Final report

PDS Precision Soil Management for Pasture Productivity

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Abstract

Variability in soil characteristics, such as acidity and the nutrients critical to pasture growth, can be substantial within a single paddock due to the ongoing influence of soil types, management decisions, and livestock movement. Variable Rate (VR) Applications are commonly used in cropping to provide better targeting of fertiliser and ameliorants, but uptake is low in the livestock industry. This Producer Demonstration Site (PDS) aimed to assess variability in representative paddocks in east South Australia/West Victoria and measure any differences in soil, pasture, and livestock outcomes using a paired-paddocks design to compare VR and conventional practices. VR was often more effective at reaching target soil critical values and tended to manage or reduce variability more than uniform applications, but also had higher upfront costs involved. The methods used to measure pasture and livestock outcomes in this PDS were not sensitive enough to detect any differences and further work is required to quantify the longer-term costs/benefits associated with VR practices.

Executive summary

Background

Variability in soil characteristics, such as acidity and the nutrients critical to pasture growth, can be substantial within a single paddock due to the ongoing influence of soil types, management decisions, and livestock movement. Variable Rate (VR) Applications are commonly used in cropping to provide better targeting of fertiliser and ameliorants, but uptake is low in the livestock industry. This PDS project aimed to build the capacity of group members to manage soil constraints and nutrition through variable rate application (VRA) of ameliorants and fertiliser, and demonstrate any productivity, profitability, and sustainability benefits associated with the approach. The main target audience was farmers and advisors involved in pasture-based livestock systems who may benefit from increased uptake of VRA to manage intra-paddock variability in soil acidity, sodicity, and nutrition. Relevant examples, with relevant economic analysis, are not otherwise widely available.

Objectives

The objectives of this PDS centred on assessing variability across nearly 1000 hectares (ha) of representative paddocks, supporting core producers to implement demonstrations comparing a VRA to a conventional uniform application, and measuring the soil, pasture, livestock, and economic outcomes associated with each treatment. The PDS was successful at assessing both initial soil variability and measuring the change in soil conditions but was unable to adequately assess whether there were any changes to livestock or pasture outcomes.

Methodology

Grid based soil sampling was used to assess variability in soil nutrients across representative grazing paddocks in the east of South Australia and the west of Victoria. Paired-paddocks demonstrations were established comparing a variable rate application of a target input to a conventional uniform application of the same. Return soil sampling was used to assess any resulting changes in soil conditions, and Cibo Labs Pasture Key satellite-based pasture estimates were combined with farmers' livestock movement records to assess impact on livestock and pasture outcomes.

Results/key findings

Soils displayed substantial variability across all tested analytes, although the degree of variability itself varied substantially between paddocks. Variable rate applications were often more effective at reaching target soil critical values and were often also more effective at managing or reducing variability compared to conventional uniform applications, but the approach had consistently higher up-front costs due to the expense of additional sampling and higher prescribed rates. A more intensive experimental design is necessary to pick up any changes to pasture, livestock, and broader financial outcomes arising from different fertiliser and ameliorant strategies.

Benefits to industry

There is substantial soil variability that is currently under-managed in many pasture-based grazing systems. Variable rate applications can increase fertiliser efficiency and effectiveness, with the potential for pasture, livestock, and financial benefits, but these were unable to be measured using the low-intensity monitoring techniques applied in this demonstration.

Future research and recommendations

The potential value of VR justifies further work aimed at effectively measuring livestock and pasture outcomes to provide a more complete base of knowledge and to support effective adoption across the industry.

PDS key data summary table

Project Aim: The aims of this PDS centred on assessing soil variability across nearly 1000ha of representative paddocks, supporting core producers to implement demonstrations comparing a VR application to a conventional uniform application, and measuring the soil, pasture, livestock, and economic outcomes associated with each treatment.			
	Comments		**Unit**
Production efficiency benefit (impact) Pasture productivity – kg DM/ha Stocking rate – DSE, AE or LSU/ha	The results from this project identified that a more intensive experimental design was necessary to pick up any changes to pasture, livestock, and broader financial outcomes arising from different variable rate fertiliser and ameliorant strategies.		
Net $ benefit (impact)	Impact not determined		
Number of core participants engaged in project	This was initially 10 prior to the contract variation.	3	
Core group no. ha		8,525	
Core group no. sheep	Total No. sheep	50,850	hd sheep
Core group no. cattle	Total No. cattle	9,100	hd cattle
% change in knowledge, skill & confidence – core	*All 3 core participants submitted a post project survey, however not all questions were answered.*	5.7/10 5.7/10 7/10 7.5/10	Pre-survey Knowledge/skills Confidence Post Survey Knowledge/skills Confidence
% practice change adoption – core	*Grid sampling/VRA* *Pasture measurements*	<25% <25 to >75%	Response varied by grower
% change in knowledge, skill & confidence – observer producers	Beyond the core participants, field day feedback was one of the key metrics for demonstrating the efficacy of the project. Through the 2023 (12 respondents) and 2024 (4 respondents) field day sheets we observed that:	6.6/10 8.3/10 in 2023 6.5/10 in 2024 83%	Participant knowledge / understanding about soil variability and VRA increased A number of participants were motivated to improve their enterprise intended to seek additional information on soil variability and VRA
Key impact data			
Gross Margin / Ha	**Impact not determined**		
Gross Margin / dse	**Impact not determined**		

Table of contents

1. Background

This PDS project aimed to build the capacity of group members to manage soil constraints and nutrition through variable rate application (VRA) of ameliorants and fertiliser, and demonstrate any productivity, profitability, and sustainability benefits associated with the approach. The main target audience was farmers and advisors involved in pasture-based livestock systems who may benefit from increased uptake of VRA to manage intra-paddock variability in soil acidity, sodicity, and nutrition. Relevant examples, with relevant economic analysis, are not otherwise widely available.

Soil acidity is a widespread and significant challenge for Australian mixed farming and livestock enterprises. It reduces the availability of key nutrients, decreases microbial activity, increases soil nitrous oxide emissions, and can restrict root growth and access to water and nutrients. This ultimately leads to a reduction in biomass, increased weed prevalence, and reduced animal production and farm income.

The conventional method of treating soil acidity through blanket applications of lime is well established and broadly adopted. This is often based on the average pH of the paddock as measured by soil sampling. However, the high spatial variability of soil acidity means that a blanket approach is often ineffective and/or inefficient: within a single paddock, 10-50% of the area may not have an acidity problem, and the remaining area may require more lime than indicated by the paddock average.

Soil nutrients that are critical to pasture growth and animal health also vary substantially within paddocks. Phosphorus (P), for example, is key to cell division and growth in plants and animals, with P fertiliser applications essential for profitable production across most Australian soils. Despite a history of P applications in many enterprises, several factors contribute to its uneven distribution such as past management practices (e.g. changes to fence lines), and redistribution by stock (accumulation in camps, removal from high-performing areas). Conventional blanket applications of P may not adequately correct deficiencies in some parts of a paddock and represent an unnecessary cost in others.

The results of the demonstration will be used to support profitable adoption of VRA in the situations where it is justified by these practical results.

2. Objectives

Objective 1. Assess the variability in pH, P and exchangeable cations on paired representative paddocks across 3 livestock enterprises using a grid soil sampling approach.

Objective 1 was achieved with grid-based soil sampling undertaken on three livestock enterprises in December 2021, and again in December 2023.

Objective 2. Support core producers to implement demonstrations of variable rate application across 1000ha:

a. Identify relevant opportunities for variable rate application of fertilisers or ameliorants at each demonstration paddock.

Opportunities for VRA application of fertilisers or ameliorants were successfully identified by participating farmers across all 45 paddocks initially mapped as part of the project, and relevant VRA applications undertaken on 22 of these. On the 12 demonstration paddocks that remained in the project for its entirety, VR applications were undertaken on half of these as per the paired-paddocks experimental design.

b. Improve application efficiency across 70% of the area of VRA demonstration paddocks, compared to a conventional uniform rate, and meet specific ROI% targets set by core producers.

The average VR application rate was lower than the conventional uniform rate in 2 out of the 6 pairs of demonstration paddocks. Higher rates were required on the other 4 VR paddocks because of low starting nutrient/pH conditions relative to the desired target. These higher VR applications were generally more effective at reaching the desired target. Because of inadequacies in the approach taken to measuring livestock and pasture outcomes the actual ROI% was unable to be satisfactorily calculated. On a cost-only basis, VRA treatments were consistently more expensive than the paired conventional uniform rate approach.

c. Track benefits or improvement of relevant indicators on 3 demonstration sites (e.g. actual change in soil characteristics, stocking rate, feed availability), and develop a rigorous cost/benefit analysis.

Actual changes in soil characteristics were successfully measured at all demonstration sites. Measurements of stocking rate and feed availability based on satellite-based pasture measurements, farmer-collected stock movement data, and computer modelling were less successful as outlined below. Consequently, the cost/benefit analysis was limited to a comparison of costs involved in the VR vs. conventional approaches.

Objective 3. Achieve increased knowledge and ongoing adoption of precise soil and fertiliser management practices:

a. by all 3 core producers

This PDS was successful in providing insight into the level of variability in soils across the relevant area, and in measuring the change in soil conditions under VR and conventional practices within the lifespan of the project. Core Producer Project Exit surveys show an increase in producer knowledge of, and confidence in, applying precision agriculture (including VRA) from an average score of 5.7/10 for core participants to a score of 7/10 for knowledge and 7.5/10 for confidence. Two of the three growers have undertaken additional grid soil sampling and highlighted future plans to undertake EM38 mapping and zone based strategic sampling.

Soil Conductivity Mapping using an EM38 device is a reliable option for zoning paddocks according to soil type and related characteristics. It is a fast and cost-effective way of measuring variation in soil moisture content, salt levels, and soil texture; accurately identifying soil management zones. Combined with strategic soil-sampling, it can help diagnose the source of variability across a paddock and provide the basis for variable rate strategies, targeting soil profile management. Due to the effects of management, productivity and stock movements these zones aren't the most accurate approach for managing surface soil properties.

b. across an additional 3,000ha on observer producers' properties.

Beyond the core participants of the project, field day feedback was one of the key metrics for demonstrating the efficacy of the project in increasing knowledge, attitudes and skill development. Through the 2023 (12 respondents) and 2024 (4 respondents) field day sheets we observed that:

- Participant knowledge/understanding about soil variability and Variable Rate Applications increased (score of 6.5-6.7 out of 10)
- A number of participants were motivated to improve their enterprise as a result of attending the field days (score 8.3/10 in 2023 and 6.5/10 in 2024)
- 83% in 2023 intended to seek additional information on soil variability and VRA.

