Annual Results Report Template

2024

Annual Results Report

Best practice liming demonstration to address sub-soil acidity in North Eastern Victoria

Project code:	RPI2104-001SAX
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REPORT SENSITIVITY

Does the report have any of the following sensitivities?

Intended for journal publication	YES/NO	
Results are incomplete	YES/NO	
Commercial/IP concerns	YES/NO	
Embargo date	YES/NO	If Yes, Date: DD/MM/YYYY

KEY MESSAGES

- A replicated liming rate and incorporation trial at Lilliput clearly demonstrated how applying lime, followed by incorporation, increased subsurface pH values and reduced aluminium availability in the soil.
- There was no difference in yields due to liming rate or incorporation method in the replicated plot trial during 2024 or 2023, likely due to good seasonal and growing conditions.
- A demonstration trial looking at fine verses coarse lime quality highlighted how the rate of lime applied (3 t/ha) was more influential than the type of lime for increasing pH in this soil.
- Incremented soil testing helps identify the severity of acidification and allow the right amount of lime to be calculated for your soil type. It will also help identify any other subsoil constraints that could affect the incorporation method.
- While deep incorporation of lime has shown positive results in this trial, it's important to only incorporate lime to the depth that is suitable for that soil, considering the presence of other soil constraints (eg sodicity, slaking)
- Tools for economic analysis of liming and incorporation exist and are useful for scenario modelling, however they do not reflect the complexity of the issue.

SUMMARY

Season 2024 in North East Victoria was a lot drier during the growing season than the previous two seasons of the project. The annual rainfall from 1st January to 31st December was 700mm, however growing season rainfall was 269mm. Soil samples taken in January 2025 were tested for pH, CEC and Aluminium in the same location as that of January 2022, 2023 and 2024. Results showing the treatment with lime applied and incorporation resulted in the greatest change of pH down the profile. The lack of early season rain meant emergence was concerning, however after some rain at the end of May, there was fairly even emergence. The yields across the plots showed no statistical difference however there was a trend of lime application and incorporation giving greater grain protein, which suggests that nitrogen uptake may have been more efficient upon removal of the acidic throttle which was constraining root growth.

BACKGROUND

Acidity levels in topsoil and sub-surface layers are increasing across the Southern region of Australia and rapidly becoming a key constraint to productivity. Increasing soil acidity and the associated declining production is a gradual process and lime application to address increasing acidity is often the first input to be dropped when cash flow is limiting due to its high cost. Additionally, the development of acidity can be masked where an “acid throttle” exists (a layer of low pH soil that restricts movement of nutrients and roots past it) in a stratified layer, often not picked up in lab analysis of 0-10cm soil samples due to mixing of the layers when sampling. Often growers are not recognising the gradual increase in acidity and do not apply lime until there is an already established problem.

With the low solubility and relative immobility of lime, top-dressed lime can take ten or more years to significantly increase subsoil pH below 10 cm, subject to adequate lime being applied to do so. Soils that have not been adequately maintained with lime applications to counter the increasing rate of acidification, need a management solution to increase the subsoil pH, as well as having a faster return on investment and increase in crop productivity.

The placement of the lime in the soil plays a significant role in the lime’s ability to neutralise acidity when it exists at depth due to the need to establish contact for the acid base reaction to occur. The quality of the lime is another factor contributing to its effectiveness in neutralising soil acidity, specifically its neutralising value. The Neutralising Value or NV describes the chemical purity of the lime based on its Calcium Carbonate Equivalence (CCE) to neutralise acid and can vary greatly between lime sources. In addition, the lime’s fineness also has a significant impact on its ability to neutralise acid where finer products have higher surface area and therefore greater contact with soil particles to improve its efficacy, which is reported as the Effective Neutralising Value, or ENV. A higher Effective Neutralising Value (ENV) lime is generally more expensive, so ensuring maximum value from higher ENV lime through effective placement in the soils is of great significance to farmers.

OBJECTIVES

The objective of this project was to establish one replicated field trial to demonstrate best practice liming strategies and a field demonstration of the impacts of lime quality per annum, over three years. It demonstrated different incorporation methods, evaluated the impact of different lime types/ sources, as well as extending findings including comparisons of the economic and agronomic returns using the Acid Soils SA calculator tools (https://acidsoilssa.com.au/index.php/home/resources/).

Extension efforts were focussed on raising grower awareness on the speed of acidification and stratification of soils in this region. This is while providing resources and tools available to assist management decisions such as the aforementioned calculators.

Soil analysis over time was used to illustrate the impact of lime incorporation methods, the impact of lime source and quality on efficacy of addressing stratified subsoil acidity. This is in addition to assessing the economic benefits of each treatment as well as potential loss of production and decline in pH through a control. An acidifying treatment was considered, however it was not utilised as consequences of not liming are already highly evident due to the existing low subsoil pH values.

Growers will be able to evaluate the most practical and economical methods to manage soil pH and paddock variability by learning from these results. It is hoped that the ‘nil’ treatment will assist farmers in seeing the impact of any complacency growers might have toward addressing pH in the short and long term.

A range of communication and extension activities have been undertaken to leverage the trial site and increase confidence and adoption of best practice liming strategies. These have included field walk activities, visits to grower properties where incorporation practices are being undertaken, as well as other approaches farmers might have taken to reduce sub-soil acidity. Through paddock walks and field days in 2024/25, Riverine Plains directly exposed 75 people to the site. Monitoring and evaluation of this experiment was also be undertaken to benchmark current liming practices and track changes in adoption as a result of this investment.

By June 2025, growers and advisers in North East Victoria will have improved understanding of the state of topsoil and subsoil acidity, the limitations to crop profitability its causes, and finally, an improved knowledge of the agronomic and economic benefits of different lime sources, lime quality and incorporation methods.

METHOD

To establish a trial site, six paddocks across North East Victoria, where there was suspected sub surface acidity issues were soil tested in September 2021. These tests identified many paddocks with low pH, however the trial site was selected as it had low pH and other variables were constant.

