Field lab: Evaluating the effect of feeding willow leaves on growth rates in weaned lambs.

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1. Field Lab Aims:

- Identify impact of forage willow on growth rate of weaned lambs.
- Evaluate the impact of forage willow on blood cobalt levels in weaned lambs.
- Understand the practical consequences and considerations of using forage willow as a supplement.

2. Background:

Cobalt deficiency, or ill thrift/pine, is common in weaned lambs. Cobalt is essential for producing vitamin B12, which supports lamb growth, and even subclinical deficiencies can significantly reduce growth rates.

Grass pastures often fall short of lambs' cobalt needs, especially in dry summer months when growth should peak. As a result, cobalt and/or vitamin B12 are typically supplemented, but boluses and drenches add costs in both product and labour, and free access supplements cannot guarantee consistent intakes in all animals.

Willow leaves, rich in cobalt and palatable to lambs, present a potential natural alternative. Browsing on willow could naturally improve lamb health while reducing reliance on costly supplements.

3. Methodology and data collection:

Farm Selection

Mindrum Estate was selected as a Regenerative Organic farm that requires cobalt supplementation in lambs. The requirement for supplementation has been identified through blood tests with their veterinary practice.

The sheep flock at Mindrum is large enough to allow matched randomised groups of >100 lambs to have the statistical power for production responses.

Data collection

The trial started at weaning on the 25th of July and ran for two months to allow growth rates to be expressed. Two management groups of ewes were weaned giving over 580 lambs for the trial, these where split through restricted randomisation by live weight, within each previous group to give two groups (each of over 250 lambs) one as a control with no supplementation and one test group on a willow feeding strategy. Willow was fed as cut branches to the 'test' group in pens after weighing on a weekly basis. Quantity of willow consumed was measured by weighing branches in and out of the pens.

The lambs were weighed weekly and individual weights recorded throughout the trial (including day 0) and mortality and morbidity recorded as well as any other off trial reason (e.g. reached slaughter weight and sent off farm).

Blood Samples

- Nigel Kendall as the Researcher of this field lab organised the Animals (Scientific Procedures) Act 1986 (ASPA) license as a place other than a licensed establishment (POLE) premises.
- Following requirements stated in the above license, blood samples were collected from 10 sheep per group. Timepoints as follows, the start of the trial, the mid-point and at the end of the trial.

4. Results and Discussion:

Results

The analysis of weekly lamb weights in the field lab revealed no significant difference in Daily Liveweight Gain (DLWG) between the test and control groups (*Figure 1*).