Anecdotal evidence from Precision Agricultures Regional Managers has been that there has been a slow but steady increase in grid based sampling in pasture systems in the region.

3. Demonstration Site Design

3.1 Methodology

This project used paired paddocks to compare the impact of variable rate applications on treatment paddocks against standard farmer practice (conventional uniform rate applications) on control paddocks.

Demonstration sites were initially established across 44 paddocks over 10 properties, which were paired to enable a comparison between control (standard practice) and treatment (variable rate) practices. Locations of paddocks are summarised in Figure 1. All paddocks were grid soil sampled at 0-10cm depth at a 2ha resolution (as per commercial standard practice) in December 2020. Soil samples were tested for pH, 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 10th 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. Producers were provided with the resulting spatial maps of soil conditions and used these to determine appropriate targets for VRA on each treatment paddock, which occurred in 2021.

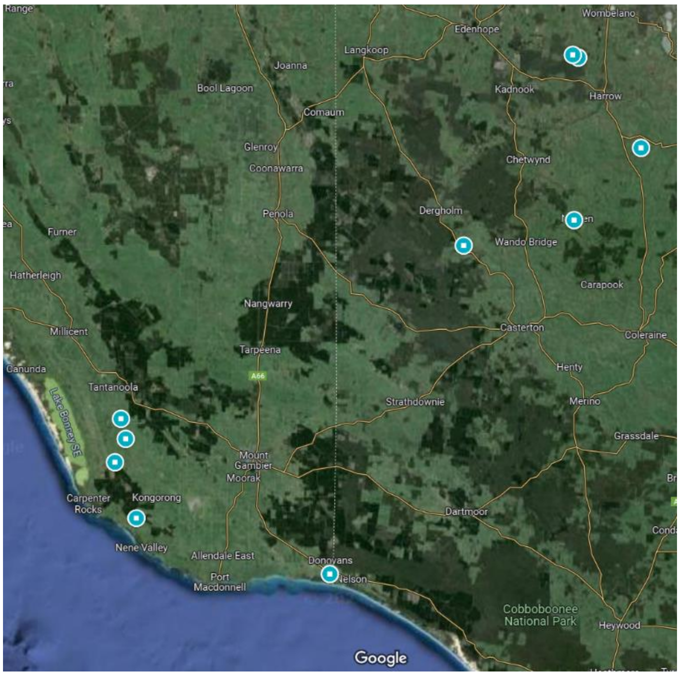


Figure 1 Locations of farms with paddocks that that were grid sampled in the initial sampling round.

Due to a lack of engagement by producers in data collection the number of demonstration paddocks was reduced in 2022 to 12 (6 pairs) across three properties, for a total of 306ha (as per Variation Agreement dated 26-Sep-2022):

One pair compared a VR application of P (targeting Olsen P of 18 mg/kg) to a blanket application of 18 kg/ha P.
One pair compared a VR application of K that used rates recommended by the participating farmer's agronomist based on K % of cations to a blanket application of 25 kg/ha K.
Two pairs compared a VR application of lime targeting pH 5.2 to a nil lime application.
Two pairs compared a VR application of lime targeting pH 5.5. to a blanket application of 3t/ha lime.

The unusual set of treatments was an artefact of the change in project scale. Where the original number of demonstration paddocks would have allowed for greater statistical analysis of the aggregate dataset, analysis of the remaining 6 paddocks shifted to a more focused case-study approach.

In these remaining 12 paddocks the following monitoring activities were undertaken:

- Pasture assessments. Cibo Labs Pasture Key satellite-based pasture estimates were used in place of physical measurements. This was intended to overcome the inadequate data collection early in the project, since estimates were also back processed for a period of several years prior to project initiation.
- Livestock numbers and movements to support stocking rate/carrying capacity calculations. Two producers were users of the AgriWebb livestock recording system. In the remaining case, comparable records were maintained using a spreadsheet.

Fertiliser applications, and related financial records.

- Grid-based soil sampling was repeated in December 2022 (for P and K demonstration paddocks) and December 2023 (for lime demonstration paddocks). These results were analysed using Excel to determine actual changes to soil conditions.

3.2 Economic analysis

The original consultant contracted to provide economic analysis became unable to complete this work in 2022. Tim Prance (from T Prance Rural Consulting) was subsequently approved by MLA to perform the analysis instead. This analysis attempted to compare the financial benefits accruing to changes in pasture production and stocking rates and the costs associated with each treatment.

CiboLabs Pasture Key Food On Offer (FOO) estimates were calculated for each demonstration paddock for a period starting in 2017 through to end 2023. FOO (in terms of Total Standing Dry Matter TSDM t/ha) was compared within pairs using the pre-project period of 2017-2020 as a baseline. Any differences were intended to be converted into dollar value using reasonable estimates of the value of feed produced.

In the demonstration paddocks where records were maintained using AgriWebb, dry sheep equivalent (DSE) grazing days per paddock were used. On the demonstration paddocks where records were kept in a spreadsheet that included numbers, livestock class, and dates in and out, monthly kg dry matter intake/ha was calculated using CSIRO GrazFeed. To this was added pasture wastage and deducted supplementary feed inputs to calculate monthly (and annual) pasture utilisation. Stocking rate was also calculated and compared for all demonstration paddocks.

3.3 Extension and communication

The PDS communications plan is outlined in Table 1.

Table 1: Summary of initial communications plan.

Activity	Target Audience	Key messages	Timing	Estimated reach

Social media posts: Facebook, LinkedIn	Primary & secondary	Key project messages and events	As required	2,120 followers
Kick-off meeting	Primary	Clarify specific project details, set shared goals and expectations	November 2020	10 core producers
Results workshop	Primary	Soil test results and analysis, soil test interpretation guidelines	Jan/Feb 2021	10 core producers
Field Day eDM	Primary & secondary	Event information and invitation	February 2021	150 producers/agronomists
2021 Field Day	Primary & secondary	Soil variability and fertiliser management information (including FertCare guidance). Practical demonstration of VRA .	March 2021	30 producers/agronomists
Factsheet/ Newsletter article	Primary & secondary	High level summary of project outcomes and key messages to date	June 2021	1,500 producers/agronomists
Field Day eDM	Primary & secondary	Event information and invitation	February 2022	150
2022 Field Day	Primary & secondary	TBD by steering committee.	March 2022	30 producers/agronomists
Factsheet/ Newsletter article	Primary & secondary	High level summary of project outcomes and key messages to date	June 2022	1,500 producers/agronomists
Field Day eDM	Primary & secondary	Event information and invitation	February 2023	150
2023 Field Day	Primary & secondary	Focus on results from return grid sampling of P/K demonstration paddocks.	March 2023	30 producers/agronomists
Technical report	Primary & secondary	Summary and aggregate analysis of project results and outcomes.	February 2024	150 producers/agronomists
Case studies	Primary & secondary	Detailed case studies for representative demonstration sites.	February 2024	1,500 producers/agronomists
Field Day eDM	Primary & secondary	Event information and invitation	February 2024	150 producers/agronomists
Final Field Day	Primary & secondary	Final project outcomes.	March 2024	30 producers/agronomists
Factsheet/ Newsletter article	Primary & secondary	High level summary of final project outcomes and key messages.	April 2024	1,500 producers/agronomists

3.4 Monitoring and evaluation

The broad monitoring and evaluation (M&E) process used in this PDS is outlined in Table 2.

Table 2: The M&E process used for data collection, plus the metrics measured.

Evaluation level	Project Performance Measures	Evaluation Methods
Inputs	• Number of core producers directly involved in establishment and monitoring of demonstration sites & their demographics • Number of producers observing demonstration sites & their demographics • Number of livestock involved • Number of soil tests taken • Number and types of organisations and groups involved in delivery of the project • Meeting of steering committee • Investments from MLA and others	○ Project entry and exit surveys ○ Event feedback ○ Soil sample submission system ○ Project reporting ○ Committee minutes ○ Budgets
Outputs	• Identification of variability in soil constraints, nutrient deficiencies and/or excesses in demonstration sites • Identification of management actions to improve productivity and uniformity of demonstration sites • Changes to efficiency of fertiliser/ameliorant application on VRA paddocks compared to conventional approach • Improved livestock and pasture production associated with the mapped variability and the VRA practice. • Number of field days held and attendees • Communications activities and reach	○ Satellite imagery (Cibo Labs) ○ Soil sampling results and agronomic interpretation ○ Fertiliser/ameliorant application data ○ Livestock number and class recording ○ Project reporting
Changes in knowledge, skills, confidence	• Change in awareness in core and observer producers of soil variability • Change in knowledge in core and observer producers of precision agriculture practices and ability to apply them • Change in core producer skills related to pasture measurement and quality assessment • Experience of producers involved in the PDS – extent to which they found the project/ activity useful or of value.	○ Project entry and exit surveys ○ Event feedback ○ Steering committee feedback
Practice changes	• Changes in the number of producers using precision soil testing • Changes in number of producers using variable rate fertilizer application • Number of producers changing fertiliser/ ameliorant applications e.g. liming • Changes to producer soil testing strategies e.g. testing different landclasses/ subsoil testing • Adoption of other practices demonstrated	○ Project entry and exit surveys ○ Event feedback ○ Steering committee feedback
Benefits	• Cost/Benefit analysis of variable rate application compared to conventional approach.	○ ROI per ha and per stocking unit ○ High level benchmarking
General observations /outcomes	• Identification of barriers / enablers to expanded adoption of precision soil management techniques • Document unintended benefits.	○ Event feedback ○ Steering committee feedback ○ Final report analysis of project results and outcomes

4. Results

4.1 Demonstration site results

4.1.1 Overall observations on soil variability from initial soil sampling

Table 3 summarises the range of results measured by 491 grid soil tests of key analytes in the initial round of sampling across 982ha approx. All analytes had very high average variability within paddocks, apart from pH, which was relatively low. However, the degree of variability itself varied widely between paddocks: the least variable pH paddock was effectively uniform with a CoV of only 0.8, whilst the most variable had a high CoV of 15.

Table 3: The mean paddock average, range of paddock average, mean paddock coefficient of variation (CoV), and range of paddock CoV in the initial round of grid soil sampling. Analytes are arranged from lowest (top row) to highest (bottom row) average variability, as measured by the average CoV.