Treatments for the project were developed in consultation with a steering committee made up of growers and researchers, as shown in Table 1.

The treatments were applied to a trial site established at Lilliput, in the Rutherglen district of Victoria, and monitored for three years from 2022–2024.

TABLE 1. BEST PRACTICE LIMING TRIAL TREATMENTS

Treatment #	Details
1	Control – nil applied lime with nil incorporation
2	Nil lime, with incorporation by shallow discs
3	Lime to target pH 5.2, incorporated by sowing
4	High rate of lime (targeting pH 5.8 in 0-10cm value), incorporated by sowing
5	High rate of lime (targeting pH 5.8 in 0-10cm value), incorporated by shallow discs
6	High rate of lime (targeting pH 5.8 in 0-10cm value), deep incorporation to 10-15cm, follow up with speed-tiller
7	High rate of lime (targeting pH 5.8 in layers to depth), deep incorporation to 10-15cm, follow up with speed-tiller (rate calculated for pH 5.8 at depth)—Deluxe option

An intense soil sampling regime was completed in February 2022 in each plot to characterise the whole site and understand the original pH levels and the presence of any other soil constraints such as sodic layers or toxicities, to inform appropriate incorporation methods.

In each plot, 20 shallow cores were collected from across the length of the plot using a standard sampling approach, incremented to 0-5, 5-10, 10-15, 15-20cm depth (collected with an hand push probe or dig stick depending on soil conditions), with four deep cores collected using a trailer mounted hydraulic corer within each plot to capture the 20-30, 30-40, 40-50cm depths. The deep cores were GPS-located with the same sites sampled each year to enable accurate year-on-year comparisons.

Rates of liming were calculated for each treatment target rate as follows:

- Lime required to achieve a target pH of 5.2 = 1.2 t/ha
- Lime required to achieve a target pH of 5.8 (high rate) = 5.0 t/ha
- Lime required to achieve a target pH of 5.8 to depth (high rate to depth, deluxe option) = 8.5 t/ha

The application of lime was done using a range of surface and incorporation techniques, including a shallow incorporation by sowing, incorporation by discs to a depth of 15 cm and a deeper incorporation by a Horsch Tiger to a depth of 20 cm. A nil control—where no lime is applied—was used to highlight the cost of complacency when addressing pH issues in both the short and long term.

The field site was established and managed by AgriSci Pty Ltd. Table 2 shows the layout of the field-scale replicated trial.

At one end of the replicated trial, demonstration trials were established to assess the impacts of two types of lime quality, granular (Mt Gambier lime) and fine (Galong lime), applied at 3 t/ha and incorporated with sowing. The lime from Galong was very fine, with bulk density of 1.4, while the Mt Gambier lime was much coarser, with a bulk density of 1.1.

Demonstration 1: Mount Gambier lime 3 t/ha, incorporate by sowing		
Demonstration 2: Nil lime, incorporate by sowing		
Demonstration 3: Galong lime 3 t/ha, incorporate by sowing		
1) 5 t/ha applied lime with deep incorporation	BUFFER	28) 5 t/ha applied lime with incorporation by sowing
2) 5 t/ha applied lime with incorporation by shallow discs		27) Nil applied lime with shallow disc incorporation
3) Control, nil applied lime with nil incorporation		26) 1.2 t/ha applied lime with incorporation by sowing
4) 1.2 t/ha applied lime with incorporation by sowing		25) 5 t/ha applied lime with incorporation by shallow discs
5) Nil applied lime with shallow disc incorporation		24) 8.5 t/ha applied lime with deep incorporation
6) 8.5 t/ha applied lime with deep incorporation		23) 5 t/ha applied lime with deep incorporation
7) 5 t/ha applied lime with incorporation by sowing		22) Control, nil applied lime with nil incorporation
8) Control, nil applied lime with nil incorporation		21) 8.5 t/ha applied lime with deep incorporation
9) 5 t/ha applied lime with incorporation by sowing		20) 5 t/ha applied lime with incorporation by shallow discs
10) 5 t/ha applied lime with incorporation by shallow discs		19) 5 t/ha applied lime with incorporation by sowing
11) Nil applied lime with shallow disc incorporation		18) 1.2 t/ha applied lime with incorporation by sowing
12) 5 t/ha applied lime with deep incorporation		17) Nil applied lime with shallow disc incorporation
13) 8.5 t/ha applied lime with deep incorporation		16) Control, nil applied lime with nil incorporation
14) 1.2 t/ha applied lime with incorporation by sowing		15) 5 t/ha applied lime with deep incorporation

Figure 1: Trial design for the liming demonstration

Lime was applied on 16 February 2022, with incorporation completed the next day. A Horsch Tiger (tynes 125–150 mm, discs 100 mm), was used for the deep incorporation, with calibration to ensure that the depth of the lime was kept above 20 cm, as the site has a sodic layer below this depth. A speed tiller was run over both incorporated treatments to a depth of 5–7.5 cm, to ensure a smooth surface for ease of sowing. Once the treatments were completed, the host sowed and managed the trial site in line with the management practices used for the remainder of the paddock.

Soil sampling was conducted in January 2022, before the treatments were established, and resampled in January 2023, 2024 and 2025 to enable a direct comparison of liming treatments and their effect on soil properties over time. Soil samples were collected in increments of 0-5, 5-10, 10-15, 15-20 cm using a hand corer, while the 20-30, 30-40, 40-50cm depth increments were collected using a hydraulic trailer-mounted corer.

The site was sown to canola in 2022, however the trial was abandoned due to waterlogging and slug damage prior to harvest, meaning that no yield results were collected. During May 2023, the site was sown to Scepter wheat, with results published in Research for the Riverine Plains 2024. On 11 April, 2024 the site was sown to Scepter wheat, for the second year in a row, along with 80 kg MAP/ha. In-crop urea was applied at 250 kg/ha during the season.

Green seeker measurements of Normalised Difference Vegetation Index (NDVI) were taken on 19 August, 4 September and 19 September to try to assess a difference in growth of the plots (data not presented). Photos were also taken during the season as a record of plot growth.

