

Precision soil mapping in central Victorian pastures

Producer case study: Lloyd Gollop

Introduction

Lloyd Gollop manages a prime lamb enterprise near Amphitheatre, Victoria. The Gollop's farm was one of four host properties in the 'Precision soil mapping in central Victorian pastures' Producer Demonstration Site (PDS) with the Pyrenees and Smeaton BestWool/BestLamb groups. The PDS aimed to demonstrate the potential of grid sampling soil to assess nutrient variability and tailor variable rate applications (VRA) of fertiliser and ameliorants in grazing systems.

Lloyd saw the project as a great learning opportunity. 'Discussions throughout these projects are fantastic- you learn about all sorts of related topics'.

Soil characteristics and nutrient levels across grazing paddocks can be highly variable due to soil type, stock camps, landscape variation, water movement and management. Grid soil mapping provides a one pass, laboratory analysed method of testing a paddock for variability in pH and nutrient levels. It is currently the most accurate method for developing VRA, which utilize Variable Rate Technology to match fertiliser rates to pasture requirements across an entire paddock. This approach is widely used in the cropping industry but has seen limited uptake in grazing systems in central Victoria.

The site provided an opportunity to map the distribution of soil nutrients across two neighbouring paddocks, apply a blanket fertiliser rate to one and VRA to the other (targeting an Olsen P of 15) and re-

map nutrients three years later to demonstrate the impact of VRA within a dynamic livestock system.

The site

The Gollop's farm is an undulating landscape featuring granite hills. Average annual rainfall is 500-550mm, however during this 4-year project it received a much higher rainfall in 2022 (particularly spring) and experienced a wet summer 2023/24.



Figure 1 Aerial view of the site

Traditionally, Lloyd undertakes soil sampling every 4-5 years in line with the pasture renovation program, which includes a fodder crop, then straight to a perennial pasture. Nutrient management traditionally involves a blanket rate of 100kg/ha single superphosphate (SSP) annually, with lime applied every 8-10 years. The pasture base across the farm is primarily cocksfoot, fescue and sub-clover, with some phalaris/clover pastures. This is a winter-active pasture system, so throughout the

summer period stock are maintained on summer fodder crops with supplementary feeding of grain.

The Gollops demonstration site utilised VRA technology for phosphorus applications.

Trial paddocks had a winter-active fescue, cocksfoot and sub-clover pasture. The VRA paddock sits immediately above the control paddock within the landscape, as the two paddocks were subdivided just prior to the demonstration commencing. This subdivision led to changes in stock movements and sheep camp locations, which in turn had an impact on nutrient redistribution.

The demonstration

Grid-based soil sampling was used to assess variability in soil nutrients across representative grazing paddocks at each of the four host farms. All paddocks were grid soil sampled at 0-10cm depth at a 1ha resolution (to best understand soil variability per the parameters of this trial) in December 2020. Soil samples were tested for pH (CaCl₂), Olsen phosphorus (P), and exchangeable cations (potassium (K), magnesium (Mg), sodium (Na), calcium (Ca)) at an accredited soil laboratory. Subsoil samples were also collected at lower resolution (approximately every tenth grid square, targeted based on initial results) in 0-5, 5-10, 10-15, and 15-20cm increments to allow for identification of any pH stratification issues.

A producer steering committee developed paddock targets to address limitations to pasture production. Paired-paddock demonstrations were established to compare VRA versus the 'control' which involved conventional 'blanket' applications of key inputs (P). Application rates for the conventional applications were determined by the steering committee (using industry standards), based on a single set of soil test results (the paddock average from grid sample points) to achieve the target level.

Similar management was used across the paired paddocks, including similar grazing strategies.

Return soil sampling was undertaken three years later (in 2023) to assess any changes in soil conditions.

Pasture composition, feed on offer, stocking rate and pasture quality were monitored throughout the project to assess any impact on livestock and pasture production.

Finally, the benefits and costs of using VRA versus conventional 'blanket' (control) applications when applying key pasture inputs were assessed by comparing the costs and relative pasture production (benefits) of the two systems.