Soil Test	Average (paddock averages)	Range (paddock averages)	average CoV (paddock)	Range of CoV
pH	5.4	4.5-7.6	5.4	0.8-15
Exchangeable Sodium Percentage (ESP)	3.4	0.8-7	25	7.0-61
Olsen Phosphorus	15.6	8.6-25	32	12-83
Cation Exchange Capacity (CEC)	12	3.9-37	33	7-85
Sulphur	8.9	4.2-17	35	8-88
Potassium	202	63-610	40	16-81

As a typical example, Figure 2 shows the range of Olsen P results measured within each paddock. Most paddocks, regardless of average, contained areas both above and below this critical value. A conventional uniform application of P to any of these paddocks would only consolidate these areas of excess and deficiency.

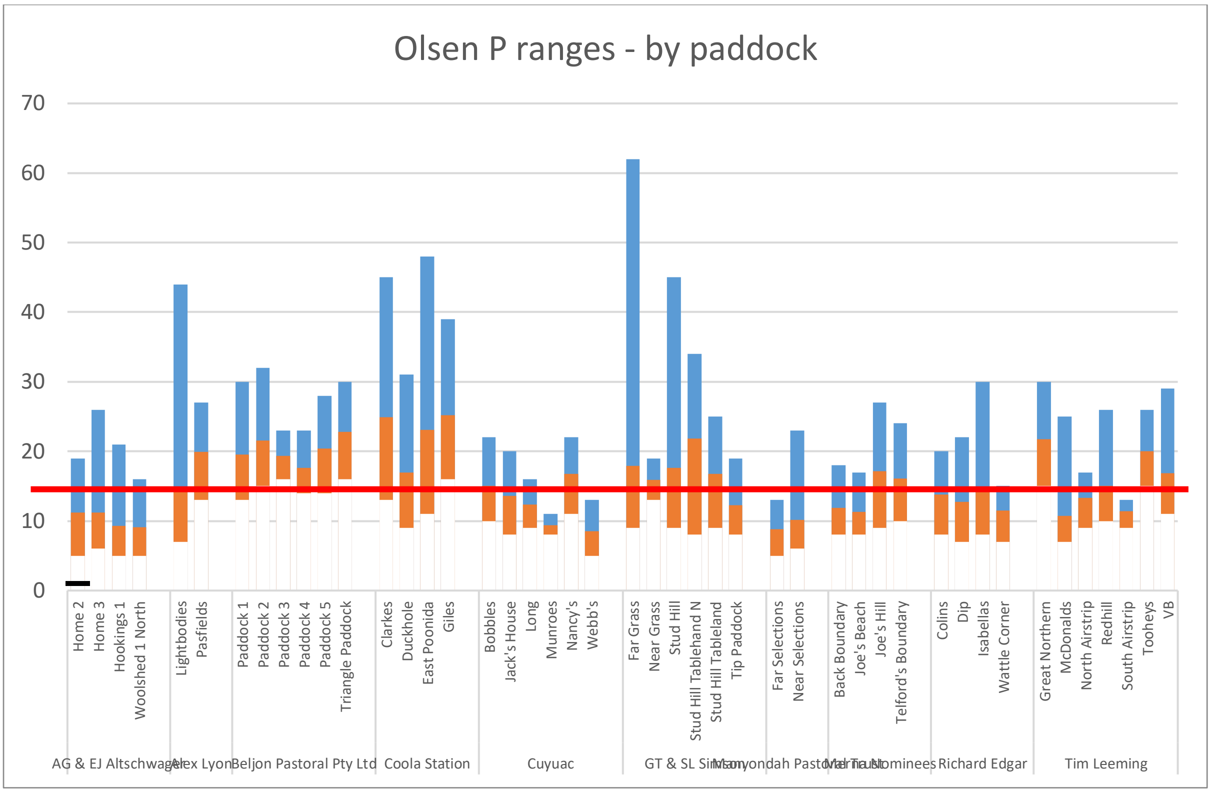


Figure 2 Olsen P ranges measured for each paddock in the initial round of grid sampling. Each paddock is represented by one bar. Each orange section represents the minimum value measured in the paddock to the paddock average. The blue section represents the paddock average up to the maximum value. The red line indicates a generic critical value of 15 Olsen P.

Consequently, all farmers involved were able to identify potential opportunities to benefit from VR application of nutrients. The priorities selected by the original 10 core producers are listed in Table 4; the results for the final 3 demonstration sites follow below.

Table 4: Priority targets selected by producers for VR applications. Some producers selected 2 targets.

Target	No. of sites at which target was selected as priority
pH (lime)	6
Olsen P	4
Potassium	5

4.1.2 P & K demonstration site results (West Cuyuac – Richard Edgar)

4.1.2.1 Soil test results

The paired paddocks that constituted the VR P demonstration site started with similar Olsen P levels and high variability in December 2020 (Table 5). By December 2022, the control paddock had only experienced a small increase in Olsen P (0.7 units) whilst the VR paddock had increased substantially

(9.75) despite receiving a lower average P rate, suggesting that the VR application had been both more effective and efficient. However, the final average for the VR paddock was well above the target level of 15-18mg/kg Olsen P as a result of the farmer making a last-minute change to a blended product with a higher P analysis (12.4% P) but still utilizing maps designed for Single Super Phosphate (8.8% P).

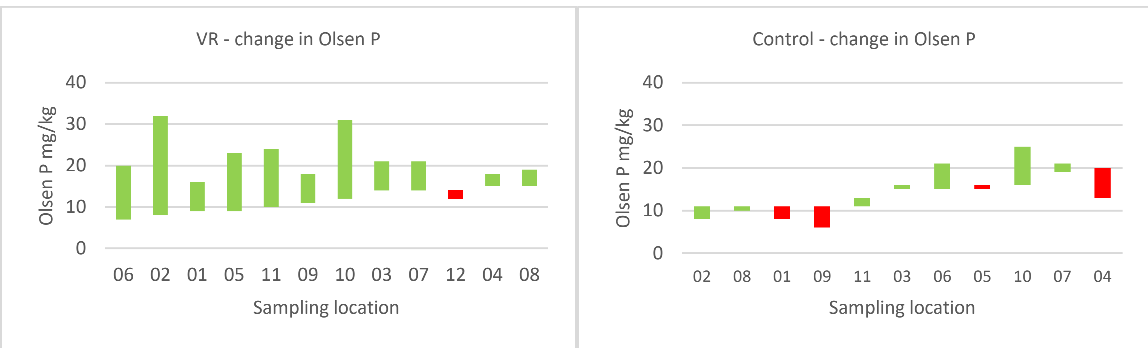
Table 5: Average Olsen P level (mg/kg) and CV% in initial and return sampling

Olsen P		VR (Wattle Corner)	Control (Colins)
2020	Average	11.5	13.8
	CV%	25%	28%
2022	Average	21.25	14.5
	CV%	27%	40%
Change	Average	9.75	0.7
	CV%	2%	12%
	Average P rate (treatment)	16.4	18

An important additional measure of success for a variable rate strategy is a reduction in variability across the paddock. In this case, both the VR and control paddock increased in variability as measured by the Coefficient of Variation (CV%). However, the control paddock became substantially more variable with an increase in CV% of 12%, whilst the VR paddock only increased by 2%. The VR application appears to have reduced the impact of factors that naturally increase nutrient variability in this system, such as animal movement, without totally removing variability from the system.

Figure 3 demonstrates the spatial impact of the two different strategies. In the VR paddock (Figure 3a), areas with lower initial levels received a higher rate and tended to increase more than areas with higher initial levels. In the control paddock (Figure 3b) no such tendency is observed.

There were no unusual changes to non-target soil characteristics. Calcium levels increased substantially in both paddocks alongside an increase in pH because of (uniform) lime applications.



a b

Figure 3: Change in Olsen P soil test 0-10cm between December 2020 and December 2022 for a) the treatment paddock, which received a VR Phosphorus application in May 2021 (average of 16.4 kg/ha P across the paddock), and b) the control paddock which received a uniform application of 18kg/ha P at the same time. Sampling locations are sorted in order of lowest to highest initial soil test result (and consequently highest to lowest VR P applications). Green bars indicate an increase

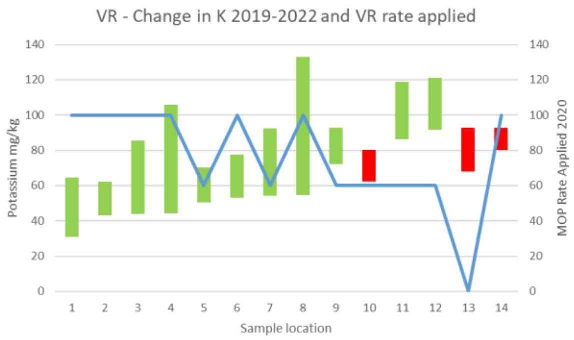
in Olsen P between sampling dates at each point, with the bottom of the bar representing Dec 2020 and the top of the bar Dec 2022. Red bars indicate a decrease in Olsen P, with the top of the bar representing Dec 2020 and the bottom of the bar Dec 2022.

The paired paddocks that constituted the VR K demonstration site started with similar K levels and high variability in December 2020 (Table 6). By December 2022 the K level in both paddocks had increased – VR by 25 mg/kg to an average of 88.2 mg/kg, and control by 15 units to an average of 99.7 mg/kg. The greater increase in the VR paddock is not unexpected since the VR application averaged 38 kg/ha potassium compared to only 25 kg/ha on the control. However, the two paddocks diverged substantially when it came to variability: the control paddock became more variable (CV increased by 7%) where the VR paddock became less variable (CV decreased by 7%). The VR treatment was evidently more effective at managing K variability.

Table 6 Average Exchangeable K level (mg/kg) and CV% in initial and return sampling.

Exch K		VR (Dip)	Control (Isabellas)
2020	Average	63.64285714	84.7
	CV%	34%	30%
2022	Average	88.17857143	99.7
	CV%	27%	37%
Change	Average	24.53571429	15.0
	CV%	-7%	7%
	Average K rate (treatment)	37.85714286	25

Figure 4 demonstrates the spatial impact of the two different strategies. Of particular interest in this case is the approach used to determine the VR application rates on the VR paddock. The conventional method for determining rates uses soil test K in mg/kg as the basis for calculation. In this case, however, the demonstration site farmer and agronomist decided to use K % of cations as the primary input. This is a more unconventional approach (given that K % levels will also be affected by changes in the levels of other cations in solution) but one that had been used with previous success in the region on lighter, low cation exchange capacity soils.