Harvest was carried out for both the replicated and demonstration trials by Kalyx, using a plot header on 20 December 2024. The host farmer harvested the crop remaining on the site with the remainder of the paddock.

LOCATION

	Latitude (decimal degrees)	Longitude (decimal degrees)
Trial Site #1	-36.140289	146.401335
Nearest Town	Rutherglen, Victoria	

If the research results are applicable to a specific GRDC region/s (e.g. North/South/West) or GRDC Agro-Ecological Zone/s please indicate which in the table below:

Research	Benefiting GRDC Region (can select up to three regions)	Benefiting GRDC Agro-Ecological Zone (see link: http://www.grdc.com.au/About-Us/GRDC-Agroecological-Zones) for guidance about AE-Zone locations

Best practice liming demonstration	Northern Region Southern Region Choose an item.	☐ Qld Central ☐ NSW NE/Qld SE ☒ NSW Vic Slopes ☐ Tas Grain ☐ SA Midnorth-Lower Yorke Eyre ☐ WA Northern ☐ WA Eastern ☐ WA Mallee	☒ NSW Central ☐ NSW NW/Qld SW ☒ Vic High Rainfall ☐ SA Vic Mallee ☐ SA Vic Bordertown-Wimmera ☐ WA Central ☐ WA Sandplain

RESULTS, OBSERVATIONS AND DISCUSSION

Rainfall

While total 2024 calendar year rainfall at the site was 700 mm, only 269 mm fell during the growing season (April to October), with the site receiving very poor early spring rainfall, which meant that crops needed to rely on stored moisture for grain fill, impacting yields. The area also received 209 mm over nine days during November, which skewed the yearly total.

During 2024, the site received similar rainfall to the 2023 season, although the timing was different, however this was much less rainfall than received in 2022 season (1159 mm) (Figure 2).

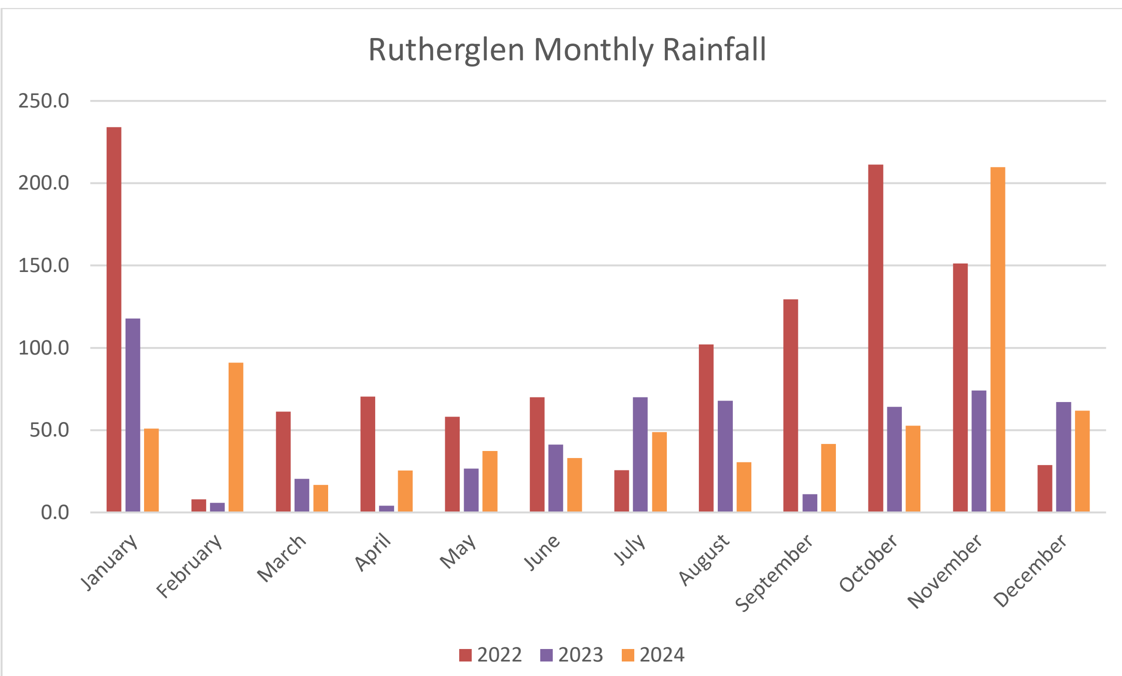


Figure 2 Monthly Rainfall taken at the Riverine Plains on farm Rutherglen weather station across the years of the trial, 2022, 2023 and 2024.

Emergence or Crop Issues

Dry sowing meant establishment was slow. The emergence was fairly even albeit slow. As the season progressed it was noted that a large strip on the southern plots was starting to be visible. Upon examination, there was limited crop damage. The conclusion from speaking with the farmer was that there was a prior stream located through the trial that was only visible once the profile had started to dry out.

