium or Vitamin B12 deficiency are summarised in the break-out boxes.

Selenium deficiency

Symptoms

- Ill-thrift – reduced weight gain and wool growth in lambs.

White muscle disease – can affect lambs and calves.

- Stiff-legged gait or unable to stand.
- Arched back.
- Sudden death – caused by lesions in heart muscle.

Risk factors

- Stock class - Young growing stock are most susceptible
- Soil type - sandy or granite soils
- Seasonal variation - lowest levels of selenium in pastures occur in spring and summer.
- Variation between years - white muscle disease in lambs and calves in spring is most prevalent in years when there is good autumn rainfall and abundant clover growth in spring
- Heavy or long-term applications of fertilisers containing sulphur (eg.superphosphate or gypsum) decrease the concentration of selenium in pastures and may also decrease the uptake of selenium by livestock.
- Pasture type - Clover dominant pastures – clovers have lower Se concentrations than grasses.

Vitamin B12/Cobalt deficiency

Symptoms

- Reduced appetite and growth rates
- Diarrhoea
- Weeping 'rheumy' eyes
- Anaemia
- Scaly ears (Affected sheep show signs of photosensitization associated with liver damage).

Risk factors

- Stock class - Young growing stock are most susceptible. Lambs are more susceptible than calves.
- Soil type - coastal calcareous sands, sandy or well drained soils.
- Seasonal variation - cobalt in pastures and plasma vitamin B12 in livestock is lowest in spring.
- Variation between years - seasons favouring lush pasture growth favour development of cobalt deficiency. This is due to animals ingesting less soil when grazing lightly stocked, rapidly growing pastures. Soil provides a more concentrated source of cobalt to the ruminant than pastures.
- Pasture type - Grassy pastures – grasses have lower Co concentrations than clovers.

Diagnosis

Early diagnosis of a disease and treatment are essential to minimise production and stock losses. A veterinarian can help diagnose a selenium or Vitamin B12 deficiency by collecting blood samples or post-mortem liver samples for laboratory analysis.

Blood samples can also be taken from weaned lambs (or adult sheep), who are not showing clinical signs of disease, to determine their trace element nutritional status and see if they might be at risk. Plant leaf analysis or soil tests are not appropriate methods to determine the nutritional status of stock.

Selenium nutrition is assessed by determination of the activity of the enzyme glutathione peroxidase (GSHPx) in blood. Blood GSHPx levels of 50-550 (µmol/min/g) are considered adequate, between 20-50 are marginal and less than 20 is deficient.

Cobalt nutrition is assessed by determination of the vitamin B12 concentration in blood plasma. Plasma vitamin B12 levels of 400-5000 (pmol/l) are considered adequate, between 200-400 are marginal and less than 200 is deficient.

Recently, the Bairnsdale Bestwool/Bestlamb group undertook a survey of group members flocks to ascertain the Se and vitamin B12 status. The area is known to be marginal for selenium and cobalt (Figures 1 and 2). On each farm, blood samples were taken from lambs (born in late winter/spring 2020) at marking and weaning, before any trace elements were given in vaccines. This work was part of a MLA Producer Demonstration Site project. The results highlighted that 5 out of 10 group members flocks had blood selenium levels considered to be marginal and 1 flock was deficient. Only one of the 10 flocks had blood vitamin B12 levels that were marginal. Spring pasture conditions were above average during 2020 to 2021 when the PDS was run.

If blood tests indicate weaner sheep have marginal /deficient levels of a trace element a response trial can be conducted. A definitive diagnosis of a trace element deficiency can only be made from measured improvements in health and production of animals following supplementation compared with a “Control” group with no supplementation.

However, carefully controlled response trials cannot always be conducted on farms and predictions of likely benefits from supplementation may have to be based on information relating production responses to the results of blood tests.

Preventative treatment options

Selenium is available by injection either alone or in combination with vaccines or drenches, as is Vitamin B12 (but as cobalt in drenches). Se and Co are also available in rumen pellets which can be given to lambs at weaning and can last for 3 years.

In low Se areas, lambs can be treated with a Se injection at marking and weaning. Short-acting forms of Se found in vaccines can give 6-8 weeks protection. The need for any follow up treatment, or the need for a longer-acting Se injection (18 months protection) at marking or a selenium rumen pellet at weaning, will depend on the extent of the deficiency/risk period and the age that the lambs are kept.

In Victoria, no responses to selenium treatment have been observed in adult sheep. However, if pregnant ewes are deficient, they can be treated with a short-acting selenium injection four weeks before lambing so that lambs are protected from white muscle disease in the first few weeks after birth.

In low cobalt areas, lambs can be treated with a vitamin B12 injection at marking and weaning. Short-acting forms of vitamin B12 in vaccines or separate injections can give up to 6-12 weeks protection, depending on the extent of the deficiency. There are no long-acting B12 injections available in Australia. The need for any follow up treatment or the need for a cobalt rumen pellet at weaning will depend on the extent of the deficiency/risk period. If ewes are deficient, they can be treated with a vitamin B12 injection before lambing to ensure adequate vitamin B12 reserves in the foetal liver and colostrum.

The addition of Se to a 6 in 1 vaccine increases the cost by around 5 c/dose while the addition of vitamin B12 increases the cost by around 40 c/dose (ie. nearly doubles the cost of the 45c/dose

vaccine). A separate vitamin B12 injection costs around 8c/dose (lamb dose) so is a cheaper option if it is needed but requires the extra labour/time for a separate injection. A long-acting Se injection can cost 30c/dose (lamb) to 60c/dose (adult). In severely deficient areas where use of rumen pellets may be an option at weaning, the cost is around 90c for a selenium pellet (with a grinder), $1 for a cobalt pellet (and grinder) or $1.50 for a Se and Co pellet.

Seek advice

If you are uncertain about whether your stock may be at risk of certain trace element deficiencies it is important to seek expert advice from your veterinarian or animal health advisor. They can diagnose if selenium or vitamin B12, or both, is an issue or not and if so then work out which product/s will supply the required trace elements to cover your main risk period, most efficiently and at lowest cost.

For more information about the MLA PDS "Managing trace elements in sheep" go to the MLA website: *https://www.mla.com.au/extension-training-and-tools/search-pds/pds-data/managing-trace-element-deficiencies-in-sheep/*

9.3 Workshop details

Distributed/emailed to: Bairnsdale BWBL group, Gippsland Sheep breeders group, Agriculture Victoria vets, Alison Gunn (vet consultant, Herdsolutions), Gippsland Ag Group.

Date: Wednesday 20 July 2022

Time: 9 am – 1 pm

Venue: Ken & John Alexanders – meet at yards at Ken's - 165 Cowells Lane, Walpa.
Then onto Lindenow hotel for guest speaker – Dr. Jim Walsh, Coopers Animal Health.
Option to purchase lunch afterwards.

Topics:

- Sheep handling equipment demonstration.
- Sheep eID – making best use of it for your enterprise.
- MLA PDS "Managing Trace elements in sheep"
    - Lisa Warn - update on demo site results.
    - Dr Jim Walsh, Coopers Animal Health - Jim will lead the discussion about all things trace elements in the light of results from our local trials.
      He will cover - Diagnosis, Risk factors (stock class, soil type, pasture, season), Treatment options & costs.