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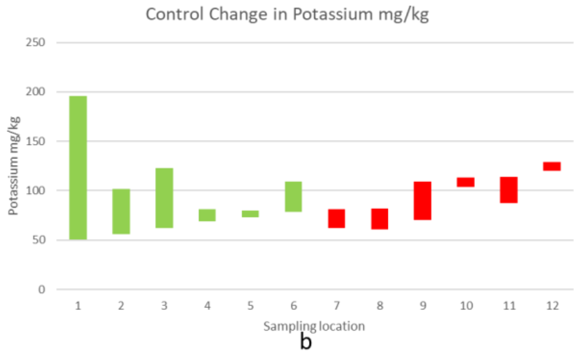

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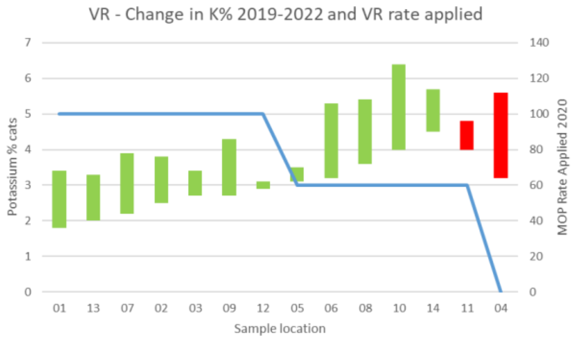

c

% K		VR (Dip)	Control (Isabellas)
2020	Average	3.257142857	4.3
	CV%	34%	33%
2022	Average	4.192857143	5.5
	CV%	25%	27%
Change	Average	0.935714286	1.2
	CV%	-9%	-7%
	Average K rate (treatment)	37.85714286	25

d

Figure 4: Change in exchangeable K (a, b), K as a percentage of cations in the VR paddock only (c), and changes to average K as a percentage of cations and CV% (d) for soil test 0-10cm between December 2020 and December 2022. Changes are displayed as per figure 1. The blue line on a, c, displays the variable rate applied at each point.

Instead of targeting an actual K level in mg/kg that may be unrealistic, the K % of cations figure is used to determine which areas may have the capacity to hold more K and hence try to 'fill the bucket' instead. As a rule of thumb, if the K % cations was 3 %, it predicts a response and more fertiliser will be applied there, whereas when it is close to 5% the idea is that the soil bucket is full so any additional application would be of limited benefit. This approach is demonstrated by the blue line in figures 2a and 2c, which shows the rate applied at each point on the VR paddock: 2a in mg/kg, and 2c as a % of cations. The approach appears to have been successful and is worthy of further and more rigorous study to better understand it in comparison to a more conventional approach.

As with the VR P demonstration, there were no unexpected changes to non-target soil characteristics.

4.1.2.2 Pasture and livestock results

Unfortunately, despite excellent quality data, monthly DSE grazing days/ha for each of the four paddocks was highly variable and there was no clear pattern of difference between VR and control (Table 7).

Table 7: Average annual DSE/ha. Monthly average DSE/ha was even more variable.

Paddock	Treatment	Average dse/ha from AgriWebb			
		2019	2020	2021	2022
Colins	Control	14.0	22.9	15.5	20.4
Wattle Corner	VR P	12.2	12.2	17.7	13.7
Dip	Control	14.1	12.0	18.6	15.7
Isabellas	VR K	22.0	11.1	32.9	19.0

Cibo Labs estimates of total standing pasture dry matter (TSDM, both dead and green) was summarised as monthly paddock average TSDM kg/ha for analysis. These were calculated back to 2017 to provide an indication of the baseline performance of each paddock.

As with the DSE measurements, data was highly variable (see results for P demonstration paddocks in Figure 5). This is unsurprising given both the impact of seasonal conditions and grazing, but it was further complicated by gaps in the data caused by cloudy conditions that blocked collection of satellite imagery during some winter months.

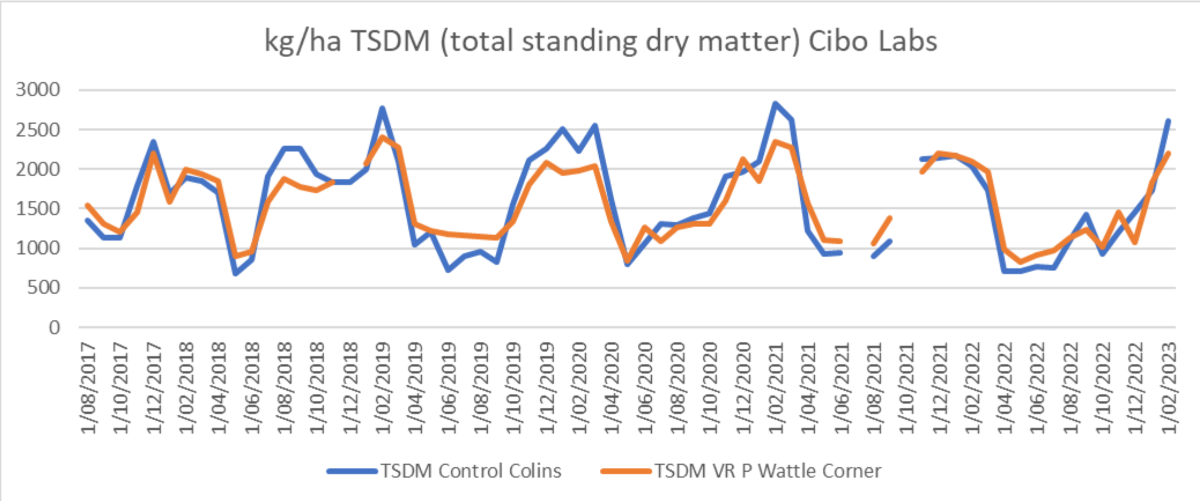

Figure 5 Monthly average Total Standing Dry Matter (TSDM) measurements from CiboLabs for the VR P paired paddocks. Spreading occurred in May 2021. There was no significant difference either before or after VR spreading occurred.

There was no obvious or statistically significant difference (based on a paired-samples t-Test) in average monthly TSDM between control and VR paddocks throughout the demonstration. There was also no significant difference between the paddocks when data was split into pre- and post- VR spreading datasets. The farmer did report visual improvements to pasture composition with an increase in clover across the areas of the VR paddock that had initially performed poorly.

4.1.3 Lime demonstration site #1 (Coola Station – Tom and Hilary Ellis)

4.1.3.1 Soil test results

Pair no.1 (Clarkes – Control, Giles - VR) were similar in December 2020 (Table 1). The control paddock had an average pH of 4.8, ranging from 4.2 – 5.4. The VR paddock had an average pH of 4.6, ranging from 4.3 – 5.3.

Although pair no. 2 (Duckhole – control, East Poonida – VR) shared a similar starting average pH, the VR paddock was twice as variable as the control paddock.

Return sampling detected some unusual changes at certain points in each paddock, (circled in Figure 6). A lime dump site location and adjacent gateway caused large jumps in pH at Giles point 1 and Clarkes point 11. In pair no. 2, Duckhole point 10 was affected by additional lime that was spread around a trough. East Poonida point 6 is the location of a limestone reef, and surface limestone appears to have biased on set of measurements more than the other.

Because these outliers were affected by measurement errors or conditions unrelated to the lime application, they have been removed from the analysis in Table 8 and below.

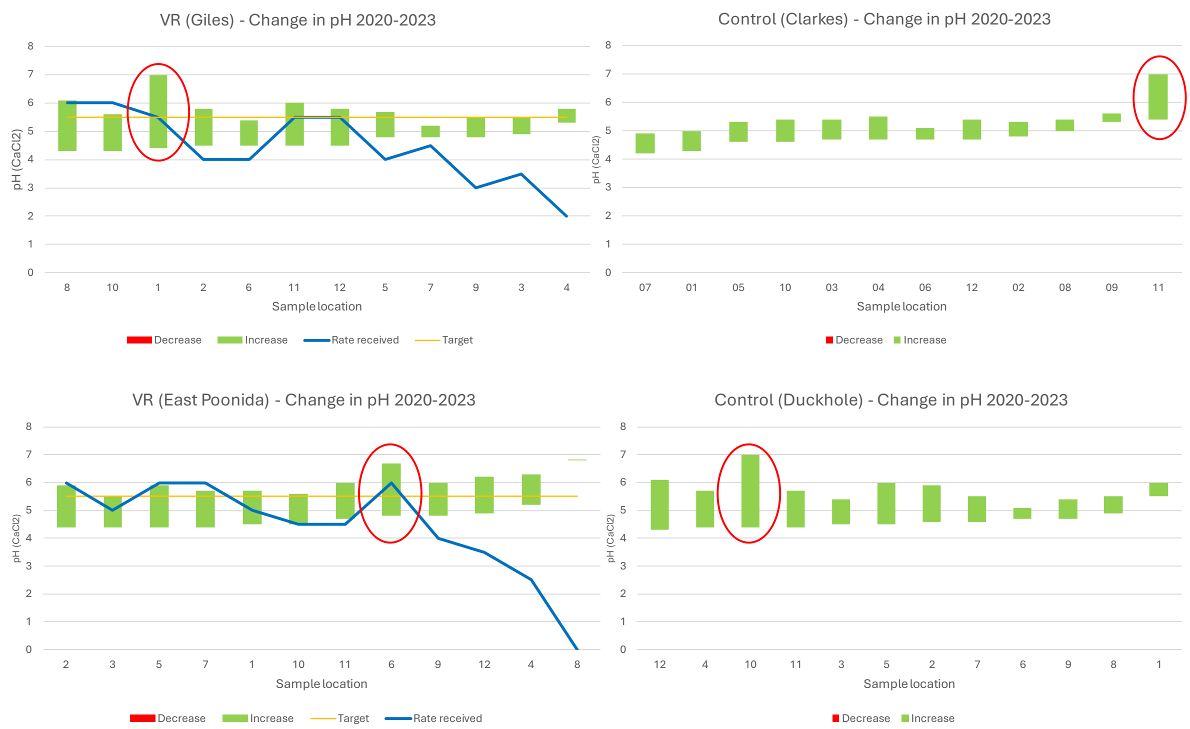

Figure 6: Change in pH soil test 0-10cm between December 2020 and December 2023 for the first (a) and second (b) pair of paddocks. VR paddocks received a VR application of lime targeting a final pH of 5.5, and control paddocks received 3t/ha lime. Sampling locations are sorted in order of lowest to highest initial soil test result (and consequently highest to lowest VR P applications). Green bars indicate an increase in pH between sampling dates at each point, with the bottom of the bar representing Dec 2020 and the top of the bar Dec 2023. Red bars indicate a decrease in pH, with the top of the bar representing Dec 2020 and the bottom of the bar Dec 2023. The VR paddock also displays the rate received at each point (blue line) and the target pH (yellow line). Outliers removed from analysis are circled in red.