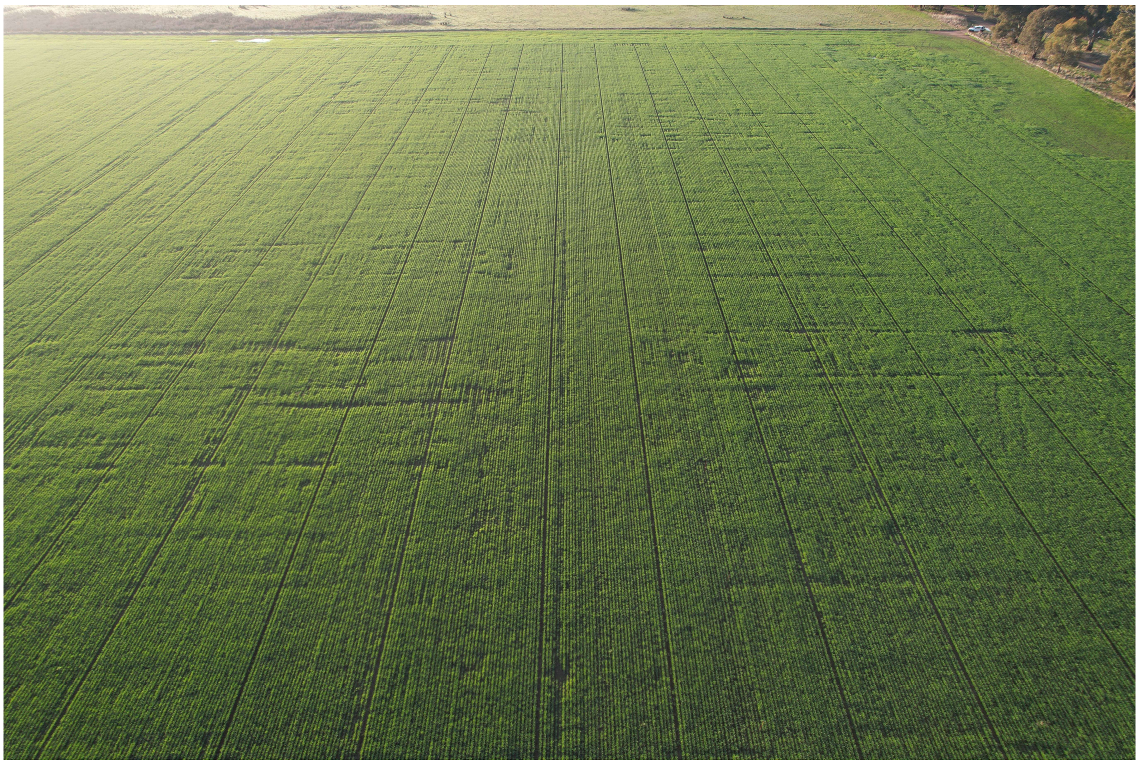


Figure 3: Drone image taken 23/07/2024. crop establishment was good, with site buffer mown in September. Site managed by AgriSci Pty ltd on behalf of Riverine plains.

Figure 4: Drone image taken 05/12/2024, after 250mm of rainfall, possible prior stream visible. Site managed by AgriSci Pty ltd on behalf of Riverine plains.

Soil Analysis

Soil sampling was conducted pre-treatment in January 2022, and resampled in January 2023, 2024 and 2025 to enable direct comparison of liming treatment effects on soil properties over time. Depths were sampled in increments of 0-5, 5-10, 10-15, 15-20cm with a hand corer or dig stick, and the 20-30, 30-40, 40-50cm depths sampled with a hydraulic trailer mounted corer. While a comprehensive site analysis was completed in the January 2022 soil sampling, follow-up soil sampling focussed on measurement of pH and CEC, with aluminium and sodium percentages being calculated from the CEC values.

Note, while standard errors of the mean (SE) have been calculated for the following results, analysis of variance has not yet been completed due to delays in accessing statistical support. This means that any reference to treatment effects is estimated based on the SE values, not p-values.

Treatment effect on Soil pH and Aluminium %

The following graphs show soil pH and aluminium percentage in depth increments of 0–5, 5–10, 10–15, 15–20, 20–30, 30–40 and 40–50cm along the y-axis, with the measured characteristic along the x-axis. The bars are standard error of the mean and each graph shows annual results from 2022 (prior to treatments being applied), 2023, 2024 and 2025 (after the trial was completed), sampled at the same time each year.

Treatment 1: Control – No applied lime with no incorporation

This treatment was the control, with no lime applied in 2022 and sown as per the surrounding paddock.

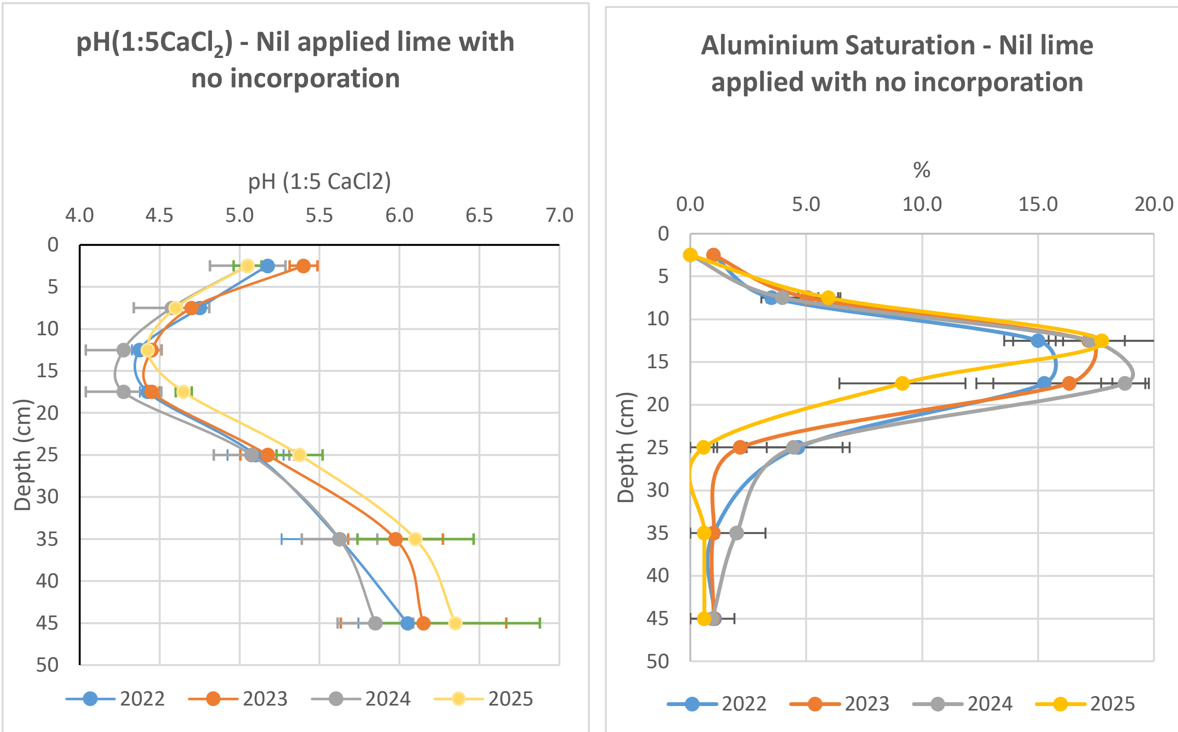


Figure 5a and b: Soil pH and aluminium saturation (% of the CEC) in the nil lime applied with no incorporation treatment at Lilliput, 2022-2025. Bars are measures of standard error (SE)

This treatment aimed to show the result of a "do nothing" approach to soil pH, however the results show some year-on-year variance in the results which is expected in large scale plot experiments (these would all be within error, noting that the bars as measures of SE only).