The Olsen P soil target for the site was 15mg/kg. Paddock treatments included:

Control paddock: Year 1 -100 kg/ha SSP

Year 2 – 150 kg/ha SSP

Year 3 – 102 kg /ha SSP

Total – 352 kg/ha SSP

VRA paddock: Year 1 – average of 168 kg/ha SSP

Year 2* – average of 112kg/ha SSP

Year 3* – average of 67 kg/ha SSP

Total – average of 346 kg/ha

* In years 2 & 3, the decision was made not to apply fertiliser areas in the VRA paddock which had an initial Olsen P greater than 20 mg/kg. This significantly reduced the maintenance P used. Maintenance rates for the VRA and control paddocks in Years 2 and 3 were the same apart from these areas.

Annual application maps for the VRA paddock are shown in Figure 2

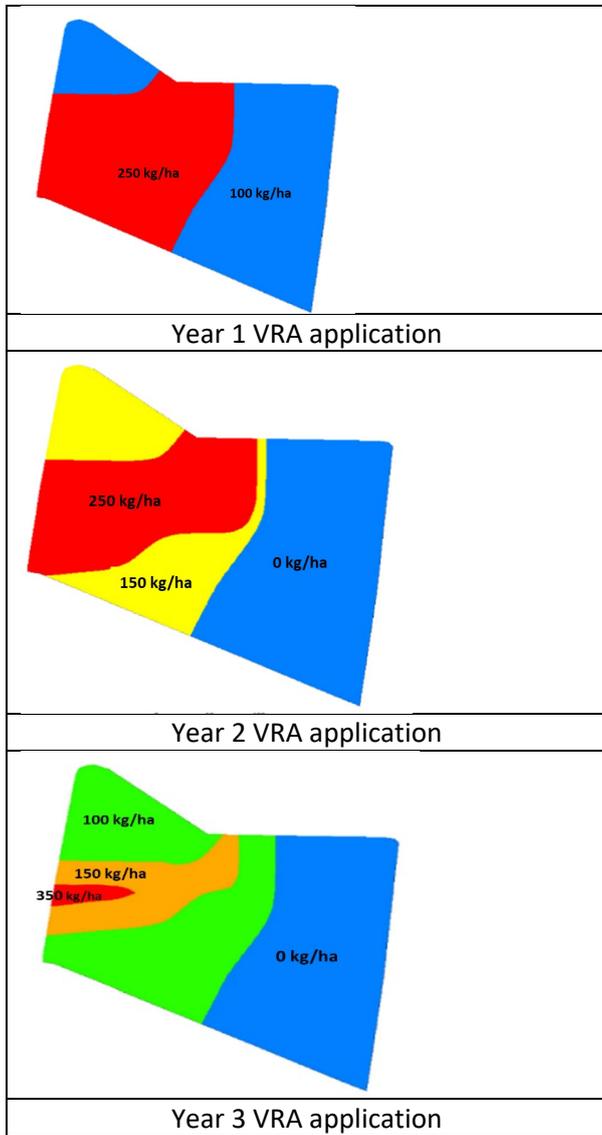


Figure 2 VRA single super phosphate applications over 3 years combining capital and maintenance fertiliser requirements

Results

Soil test results

Both the control and VRA failed to meet the target Olsen P of 15mg/kg and the average Olsen P dropped in both paddocks. This was exacerbated by an increased stocking rate over the demonstration period (to better manage the fescue pasture), which was not adequately accounted for in the maintenance fertiliser calculations. The VR application failed to reduce paddock variability as sheep continued to transport nutrients to higher points in the landscape.

Control

The control paddock started with an average Olsen P of 11.5mg/kg (range 7-19mg/kg) in 2020 and fell to an average of 8mg/kg (range 5-13 mg/kg) in 2023 (Fig 3).