By December 2023 conditions had improved on both pairs. Both VR paddocks increased to above the pH target of 5.5: Giles to 5.7, and East Poonida up to 6.0 on average. This is likely due to the on-farm lime being more effective than predicted. By contrast, the control paddocks remained below the target with an average pH of 5.3 on each. The variability in all paddocks also decreased, but the difference between VR and control paddocks was less consistent.

In pair no. 2, the VR paddock experienced a large reduction in variability from a range of 2.4 units (CV 14.7%) down to a range of 1.3 units (CV 6.2%). The control paddock saw a smaller reduction (and had less variability to begin with) from a range of 1.2 (CV 7.1%) down to 0.7 units (CV 5.3%).

In pair no. 1, however, variability reduced by slightly more on the control paddock (range 1.1 to 0.7, CV 6.4% to 4.0%) than the VR paddock (range 1.0 to 0.9, CV 6.4% to 4.7%). It may be that the VR application was not precise enough. This pair of paddocks were also the least variable paddocks in the demo: it could also simply be that greater initial variability is necessary for there to be a meaningful difference between treatments.

Table 8: Average pH, coefficient of variation CV%, and range in initial and return sampling for pair no. 1 (top) and pair no. 2 (bottom)

pH ex outliers Treatment		VR (Giles) Target 5.5	Control (Clarkes) 3t/ha
2020	Average	4.7	4.7
	CV%	6.4%	6.4%
	Range	1.00	1.10
2023	Average	5.7	5.3
	CV%	4.7%	4.0%
	Range	0.90	0.70
Change	Average	1.00	0.60
	CV%	-1.7%	-2.4%
	Range	-0.10	-0.40
	Average lime rate (treatment)	4.5 t/ha	3

pH ex outliers Treatment		VR (East Poonida) Target 5.5	Control (Duckhole) 3t/ha
2020	Average	4.8	4.6
	CV%	14.7%	7.1%
	Range	2.40	1.20
2023	Average	6.0	5.3
	CV%	6.2%	5.3%
	Range	1.30	0.70
Change	Average	1.20	0.70
	CV%	-8.5%	-1.8%
	Range	-1.10	-0.50
	Average lime rate (treatment)	4.4 t/ha	3

4.1.3.2 Pasture and livestock results

There was once again too much variability in the Cibo Labs TSDM data over time to draw meaningful conclusions about the effect that VR may have had on pasture growth.

AgriWebb records of DSE grazing days per paddock were also analysed, but gaps in the data record meant that there were nil grazing days for some paddocks over the duration of the PDS, although these paddocks were grazed during this period.

Consequently, the available data did not allow for an accurate comparison of pasture/livestock outcomes between treatments in this demonstration.

The farmer did not report any visual differences between the paddocks.

Table 9 Fertiliser and spreading-related costs for both pairs of paddocks at Coola Station.

Paddock	Area (ha)	Treatment	Average lime rate t/ha	Total sampling cost ($)	Total capital input and spreading cost ($)	Total treatment cost ($)	Total treatment cost ($/ha)	Note
Clarkes	26	Control	3	$137.00	$1,079.00	$1,216.00	$46.77	Pair 1
Giles	25	VR	4.5	$775.31	$1,450.58	$2,225.89	$89.00	Pair 1
Duckhole	28	Control	3	$137.00	$1,148.72	$1,285.72	$46.45	Pair 2
East Poonida	28	VR	4.4	$878.23	$1,611.98	$2,490.21	$87.90	Pair 2

4.1.4 Lime demonstration site #2 (Calcolat Creek – Hugh Altschwager)

4.1.4.1 Soil test results

Pair no. 1 (Woolshed - Control, Hookings - VR) started in a similar position in December 2020 (Table 10). The VR paddock had an average pH of 4.6 (with a range of 0.8 units), and the control average 4.7 (range 0.9 units).

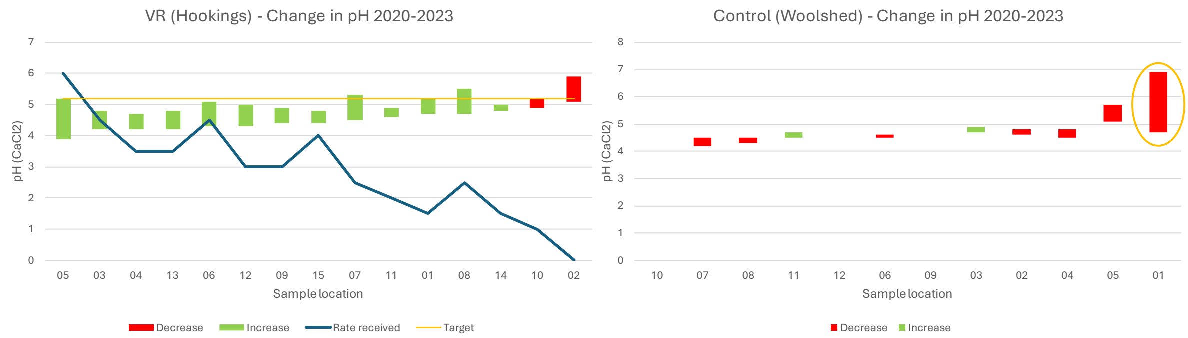

Figure 7: Change in pH soil test 0-10cm between December 2020 and December 2023 for the first pair of paddocks at Calcolat Creek.

The paddocks behaved largely as expected with the exception of Woolshed - Point 01. An unreasonably large decline in pH was measured at this location (circled in Figure 7). It is more likely that this is due to sampling results being affected by the variety of watercourses and gravel bands that run through this section of the paddock than being a true measure of change. Consequently, this point was removed from the following analysis.

By December 2023 the VR paddock had converged towards the target. This is reflected in an increased average pH (5.0) and reduced variability. This average is, however, still below the target of 5.2. This may be due to acidification rates being greater than expected or allowed for in initial calculations (due to seasonal conditions or grazing), insufficient time for lime to have full effect.

By contrast, the control paddock continued to acidify. The average pH fell slightly to 4.6, reflecting the ongoing natural process of acidification. The variability also decreased slightly (Table 1). Such a decrease in variability is often observed as a paddock reaches highly acidic pH.

Pair no. 2 (Home 3 – Control, Home 2 – VR) were also very similar in 2020 (Table 11). The VR paddock had an average pH of 5.3 (range 2.0 units), and the control an average of 5.4 (range 2.0 units). Around half of the VR paddock was already above the 5.2 target and hence received no lime.

Surprisingly, return soil test results from December 2023 indicated that many of the points that had received no lime had nevertheless increased in pH – on both the variable rate and control paddock (Figure 8). These increases were also associated with increases in calcium and certain other characteristics.

Table 10: Average pH, coefficient of variation CV%, and range in initial and return sampling for pair no. 1 at Calcolat Creek

pH ex outliers Treatment		VR (Hookings) Target 5.2	Control (Woolshed) Nil
2020	Average	4.6	4.7
	CV%	10.7%	7.7%
	Range	2.00	1.30
2023	Average	5.0	4.6
	CV%	4.4%	5.6%
	Range	0.80	0.90
Change	Average	0.5	-0.10
	CV%	-6.3%	-0.02
	Range	-1.20	-0.40
	Average lime rate (treatment)	2.8 t/ha	0

Table 11: Average pH, coefficient of variation CV%, and range in initial and return sampling for pair no. 2 at Calcolat Creek

pH Treatment		VR (Home 2) Target 5.2	Control (Home 3) Nil
2020	Average	5.3	5.4
	CV%	12.2%	10.5%
	Range	2.0	2.00
2023	Average	5.4	5.6
	CV%	10.8%	10.4%
	Range	1.7	1.60
Change	Average	0.1	0.3
	CV%	-1.4%	0.1%
	Range	-0.30	-0.40
	Average lime rate (treatment)	1.5 t/ha	0

Further investigation revealed that this is likely due to physical movement of unincorporated lime and topsoil in surface water flows. Due to a watercourse that runs through these paddocks, up to half of the area can be flooded up to a foot deep during a wet winter – which occurred during the project. The flow is, generally, from the variable rate paddock into the control paddock. Many of the points that experienced unusual increases are locations where water collects and remains for more extended periods of time. A further factor may be infiltration by alkaline groundwater during these flood events.

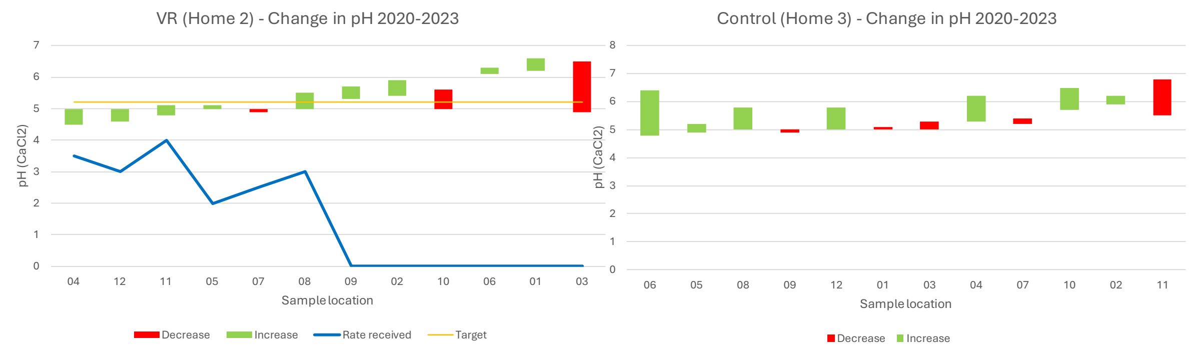

Figure 8: Change in pH soil test 0-10cm between December 2020 and December 2023 for the second pair of paddocks at Calcolat Creek.