From Figure 4a, pH gradually decreases in this soil as we move from the surface (0–5cm) to the subsoil, with pH then increasing down the profile, indicating the presence of an acid throttle. Mirroring the pH results, aluminium saturation is highest (>15–20 percent) at the 10–20cm depths, which is likely causing some toxicity to plants. Aluminium above 5% may effect root growth.

Treatment 2: No applied lime with shallow disc incorporation

No lime was applied to these plots, however when incorporation of other treatments was done this plot had a set of shallow discs run through it prior to sowing. The discs went into the soil between 5-10cm.

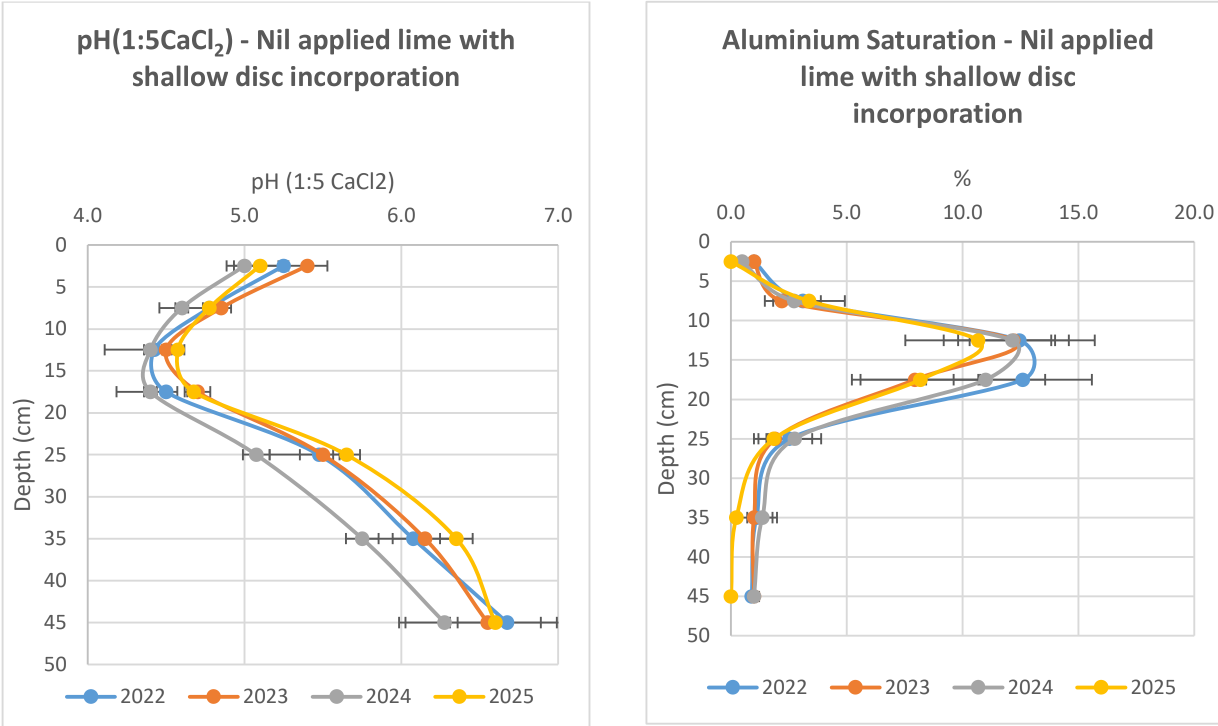


Figure 6 a and b Soil pH and aluminium saturation (% of the CEC) in the nil lime applied with shallow disc incorporation treatment at Lilliput, 2022-2025. Bars are measures of standard error (SE)Similar to the control treatment, there is no change in the pH or aluminium saturation across the years (Figure 6a, b).

Treatment 3: Lime applied to target pH 5.2 and incorporated by sowing.

Traditionally, farmers in the Riverine Plains have targeted a pH of 5.2 for grain production, which generally allows a range of crops, including legumes, to be grown without the risk of yield loss. To achieve a target pH of 5.2 across the 0–10cm depth, 1.2t/ha of lime was applied and then incorporated by sowing.