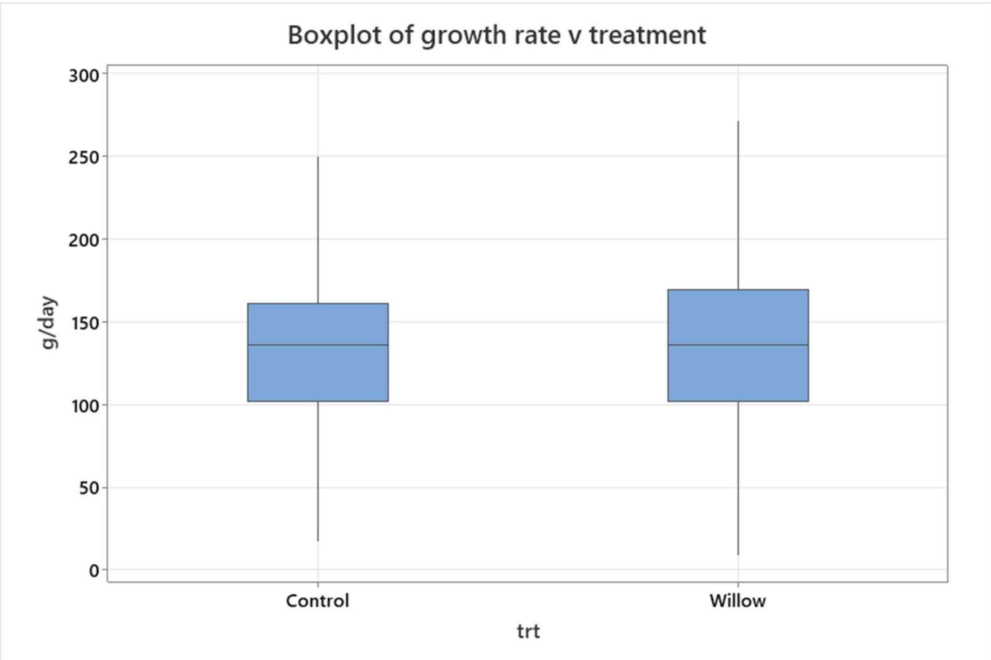

Figure 1 – The growth rate (g/day) of the lambs across the trial according to willow or control group. There was no statistical difference on overall growth or growth rate at any individual timepoint. Box and whiskers show median, with interquartile r.

Forage samples taken at start, middle, and end points showed that the cobalt content of the grazing was below the cobalt requirement of lambs (0.2 mg/kg Dry Matter (DM)) at <0.08mg/kg DM (*Table 1)*. Two species of willow available on farm were analysed at the start of the trial, identifying *Salix caprea* (Goat Willow) as having higher cobalt at 1.179 mg/kg DM compared to a *Salix Viminalis* biomass hybrid at 0.479 mg/kg DM (*Table 1 & 2 –*

Appendix 1). Demonstrating that either species has the potential to achieve lamb requirement.

Table 1 - Selenium and Cobalt concentrations in Willow and Grazing throughout Field Lab.

		start willow		start grass		middle willow		middle grass		end willow		end grass		sheep	sheep
		mean	cv	mean	cv	mean	cv	mean	cv	mean	cv	mean	cv	RQ range	MTL
Se	mg/kg DM	0.033	5.2	0.009	3	0.029	16	0.02	2.2	0.048	9.5	0.021	6	0.02 - 0.24	5
Co	mg/kg DM	1.179	5.4	0.078	2.8	0.841	6.8	0.076	0.7	0.633	7.5	0.062	2.1	0.1 - 0.21	25

Initial blood samples demonstrated that all lambs were in a deficient state for vitamin B12 (*Figure 2*). However, mid and end point samples had no lambs from either test or control group in this category, with about half marginal and the rest sufficient.

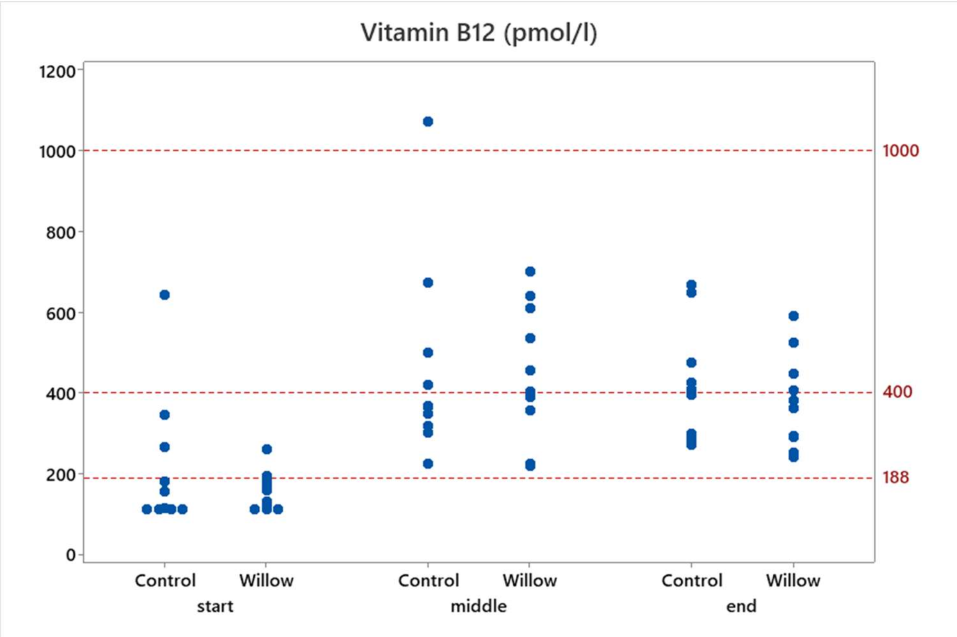

Figure 1 – Individual Concentrations of B12 in blood samples from Test and Control groups at three timepoints. <188 deficient 188-400 marginal, 400-1000 normal, > 1000 high.