4.1.4.2 Pasture and livestock results

As with the other demonstration paddocks there was too much variability in the TSDM data to draw meaningful conclusions about the effect that VR may have had on pasture growth. There was also no consistent difference detected in pasture utilisation (Table 12). However, Hugh did observe improvements in terms of pasture density, composition, residual dry feed, and lamb weights turned off Hookings (VR).

Table 12: pasture used per month in kg/ha calculated using CSIRO GrazFeed for the Calcolat Creek demonstration paddocks. Measurements were not precise enough to determine whether there were any meaningful differences between paddocks.

		kg/ha dm utilised				dse/ha			
		2021	2022	2023	average	2021	2022	2023	average
Hookings 1 (27 ha)	variable rate	8353	8770	8876	8666	20.9	21.9	22.2	22
Woolshed 1 north (28 ha	control	8717	9569	9745	9344	21.8	23.9	24.4	23
Home 2 (25 ha)	variable rate	6922	8364	5323	6869	17.3	20.9	13.3	17
Home 3 (23 ha)	control	7826	6395	6822	7014	19.6	16.0	17.1	18

4.1.5 Key performance metrics

The outcomes related to key performance metrics are outlined in Table 13

Table 13: Key performance metrics

	Performance metrics	Outcomes
Engagement	Pre and post knowledge, skills and confidence	Refer to 4.4
	Number producers directly and indirectly engaged (+demographics)	Refer to 4.3
	Practice change – intended and actual	Refer to 4.4

Productivity	Pasture productivity (kg DM / area unit) (based on Cibo Labs biomass estimates)	Refer to 4.1.2.2, 4.1.3.2, 4.1.4.2
	Stocking rate (DSE / ha or AE /area unit)	Refer to 4.1.2.2, 4.1.3.2, 4.1.4.2
Profitability	Cost of Production ($/kg red meat)	Refer to 4.2
	Gross Margin / Ha	
	Gross Margin / dse or AE	
Environmental	Soil fertility, change in fertiliser applications compared to baseline, fertiliser induced N2O emissions	Refer to 4.1 for changes to soil fertility. The average VR application rate was lower than the conventional uniform rate in 2 out of the 6 pairs of demonstration paddocks. Higher rates were required on the other 4 VR paddocks because of low starting nutrient/pH conditions relative to the desired target. These higher VR applications were generally more effective at reaching the desired target.

4.2 Economic analysis

The cost / benefit analysis intended to convert any measured differences in FOO or stocking rate into a dollar value that could be combined with records of costs involved in establishing each treatment to assess the relative economic performance of the variable rate strategies versus conventional practice.

However, as outlined in section 4.1, we were unable to draw any meaningful conclusions around pasture or livestock performance because of excessive variability in the Cibo Labs TSDM measurements and insufficient sensitivity of livestock measurements. The reasons and implications for this are outlined further in section 5.

Because there was no measurable difference in pasture production or carrying capacity, and since other useful measurements such as animal weight or pasture quality were unable to be taken, the cost – benefit comparison is reduced to a comparison of costs associated with the initial VR or conventional capital application.

Table 14 and Table 15 outlines fertiliser/ameliorant related costs for each demonstration paddock, including soil sampling (grid for the VR treatment and a conventional transect for the control), spreading and input costs. Because maintenance fertiliser applications and other management was held constant within pairs these are excluded.

VR treatments were consistently more expensive than control treatments, due to both the higher costs associated with grid sampling and higher prescribed fertiliser / ameliorant rates due to more accurate measurement of soil conditions. Compared to a hypothetical 2.5 t/ha blanket rate of lime, however, costs approach parity between Home 3 and Home 2 due to the large area of Home 2 that did not require lime under the VR application.

Table 14 Treatment costs for each paddock that received lime in the demonstration.

Property	Paddock	Area (ha)	Treatment	Average lime rate t/ha	Total sampling cost ($)	Total capital input and spreading cost ($)	Total treatment cost ($)	Total treatment cost ($/ha)
Coola Station	Clarkes	26	Control	3	$137.00	$1,079.00	$1,216.00	$46.77
Coola Station	Giles	25	VR	4.5	$775.31	$1,450.58	$2,225.89	$89.00
Coola Station	Duckhole	28	Control	3	$137.00	$1,148.72	$1,285.72	$46.45
Coola Station	East Poonida	28	VR	4.4	$878.23	$1,611.98	$2,490.21	$87.90
Calcolat Creek	Woolshed 1	28	Control	0	$137.00	$0.00	$137.00	$4.89
Calcolat Creek	Hookings 1	27	VR	2.8	$837.00	$2,435.40	$3,272.40	$121.20
Calcolat Creek	Home 3	23	Control	0	$137.00	$0.00	$137.00	$5.96
Calcolat Creek	Home 2	25	VR	1.5	$775.00	$1,312.50	$2,087.50	$83.50

Table 15 Treatment costs for each paddock that received Potassium or Phosphorus in the demonstration.

Property	Paddock	Area (ha)	Treatment	Nutrient applied	Total sampling cost ($)	Total capital input and spreading cost ($)	Total treatment cost ($)	Total treatment cost ($/ha)
West Cuyuac	Isabellas	24	Control	K	$137.00	$2,396.75	$2,533.75	$105.13
West Cuyuac	Dip	27	VR	K	$833.90	$3,219.66	$4,053.56	$150.69
West Cuyuac	Colins	22	Control	P	$137.00	$1,584.42	$1,721.42	$77.19
West Cuyuac	Wattle Corner	23	VR	P	$700.60	$2,200.56	$2,901.16	$128.37

4.3 Extension and communication

Extension and communication activities undertaken throughout the project, and their reach, are estimated in Table 16.

Table 16 PDS Extension and communication activities

Date	Activity	Audience	Attendees/reach
March 2021	Group meeting, Nelson	Core and observer producers	11

May 2021	Pasture assessment field day, Warrock	Core and observer producers	6
October 2021	Case Study: Beljon	Producers, consultants, researchers	30
February 2022	Group meeting, Nelson	Core and observer producers	6
June 2022	Steering committee / core producer meeting, Coola Station	Core producers	7
January 2023	Core producer meeting, Coola Station	Core producers	8
May 2023	P & K Demonstration Site Field Day, West Cuyuac	Producers, consultants, researchers	17
June 2023	Grassland Society of South Australia (GSSA) Newsletter Article	Producers, consultants, researchers	600
August 2023	West Cuyuac Demonstration Site technical report and case study (eDM/website)	Producers, consultants, researchers	1500
February 2024	Core producer meeting, Coola Station	Core producers	6
March 2024	Website article / eDM	Producers, consultants, researchers	1500
April 2024	Lime Demonstration Sites Field Day, Coola Station	Producers, consultants, researchers	12
May 2025	Coola Station Demonstration Site technical report and case study (eDM/website)	Producers, consultants, researchers	1500
May 2025	Calcolat Creek Demonstration Site technical report and case study (eDM/website)	Producers, consultants, researchers	1500

4.4 Monitoring and evaluation

This PDS was successful in providing insight into the level of variability in soils across the relevant area, and in measuring the change in soil conditions under VR and conventional practices within the lifespan of the project. Through extension and communication activities (detailed above) there has been significant engagement around the project outcomes and increase in the knowledge of core participants and others engaged through field days. Details of the Monitoring and Evaluation undertaken in the project is provided in the attached MER document.

For the three core participants the project achieved increased knowledge and ongoing adoption of precise soil and fertiliser management practices. The Core Producer Project Exit surveys show an increase in producer knowledge of and confidence in applying precision agriculture including VRA from an average entry score of 5.7/10 for core participants to a score of 7/10 for knowledge and 7.5/10 for confidence. Two of the three growers have undertaken additional grid soil sampling and highlighted plans to undertake EM38 mapping and zone based strategic sampling.
Soil Conductivity Mapping using an EM38 device is a reliable option for zoning paddocks according to soil type and related characteristics. It is a fast and cost-effective way of measuring variation in soil moisture content, salt levels, and soil texture; accurately identifying soil management zones. Combined with strategic soil-sampling, it can help diagnose the source of variability across a paddock and provide the basis for variable rate strategies, targeting soil profile management. Due

to the effects of management, productivity and stock movements these zones aren't the most accurate approach for managing surface soil properties.

Overall, the core participants felt that it was an interesting project despite not being able to draw strong conclusions. However, through the project variation and feedback forms, the onus on growers to collect the data was considerable and one of the main reasons for the core participants decreasing from 10 to 3. One of the final 3 core participants felt that the projects heavy reliance on data collection on farm meant that it would be more beneficial for this type of project to go to a research type farm in future.

Beyond the core participants of the project, field day feedback was one of the key metrics for demonstrating the efficacy of the project in increasing knowledge, attitudes and skill development. Through the 2023 (12 respondents) and 2024 (4 respondents) field day sheets we observed that:

- Participant knowledge/understanding about soil variability and Variable Rate Applications increased (score of 6.5-6.7 out of 10)
- A number of participants were motivated to improve their enterprise as a result of attending the field days (score 8.3/10 in 2023 and 6.5/10 in 2024)
- 83% in 2023 intended to seek additional information on soil variability and VRA,

Anecdotal evidence from Precision Agricultures Regional Managers has been that there has been a slow but steady increase in grid based sampling in pasture systems in the region.

5. Conclusion

This PDS was successful in providing insight into the level of variability in soils across the relevant area, and in measuring the change in soil conditions under VR and conventional practices within the lifespan of the project. VR paddocks were generally more effective at reaching pH, P and K targets, and were more effective at reducing variability when variability was higher to begin with, but the source of variability (animals, geography) need to be considered when deciding what the most effective tool will be to manage paddock variability.

The PDS failed to adequately measure any resulting benefits or costs beyond those related to initial soil sampling and fertiliser/ameliorant application. Factors which are likely to have contributed to this failure include:

- The limitations of using satellite data as a primary measurement. For example, there were gaps in the data from cloud cover, and changes to pasture quality were unable to be measured. Further, it proved impossible to separate the effect of grazing pressure from any changes to pasture variability using this dataset.
- The DSE rating system only provides an estimate of animal requirements, not actual livestock energy intake, which is dependent on pasture availability and pasture quality. Actual metabolizable energy (ME) intake can be different to ME requirements which might mask some differences in pasture growth and quality.
- Gaps in the grazing data collected for some sites.
- Supplement feeding and other activities might have meant that grazing pressure was not always consistent between paddocks, and the strong influence that decisions around grazing management have on the types of measurements that we were collecting.

- The targeted soil characteristics may not have been the most limiting factors, and hence there may have been no response because growth was still limited by other factors.