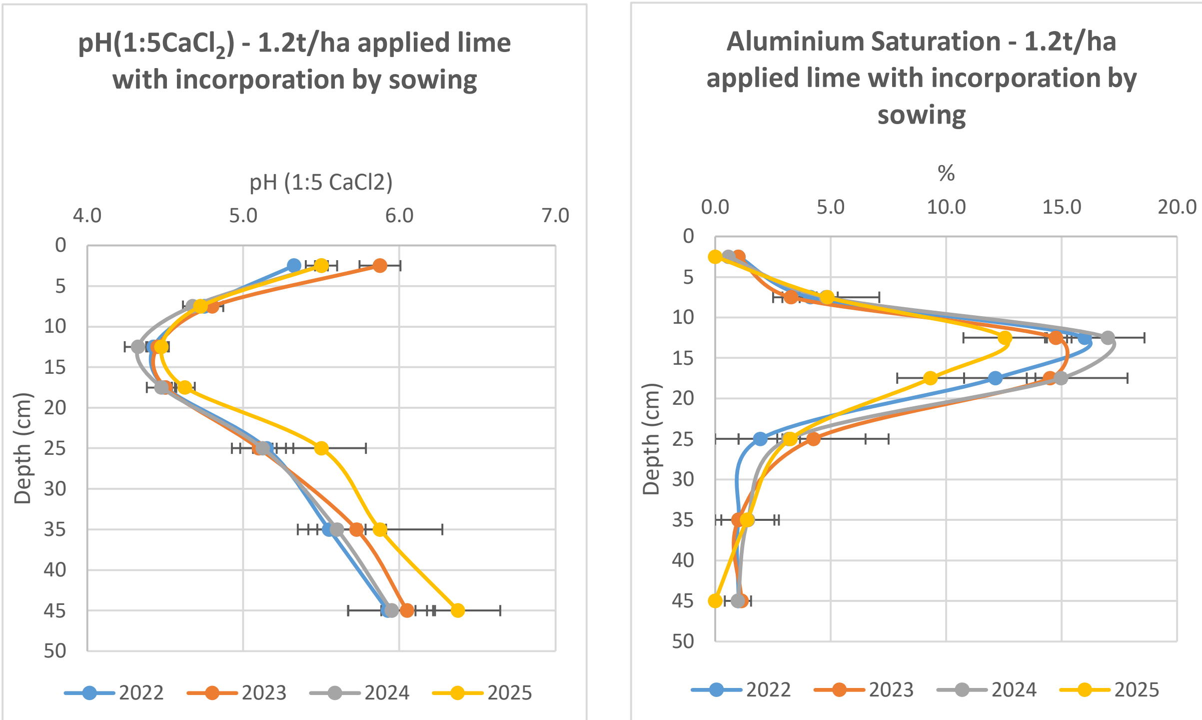


Figure 7a and b Soil pH and aluminium saturation(% of the CEC) in the 1.2 t/ha lime applied with incorporation by sowing treatment at Lilliput, 2022-2025.Bars are measures of standard error (SE)

The addition of lime in 2022 caused a transient pH increase at the 0-5cm depth in the 2023 sampling, which may be statistically significant (pending analysis of results). However, only a small shift in pH was evident at the time of the 2025 sampling time (Figure 7a, b).

Treatment 4: Lime applied to target pH 5.8 (at 0-10cm depth), incorporated by sowing

It is now recommended that farmers target a pH of 5.8 to optimise growth across all crop varieties and provide sufficient alkali to move down into the subsurface. Initial soil testing in 2022 at this site indicated the application of 5 t/ha of lime was likely achieve this target

The results indicate that the surface application of lime in this treatment has not yet impacted the high aluminium levels at depth in this soil, with saturation levels still at 15 percent (Figure 8a, b). The high surface pH values indicate that there is excess alkali in the surface which may be available to move down over time, however the relative impact and time requirement of this is unknown.

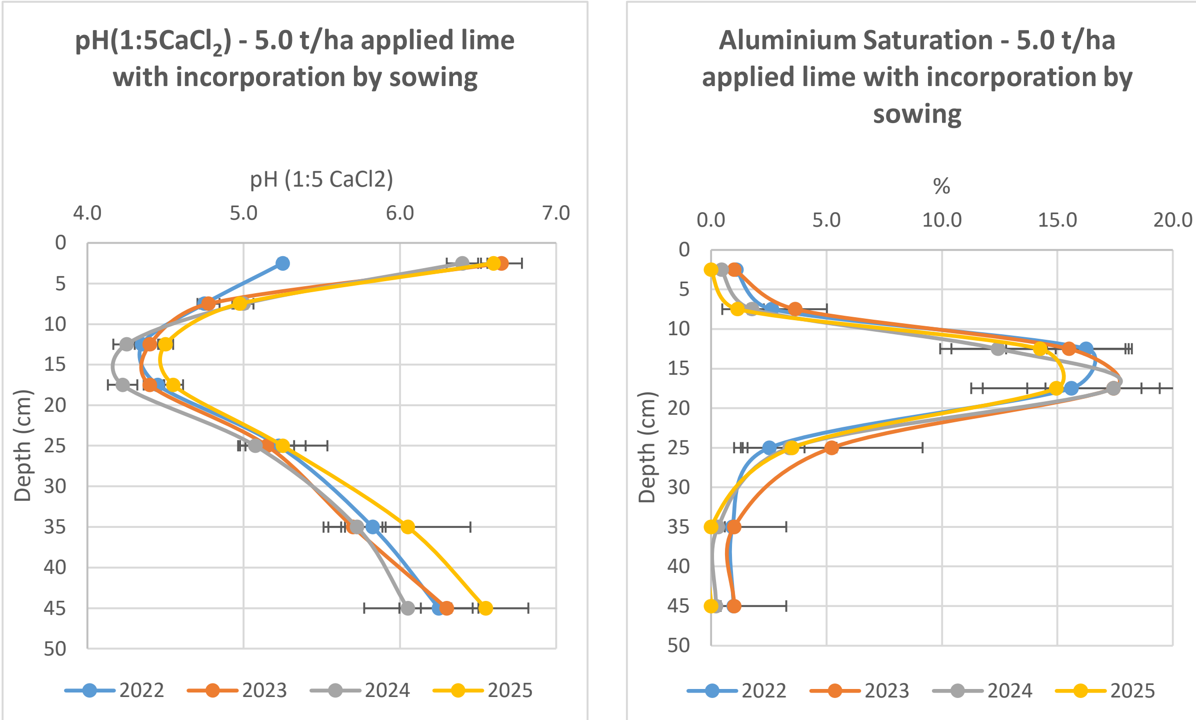
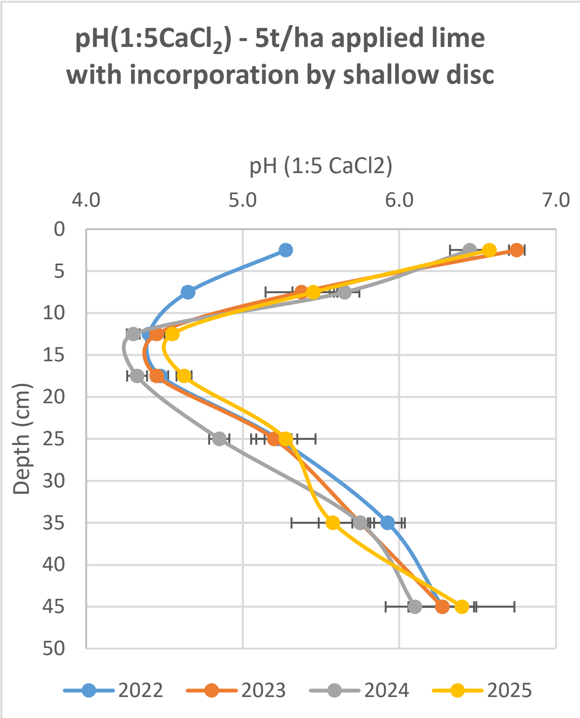