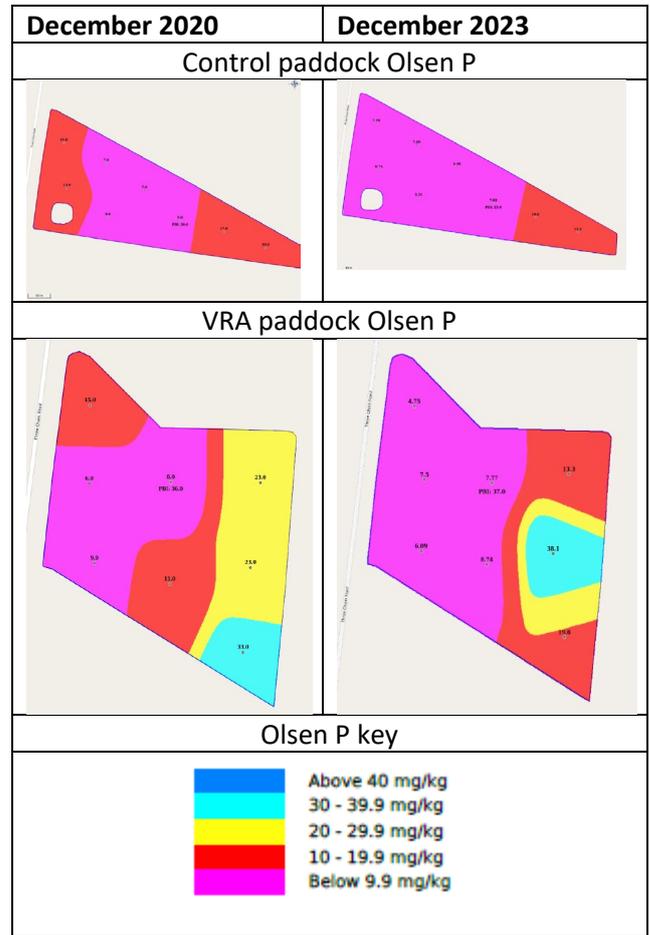


Figure 3 Figure 3: 2020 and 2023 pre/post Olsen P soil map

Generally, the SSP application rate for the control was too low to lift the Olsen P.

VRA

The VRA paddock started with an average Olsen P of 16mg/kg (range 8-33mg/kg), with the higher levels (yellow and aqua in Fig 3) across a hilltop used as a sheep camp. This dropped during the demonstration to an average of 13mg/kg, whilst increasing in variability across the paddock (range 5-38mg/kg). Phosphorus levels fell across the whole paddock, except for an area on the hilltop, which increased to an Olsen P of 38mg/kg. It is likely that the new subdivision fence to the south of the paddock caused a slight shift of the stock camp area.

Distribution of other soil attributes also changed throughout the 3-year demonstration, even though they were not targeted through fertiliser or ameliorant applications. Figure 4 shows changes in pH and potassium, which followed a similar redistribution (to higher points in the landscape) as phosphorus.