We recommend that the following additional activities would better enable valuation of any differences in pasture or livestock performance:

- Regular (maybe 4 x) monitoring of pasture composition through visual surveys/paddock walks with a focus on the percentages of total ground cover, percentage of desirable species vs undesirable, percentage of legumes vs grass during the growing season at each site.
- Recording weight of lambs at weaning, or even better, continuous monitoring of lamb weights on the paddock using an in paddock weighing system.

These recordings would have required substantial extra time and equipment and were therefore outside the scope of this PDS. Indeed, more intensive, farmer-collected measurements of this type were part of the initial project plan: due to the high time requirements of pasture composition and Feed on Offer measurements there was a lack of engagement by participants with these activities was the main reason that the project was forced to instead rely heavily on satellite measurements and grazing data that was already collected during normal farming activities. In fact on participant noted on their post project survey that the time required of participants was too high for more detailed measurements and a research farm might be a better option.

Increased project length with additional soil sampling would have also improved the accuracy by which changes to soil characteristics could be measured, since at least three and preferable five soil sampling points are required to establish a trend per MLA Five Easy Steps.

Regardless of these limitations, participants reported general satisfaction with project outcomes on their properties. Field-day attendees reported an average improvement in Skills and Knowledge related to soil variability and variable rate applications.

5.1 Key Findings

Soils in pasture-based grazing systems in the project area displayed substantial variability across all tested analytes, although the degree of variability itself varied substantially between paddocks. Variable rate applications were often more effective at reaching target soil critical values than and were often also more effective at managing or reducing variability compared to conventional uniform applications, but the approach had consistently higher up-front costs due to the expense of additional sampling and higher prescribed rates.

A more intensive experimental design is necessary to pick up any changes to pasture, livestock, and broader financial outcomes arising from different fertiliser and ameliorant strategies.

5.2 Benefits to industry

There is substantial soil variability that is currently under-managed in many pasture-based grazing systems. Variable rate applications can increase fertiliser efficiency and effectiveness, with the potential for pasture, livestock, and financial benefits, but these were unable to be measured using the low-intensity monitoring techniques applied in this demonstration. The potential value of VR justifies further work aimed at measuring these outcomes over the long term to provide a more complete base of knowledge to support effective adoption across the industry.

6. Appendix

3.1 Field Day Flyers:

Producer Demonstration Site

mla MEAT & LIVESTOCK AUSTRALIA

You're invited

Variable Rate (VR) fertiliser and pasture nutrition

Precision soil management for pasture productivity – Field day

WHAT	**Real world results from a local investigation of VR Fertiliser**
WHEN	**Tuesday 23 May 2023 | 8:30AM – 10:00AM**
WHERE	**West Cuyuac, 938 Woodacres Road, Nareen, Victoria**

MLA's PDS program supports producers to adapt, validate and demonstrate the business value of integrating new management practices/skills into their local farming systems.

Overview of the Producer Demonstration Site

VR fertiliser management is becoming widespread in cropping but is still finding its place in pasture systems. An ongoing project is investigating just how variable soil conditions are, how well VR stacks up in real-world conditions, and what this means for your bottom line.

Find out what we've learnt at a local Phosphorus (P) and Potassium (K) demonstration site, and hear from experts in soil nutrition, pastures and exciting new technologies that can support your decision making.

What's on the agenda?

- Variable Rate P&K Demonstration results: did VR improve soil nutrition, grow more grass, and make more money? – Tim Prance, T Prance Rural Consulting & Sebastian Ie, Precision Agriculture Pty Ltd.
- Managing Micronutrients and Copper – Elizabeth Kennedy, Vickery Bros
- Cibo Labs: Satellite Assisted Forage Budgeting – TBC
- On-site display of precision soil sampling equipment

RSVP and for more information

Sebastian Ie | sebastian@precisionagriculture.com.au| 0476 849 665

precision agriculture

This event is funded by Meat & Livestock Australia with the support of Precision Agriculture Pty Ltd.

Producer Demonstration Site

mla MEAT & LIVESTOCK AUSTRALIA

Variable Rate (VR) Lime in Pastures

Precision Soil Management for Pasture Productivity – Field Day

Thursday 11 April 2024 | 08.30am – 10.30am

Coola Station Woolshed, 455 Coola Road, German Creek, South Australia

MLA's PDS program supports producers to adapt, validate and demonstrate the business value of integrating new management practices/skills into their local farming systems.

Overview of the Producer Demonstration Site

Using VR lime to manage soil acidity has become widespread in cropping but is still finding its place in pasture systems. A farmer-driven project has investigated just how variable soil conditions are in the local area, how well VR stacks up in real-world conditions, and what this means for your bottom line.

Find out what we've learnt at two local lime/soil acidity demonstration sites, and hear from experts in soil nutrition, pastures, and exciting new technologies that can support your decision making.

What's on the agenda?

- Regional Insights: How variable are local soils? – David Oddie, Precision Agriculture Pty. Ltd.
- Variable Rate Lime Demonstration Results: did VR improve soil conditions, grow more grass, and make more money? – Tim Prance, T Prance Rural Consulting, and Sebastian Ie, Precision Agriculture Pty. Ltd.
- Demonstration paddock walk.

This event is funded by Meat & Livestock Australia with the support of:

precision agriculture

RSVP and for more information:

Kirsten Barlow/Precision Agriculture
0437 374 947
k.barlow@precisionagriculture.com.au

3.2 Project Articles:

April 2021: Click here to download the article

precision
agriculture

Two new Producer Demonstration Sites aim to inform about variable rate in pasture systems.

Precision Agriculture is pleased to announce our involvement in two Producer Demonstration Site projects, funded by Meat and Livestock Australia (MLA), that are investigating the economic benefits of variable rate applications (VRA) and soil mapping in pasture systems.

Both projects are producer-led and involve paddock demonstrations across multiple farmers properties in Victoria and South Australia.

"Precision Soil Mapping in Central Victorian Pastures" is a collaboration with the Smeaton and Pyrenees BestWool BestLamb groups and Agriculture Victoria, who are providing group facilitation and economic expertise to the project. This project is focused on smaller permanent pasture paddocks and is taking an intensive approach to monitoring across four demonstration sites.

"Precision Soil Management for Pasture Productivity" involves ten core growers from South Australia and Western Victoria, centred on Mount Gambier. As well as PA's involvement, growers are supported by Compass Agribusiness' expertise in financial analysis and agronomic guidance from Incitec Pivot. This project involves approximately 1000ha of paddocks across ten properties, trading less intensive monitoring for greater scale and replicability.

The demonstration projects involve a comparison of paddocks that receive variable rate fertiliser and ameliorants with similar paddocks that receive more conventional treatment. These treatments are based on a grid soil mapping approach that identifies the variability in soil conditions within each paddock.

"Variable Rate and grid sampling is well known and adopted in cropping systems but the economic benefits in pasture systems are less understood," says Sebastian le from Precision Agriculture.

"These projects are a great opportunity to answer producers' questions and provide some hard numbers around cost/benefit decision making," commented Mr. le.

Initial soil sampling was completed over summer and identified a range of potential targets for VRA in each paddock. Spreading is underway and producers will be undertaking a range of monitoring activities to measure the impact that it has on pasture growth and financial performance.

The first field days and other events have been held for the growers involved in each project, but future events will be open to the public to learn about project progress and develop related skills in soil test interpretation and pasture assessment.

For more information please contact:
Sebastian le
0476 849 665

Producer Demonstration Site

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Precision Agriculture Field day Casterton Tuesday, May 23 2023 Wrap-up Article

Tim Prance T Prance Rural Consulting

17 farmers and advisers attended a precision soil management for improved pasture productivity field day hosted by Richard Edgar at "West Cuyuac", Nareen in western Victoria.

Precision Agriculture at Ballarat have established three Producer Demonstration Sites with funding from Meat and Livestock Australia (MLA) with the aim of investigating the economic benefits of variable rate fertiliser applications in high rainfall intensively grazed pasture systems. There are three sites, one at Nareen (north of Casterton) and two in the lower south east of SA.

There are 12 paddocks of about 25 ha each across the three sites (three different properties) in 6 pairs. Each paddock has been sampled in a 2-ha grid to a depth of 10cm to assess variability in pH, P, S and K along with exchangeable cations and trace-elements copper and zinc.

One paddock in each pair has then received a variable rate application of one nutrient (chosen by the farmer + advisor based on soil test results), whilst the other paddock has received a conventional blanket application (control). Management within the pair has been kept as identical as possible.

Animal movements in each paddock has been recorded using AgriWebb and pasture availability measured every 15 days using Cibo Labs Pasture Key service (10m10m pixels).

The Nareen site was zone soil sampled in December 2020 and again in December 2022 and as result was the site for the first field day. The other two sites in south east SA have only been zone soil sampled once, so field days will take place after the next zone soil sampling in December 2023.

What has been learnt so far?

Results from the Nareen site builds on information learnt from an earlier zone soil sampling study undertaken by the Grassland Society in south east SA in January 2018 *"Nutrient mapping on broadacre grazing properties in south east SA, Tim Prance, T Prance Rural Consulting, January 2019"* An abstract is in the 60th annual conference proceedings July 2019 Creswick, Victoria p.92

Zone soil sampling has confirmed there are large variations in all soil nutrients, plus pH, across paddocks grazed by livestock even if the soil is apparently even and paddocks relatively flat. For example, at "West Cuyuac" Olsen soil P in one paddock varied from 8 to 30 mg/kg P, available S varied from 3 to 8 mg/kg, available K between 62 and 129 kg/kg and pH $_{(CaCl2)}$ between 4.7 and 5.6.

Importantly transect sampling didn't always pick up these differences. For example, in one paddock if available K had been determined using a east west transect, it would have been 137 mg/kg but only 102 mg/kg using a north south transect.

In this demonstration, the application of either variable rate P fertiliser in one paired paddock, or variable rate K fertiliser in another paired paddock, resulted in less variability in soil P or soil K levels compared to the blanket rate over the whole paddock (control) after zone soil sample results were compared between 2020 and 2022. However, there were no $ fertiliser savings resulting from a variable rate application compared to a blanket rate, although in other parts of south eastern Australia, farmers have paid for the cost of zone sampling in one year by reducing fertilizer application rates in zones where less is required.

At the time of the field day where were no differences in either dse grazing days/ha or kg/ha monthly pasture availability between either of the variable rate and the control paddocks. It is possible differences may still show up in the future.