Discussion

Considering the initial cobalt deficient state of the lambs, the low concentration of cobalt in the grazing, and the high concentration in the willow selected at the start of the field lab, why were the expected results not seen? The answer is most likely the result of more than one confounding factor, including growth rates, other essential micronutrients and levels of consumption.

<u>Growth rate</u>

The growth rate of the lambs for the two months of the trial averaged around 140g/day (*Figure 1*). Compared to conventional benchmarks for weaning to finishing from an April lambing flock of 210g/day (Stocktake 2016), the growth rates could be considered slow in the context of previous nutrient requirement research. However, it is important to note that from the farm perspective growth rates achieved were appropriate for the system.

Mindrum is exploring the best organic regenerative models, for sustainable upland production, alongside building the genetics within their closed flock that will thrive. Confirmation that the lambs produced where achieving farm targets was demonstrated with high quality carcass grading, resulting in a Farmstock award for the season.

The grazing throughout the trial was in rotation around a forb ley (ley including high population of non-grass species) particularly rich in red clover, compared to permanent pasture pre-trial. The rotation worked well, and lambs settled into the system quickly, however, a transitional 'knock' may still have occurred.

Cobalt requirements are strongly linked to growth rate, the faster the growth the higher the requirement. Therefore, the lower cobalt concentrations in the grazing *(Table 1)* that all the lambs shared may have been sufficient to support their growth rate. Resulting in the supplementary cobalt supplied to the test group not being utilised, and no significant difference between the groups seen in growth rate. It should also be noted that the willow cobalt concentrations found in this trial were lower than previous research has demonstrated. *Kendall et al. 2021* found willow cobalt concentrations across 3 sites to have 6 to 10-fold of growing lamb requirement, whereas in this trial only at 4 to 5-fold requirement was seen. It is also important to remember that we are not looking to supplement the total requirement, but only the supplementation gap, as the basal diet (grazing) did have cobalt present.

The serum B12 concentrations in *Figure 2* further support the consideration that the supplementary cobalt from the willow leaves was not being utilised by the lambs in the test group. With no significant difference shown at either the mid, or end time points between the two lamb groups.

<u>Micronutrients</u>

Selenium levels in the pasture were also found to be low. Levels started at 0.009 mg/kgDM, and increased to 0.02 mg/kgDM and 0.021 mg/kgDM at the mid and end timepoints, respectively. However, still below the recommended levels for growing lambs (0.143 to 0.239 mg/kg DM). The blood samples confirmed the low selenium status with many of the lambs in the marginal (<40 u/mlPCV) and deficient categories (<20 u/mlPCV) for glutathione peroxidase activity *(Figure 1 – Appendix 1),* an enzyme that contains selenium, and its activity is linked to dietary selenium intake (*Figure 2 – Appendix 1*). Low levels of selenium can compromise growth rates and may have been a contributing factor when looking at the production results. Additionally, although the willow leaf had higher concentrations of selenium than the grass, it was still lower than the lamb's nutritional requirement.

Regarding other key micronutrients, Iodine levels were also found to be below nutritional requirements (*Figure 3 – Appendix 1*). Although Iodine is usually considered around fertility and lamb survival issues, its role in energy metabolism, protein production and appetite, link it to impacts on lamb performance. Availability of micronutrients in grazing can vary according to location, management, and the weather. Cobalt availability for example is linked to the redox potential (tendency of environment to oxidise or reduce substrates) of the soil, therefore reduced in dry conditions.