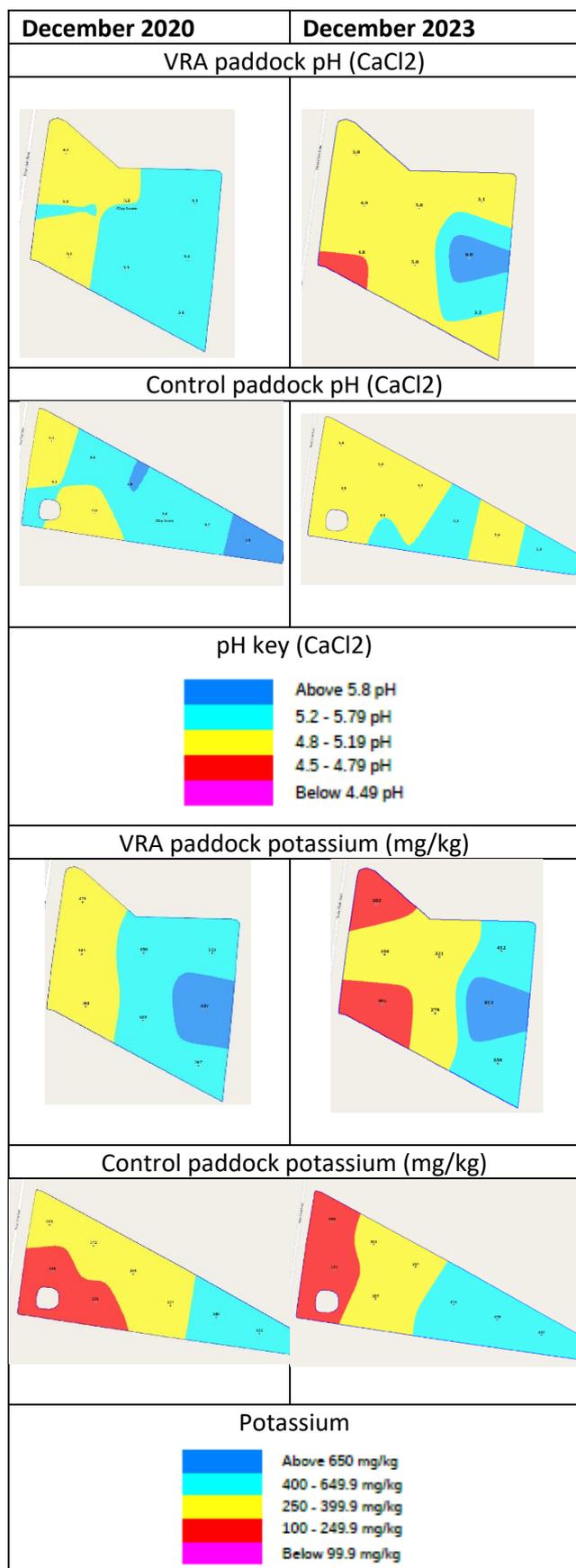


Figure 4 2020 and 2023 pre/post pH (CaCl2) and potassium (mg/kg) soil maps

Pasture Response/Production

No consistent difference was measured in pasture production, stocking rate, pasture quality or pasture

composition between the control and VRA paddocks at each of the four sites throughout the demonstration. The Gollops site grew an estimated 0.9t DM/ha in the VRA paddock over the three years, however this is unlikely to be statistically significant.

Economic outcomes

The economic analysis focused on the costs relative to the pasture production in the VRA and control paddocks. The results presented in Table 1 show that there were large differences in the soil sampling cost between the two treatments, with the 8.5 ha VRA paddock equating to \$637.50 (compared to a single soil test cost). Commercially in other Central Victorian grazing enterprises, a 2ha grid size (\$40/ha) is most commonly used to best manage testing costs with meaningful and practical VR outcomes.

	Control	VRA
Total soil sampling cost (\$/ha)	\$9	\$75
Total capital fertiliser cost (\$/ha)	\$0	\$61
Total maintenance fertiliser cost (\$/ha)	\$136	\$75
Total treatment cost (\$/ha)	\$145	\$211
Total 3-year pasture growth (tDM/ha)	21.0	21.9
Total treatment cost (\$/tDM)	\$7	\$10

Table 1. Comparison of 3-year (2021-2023) costs and pasture growth of the two soil management treatments.

The cost of fertiliser applied was similar between the two paddocks, however VRA paddock had higher sampling cost, leading to \$211/ha compared to \$145 for the control paddock for soil testing and fertiliser combined.

These results demonstrate the benefits and costs of additional information, however in this case the extra information did not lead to improved outcomes as both the control and VRA failed to hit the target Olsen P of 15 mg/kg and in fact, moved further away from the target.

Lloyd's feedback

Lloyd was surprised by the drop in Olsen P across control paddock that was spread at his traditional rate of single super, as well as the VRA paddock. 'We carried more sheep to manage the fescue and it was surprising just how much nutrient was shifted around the paddock making the sheep camps larger. More nutrient was moved off the paddock at the higher stocking rate as well.

The mapping was an expensive exercise, especially at the 1ha grid size. I'll probably continue to soil test away from sheep camps in the future. I can soil test and apply nutrients at the lower part of these paddocks and know the sheep will move it up the hill to the camp areas- that's a savings there.'

Summary

- Grid soil sampling provided detailed soil information and identified variability in Olsen P which aligned to landscape differences and sheep behaviour. Reading the landscape (eg identifying sheep camps or different soil types) can help predict variation in soil fertility. Fencing according to landscape changes (eg hills or slopes) can reduce variability.
- The increased level of soil information came at an increased cost (\$75/ha) compared to the control (\$9/ha or \$84 for one test).
- Applications of SSP to both the VRA and control (blanket application) fell short of the target Olsen P of 15 mg/kg.
- VRA for SSP did not reduce Olsen P variability. There were a couple of factors including (1) livestock movement of nutrients into high points in the landscape (stock camps) and the changed fence line, (2) underestimation of stocking rates on the individual paddocks and therefore maintenance P rates and nutrient movement off the paddocks. Overall outcomes in soil nutrition were similar between the VRA and control paddocks.
- No obvious or consistent differences were measured in pasture production, quality and composition and stocking rate between the control and VRA paddocks.
- The demonstration highlighted the importance of re-sampling paddocks over time to understand trends and impacts of applications (and animal movements within paddocks and across the farm).

Please note: This site demonstrated VRA for phosphorus only. VRA lime, gypsum and potassium applications were made at other sites with different outcomes.

Further details on the other sites can be found [Precision soil mapping in Central Victorian Pastures | Meat & Livestock Australia](#)

Acknowledgements

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