This demonstration site has shown that a one-off zone soil sampling could be economically beneficial if it is used to determine transect sampling paths for future soil fertility monitoring. More learnings are expected as the other two demonstration sites reach completion next year.

Richard thought the recent CiboLabs Pasture Key satellite imagery for May provided a reasonable estimate of current pasture availability at "West Cuyuac".

March 2024: Click here to download article

Implementing Variable Rate Technology in Pasture Systems

Final results from a three-year MLA-funded Producer Demonstration Site project implementing variable rate spreading in livestock systems will be presented at a field day at Coola Station in German Creek on the 11^{th} of April.

Particular focus will be on the variable rate lime paddocks and how effective this has been at ameliorating soil acidity, growing pasture and making money than conventional lime applications.

"Variable rate applications, or VR, aims to put the right amount of fertiliser or other product in the right place, which can differ substantially across a single paddock," reveals Precision Agriculture's Sebastian Ie. "It's widespread in cropping but has seen less adoption in livestock systems."

This is partly due to a lack of real-world, practical examples of how it can be implemented and the kinds of results it can deliver.

The Producer Demonstration Site at Coola Station and nearby properties aimed to fill this gap by using paired paddocks to compare the results of VR applications to more conventional blanket-rate approaches.

A variety of readily available technologies were used to implement and monitor the results, including grid-based soil sampling to map the variability in soils within each paddock and Cibo Labs Pasture Key satellite-assisted forage budgeting to determine impact on pasture growth.

The results of this analysis will be delivered by specialists from Precision Agriculture Pty Ltd and experienced livestock consultant Tim Prance from 8:30AM on Thursday the 11^{th} of April at the Coola Station Woolshed, 455 Coola Rd, German Creek SA.

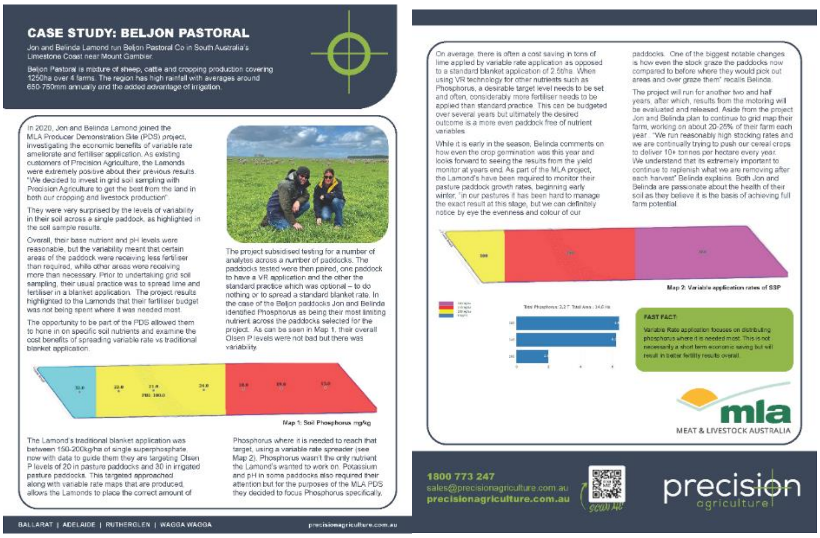
For queries or to register your attendance at the event, please contact Kirsten Barlow on 0437 374 947 / k.barlow@precisionagriculture.com.au.

Producer Demonstration Site

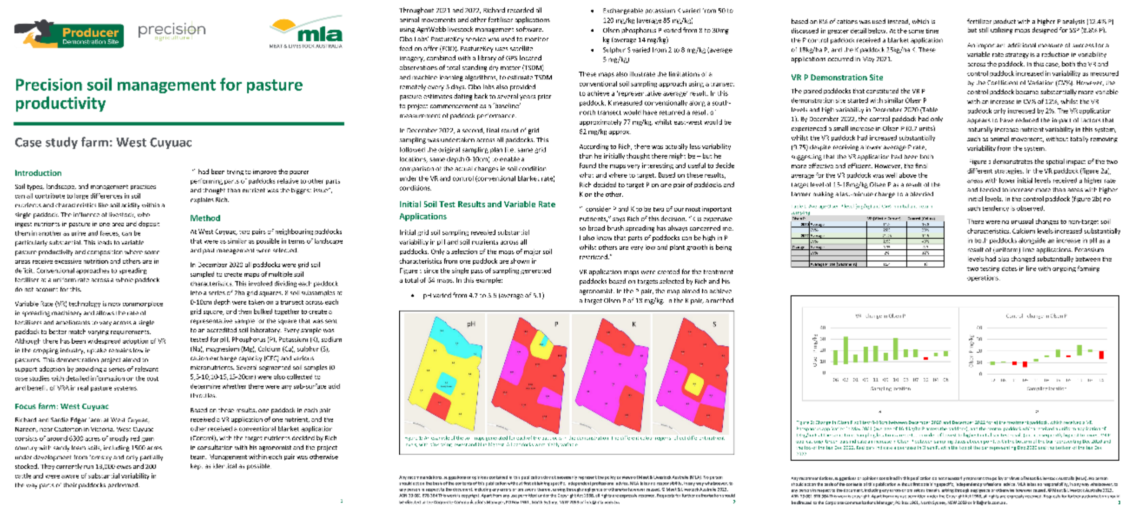
MEAT & LIVESTOCK AUSTRALIA

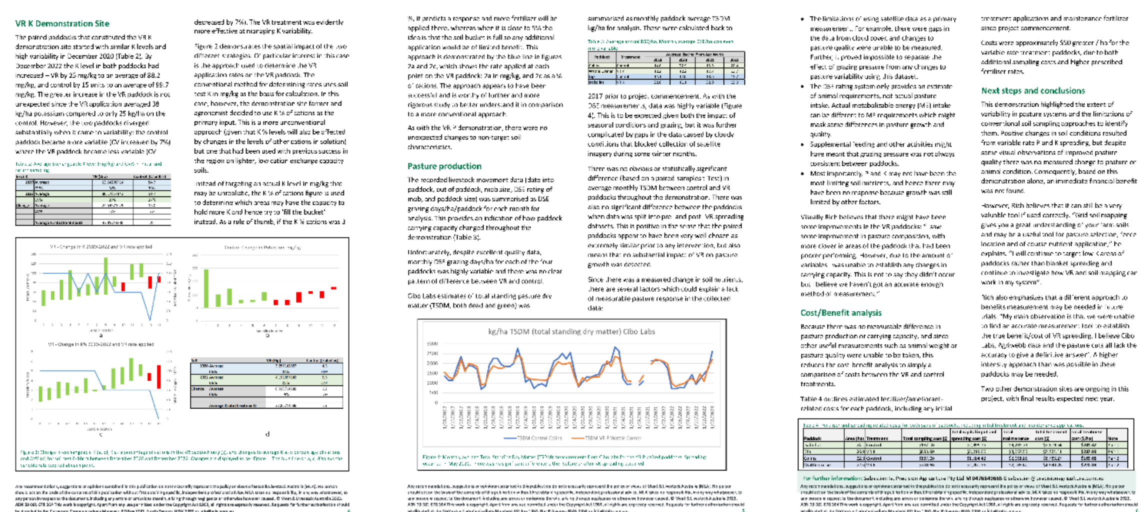
3.3 Project Case Studies:

Beljon Pastoral: Click here to download the case study

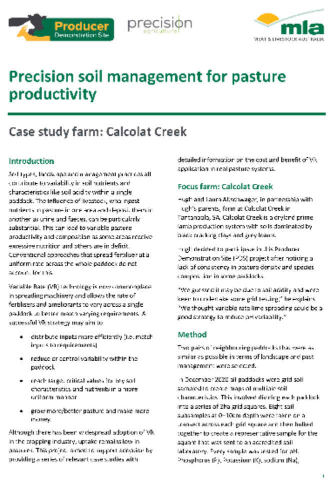


West Cuyac: [Click here to download the case study.]





Calcolat Creek: [Click here to download the case study]

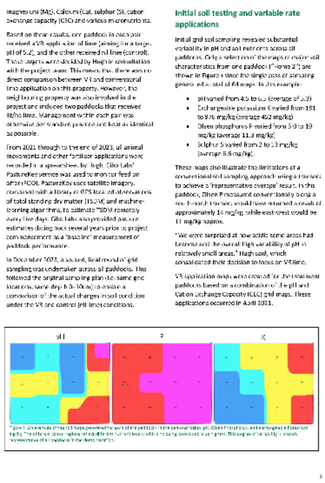

Precision soil management for pasture productivity

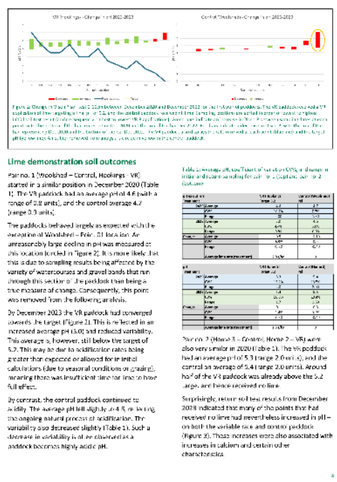
Case study farm: Calcolat Creek

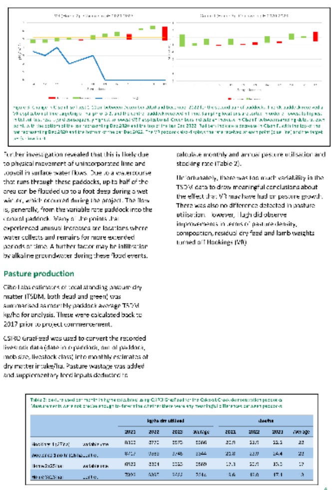
Introduction

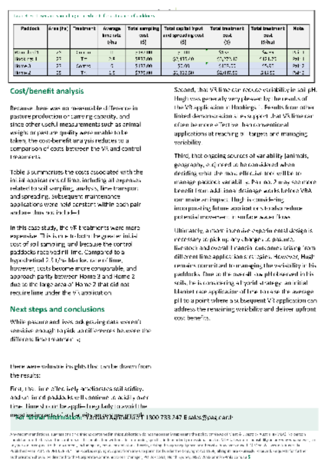
Focus farm: Calcolat Creek

Method


Initial soil testing and variable rate applications


Lime demonstration soil outcomes


Pasture production


Cost/benefit analysis

Next steps and conclusions

Coola Station: [Click here to download the case study]