*Figure 8**a and 7b** Soil pH and aluminium saturation (% of the CEC) in the 5 t/ha applied lime applied with incorporation by sowing treatment at Lilliput, 2022–2025. Bars are measures of standard error (SE).*

Treatment 5: Lime applied to target pH 5.8 (at 0-10cm depth), incorporated by shallow discs

Similarly to the 5 t/ha applied lime with incorporation by sowing treatment, the 5 t/ha applied lime with incorporation by shallow disc treatment aimed to achieved a target pH of 5.8 across the entire 0–10cm depth, with the rate applied based on initial soil test results. The 5 t/ha lime incorporated using shallow discs treatment resulted in an increase in pH down to the depth of incorporation (Figure 9a, b).



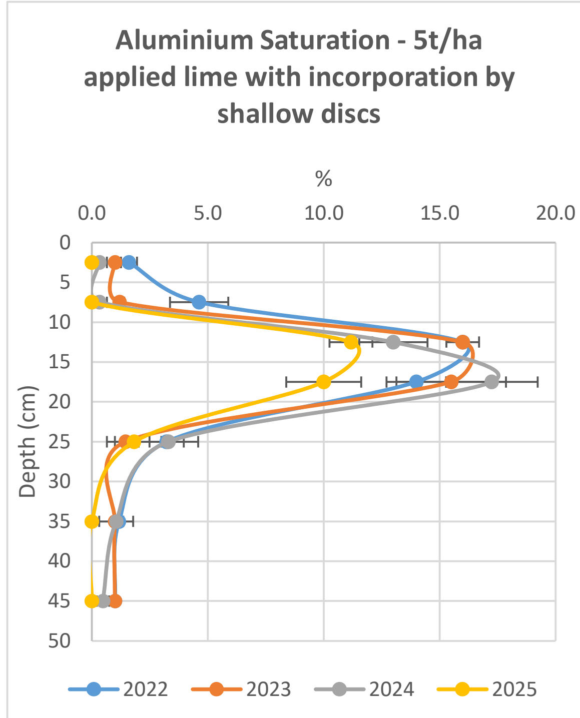


*Figure 9**a and b** Soil pH and aluminium saturation (% of the CEC) in the 5 t/ha applied lime with incorporation by shallow discs treatment at Lilliput, 2022–2025. Bars are measures of standard error (SE).*

By January 2025, soil pH had increased significantly down to the target depth of 10cm after lime was applied and incorporated by shallow discs in 2022. There was also a resulting decrease in aluminium in the same target area (0-10cm), measured across the same period; this indicates that the lime was successfully moved down the profile during the incorporation process and that it was able to react to increase soil pH within this zone.

Treatment 6: Lime applied to target pH 5.8 (at 0-10cm depth), incorporated deep (15cm)

This treatment is aiming to get the 5 t/ha of lime mixed to a depth of 15-20cm, to do this a Horsche Tiger was used. The reason for the limited depth of incorporation is due to the presence of a sodic layer beneath this depth, which, if mixed with the surface soil would likely cause dispersion and crusting on the soil surface, potentially limiting crop emergence and water infiltration.

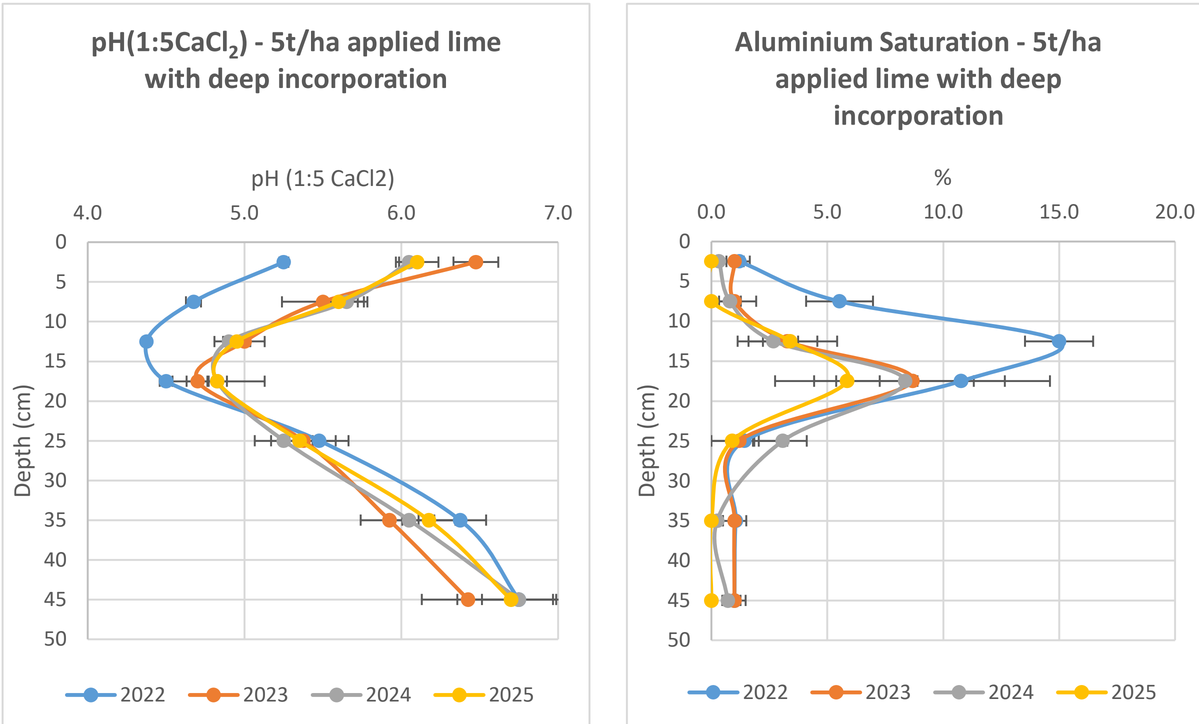


*Figure 10**a and 9b** Soil pH and aluminium saturation in the 5 t/ha applied lime with deep incorporation treatment at Lilliput, 2022–2025. Bars are measures of standard error (SE).*