Deficiencies in cobalt, selenium, iodine, and copper are common across the UK, and all should be taken into account and monitored when considering supplementing livestock. Historically the trial farm has principally supplemented cobalt only. However, the results from the analysis of blood samples and field lab discussions have led to a change in practice.

<u>Consumption</u>

A further potential confounding factor regarding the impact of forage willow on lamb growth rates was intakes. The way the willow was fed was constrained by the need to incorporate it into the trial while keeping the lambs on the same pasture. As a result, it was decided to feed the willow after the weekly weighing, just before the lambs were returned to fresh grazing. The willow consumption ranged from an initial 76.2 g/head to as low as 16.7 g/head later in the trial. During browsing periods, which lasted approximately a couple of hours, the lambs became satiated and stopped browsing the leaves available in the pen. These intakes were not able to cover the supplementation gap between requirement and grazing (0.2-0.07) of ~0.13mgCo/kgDM per day. The willow cobalt intakes were only 0.006 to 0.025 mg/day.

Table 2 – Willow consumption. Willow branches weighted before and after lamb access. Top line denotes dates.

	29-7	1-8	6-8	13-8	20-8	28-8	4-9	10-9	17-9	26-9
sheep in willow group	302	300	300	295	292	280	278	268	267	251
apparent total intake (kg)	23	5	9	5	8	8	9	9	10.8	
per sheep (g)	76.2	16.7	30.0	16.9	27.4	28.6	32.4	33.6	40.4	
approx DM	25.4	5.6	10.0	5.6	9.1	9.5	10.8	11.2	13.5	
Co intake (mg) @ 1mg per kgDM	0.025	0.006	0.010	0.006	0.009	0.010	0.011	0.011	0.013	
% daily RQ@0.5 kg DMI	25.4	5.6	10.0	5.6	9.1	9.5	10.8	11.2	13.5	
% daily RQ@1.0 kg DMI	12.7	2.8	5.0	2.8	4.6	4.8	5.4	5.6	6.7	

Previous supplementation work with willow has largely been based on daily feeding. Walker et al 2022 offered ~300g (100gDM) of fresh leaves daily, with >90% consumption rate and found a significant effect on serum vitamin B12 concentrations (>1000 pmol/l compared to ~400 for control and drenched lambs). In this trial we did not achieve anywhere near this rate of willow consumption.

<u>Feeding Schedule</u>

When looking at trial design we had the option of trying to keep the test and control groups of lambs separate (but in the same field and feeding test group) or going for the split and feed option. Due to the requirement for regular weights to be recorded for the primary aim, it was decided that the split and feed option presented less risk of groups getting mixed and therefore impacting results. However, this option did restrict the time period in which lambs had access to willow. Without these trial restrictions, it would have been much easier to offer willow for a longer browsing period if being fed weekly, or even to have more regular willow feeding up to ad libitum willow availability. On farm observations noted that cost/workload associated with cutting willow to feed lambs was not insignificant and probably not feasible to do at scale in this context.

<u>Farm Learnings</u>

The results and observations from this field lab have led to many more questions around the impact and ease of incorporating willow into lamb diets with the aim of supplementing cobalt. For the field lab farm, the context of participating was an initial field observation (2023) of sheep and lambs browsing willow, linked to the knowledge that the farm is short of cobalt. This was followed by a 3-week 'quick and dirty' on farm experimentation (2023) project with their vet, where cut branches of willow were fed twice a week, which demonstrated a double in Vitamin B12 levels in a group of 10 sheep. Although it was under different variables than were then tested, it provided indicative, but not rigorous evidence that they were keen to take further.

Participation in the field lab demonstrated that production impact is dependent on a range of contextual factors, not limited to the availability of willow. Active management of diverse factors through the production process is necessary to achieve the optimum final product. This may not always be speed of production.

5. Conclusions

- Growth rate of the lambs in the trial reduced Cobalt requirements, therefore well managed red clover/forb ley provided adequate dietary concentration under constant intakes.
- Supplementary cobalt acquired from willow by the test group of lambs was not utilised due to compressed requirement.
- Correcting wider micronutrient deficiency, principally Selenium, could potentially have a positive effect on lamb growth rates across both the test and control group.
- Low consumption rates of willow provided negligible cobalt.
- For a commercial farming system browsing needs to be considered for effective intakes levels and resource management.
- More work is needed on practical delivery, which tree species are best suited, and animal behaviour to name a few.

6. Tips and recommendations

- Know your micronutrient levels - blood tests and forage analysis should be used to make sure you aren't missing anything. Be aware that concentrations and requirements can change throughout the season.

7 Further reading

Stocktake 2016 - https://ahdb.org.uk/stocktake-and-farmbench-reports

N.R. Kendall, J. Smith, L.K. Whistance, S. Stergiadis, C Stoate, H. Chesshire, A.R. Smith (2021) Trace element composition of tree fodder and potential nutritional use for livestock. Livestock Science 250,104560, https://doi.org/10.1016/j.livsci.2021.104560.

Trace element supplementation of lambs post weaning. Dr Tim Keady and Seamus Fagan 2015.

[References and useful literature]

Appendix 1

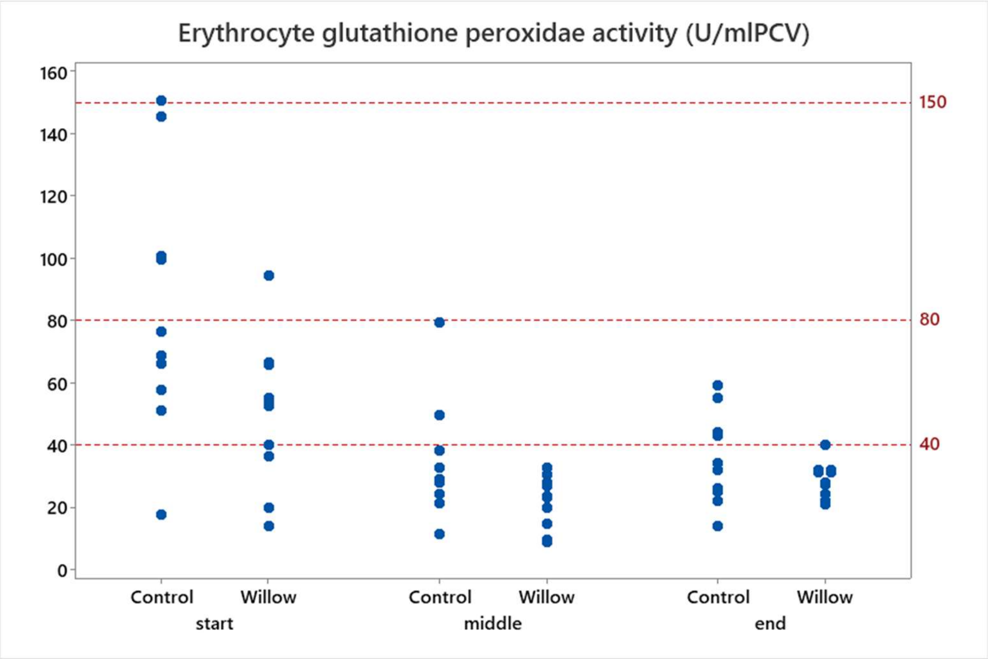

Figure 1 - Erythrocyte glutathione peroxidae activity is an indicator of selenium metabolism.

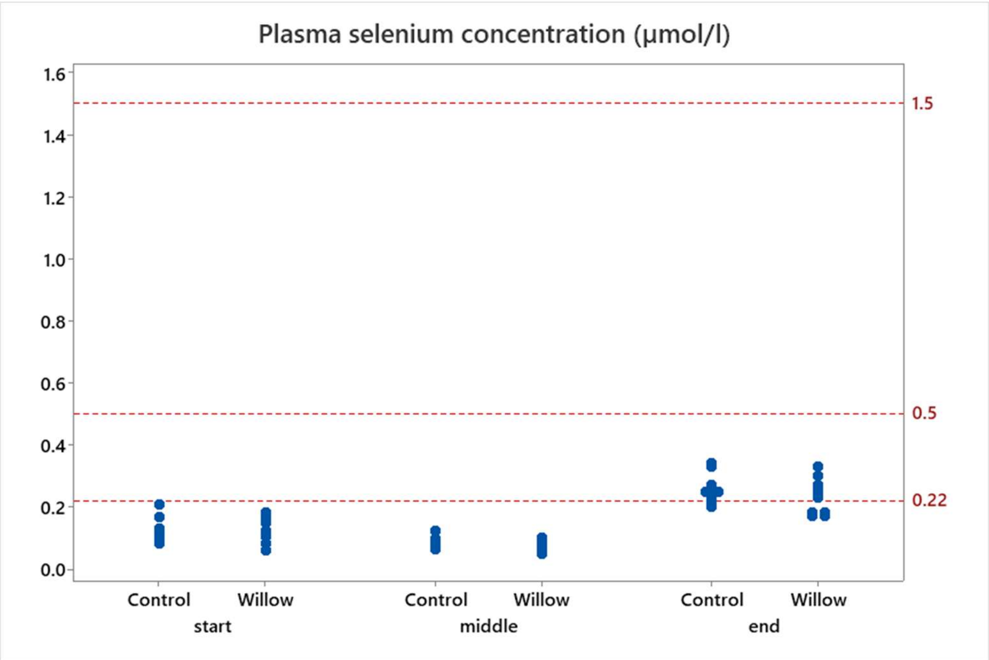

Figure 2 - Plasma selenium concentration

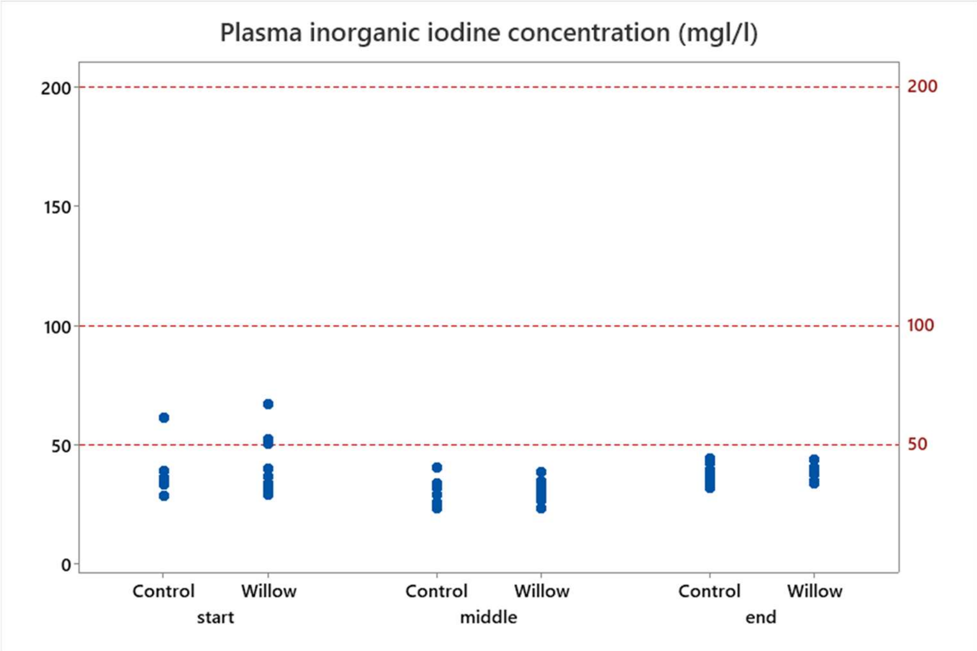

Figure 3 - Plasma inorganic iodine concentration

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