The results show that the Horsch Tiger was successfully able to move lime down to the depth of incorporation (15cm), with pH increasing significantly in the 0–5, 5–10 and 10–15cm depths between 2022 and 2025. Aluminium saturation was also significantly reduced down to a depth of 15cm.

Treatment 7: Lime applied to target pH 5.8 at depth, incorporated deep (15cm)

This treatment reflects a "deluxe" treatment approach not limited by the cost and practicalities of farming. The treatment targeted a pH of 5.8 from the surface, right down the profile to a depth of 20 cm. To do this, 8.5 t/ha of lime was applied and incorporated to the 15–20cm depth using a Horsch Tiger. The aim was to incorporate to 20cm, however due to being cautious about not disturbing the underlying layer and going any further than 20cm, the depth was only to 15cm.

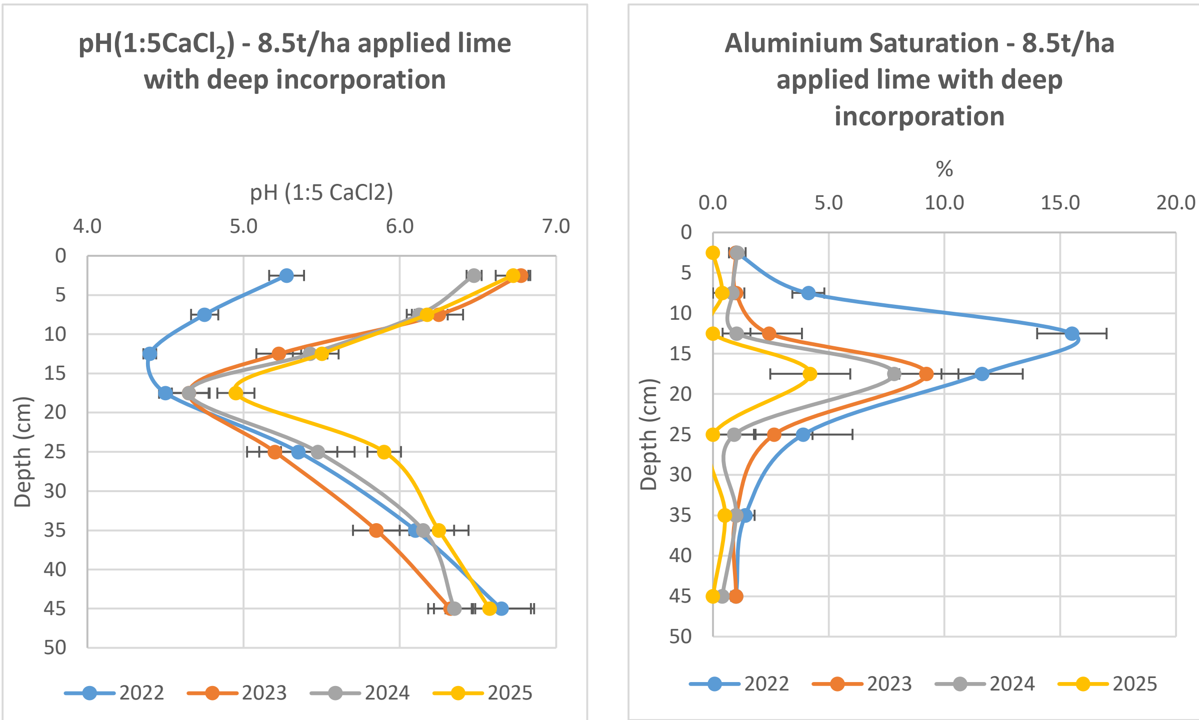


*Figure 11**a and 10b** Soil pH and aluminium saturation in the 8.5 t/ha applied lime with deep incorporation treatment at Lilliput, 2022–2025. Bars are measures of standard error (SE).*

The results show that the combination of a high lime application rate and deep incorporation was able to completely ameliorate soil acidity in this situation. The treatment was able to remove both the acidic and toxic aluminium layers, which means the soil can now support optimal root growth.

Overall Results

These results have clearly supported the premise of this project, that the incorporation of adequate lime is required for the amelioration of subsurface acidity.

The results for the January 2025 sampling compared with the previous 3 years sampling show that when lime is applied without incorporating, it only changes the pH value on the surface. Incorporating by sowing, increases the pH in the top 5cm with the rate of increase depending on the amount applied. Incorporating with shallow discs or deeper with the Horsche Tiger enables the lime to move to the depth of incorporation, with the discs moving it to 10-15cm and the Tiger to 15-20cm. 5t/ha of lime application had a significant change to the original soil tests at the surface when incorporated by sowing. The 5t/ha incorporated by shallow discs was significant to the depth of incorporation as was the deep incorporation.

As expected, when no lime is applied, the subsurface acidity and Al toxicity is maintained.

The CEC values for this soil show a depletion in cations in the 5-15cm depth, which is expected in this duplex soil with a bleached A2 horizon. The band of low CEC values (and low clay content) consistently aligns with a zone of subsurface acidification, due to high root density, high cation extraction and low pH buffering capacity. Changes in CEC over time are not shown, as results only vary within the background variation of clay content, with no significant impact due to treatment, with the calculated Al percentages demonstrating the impact of the carbonate at depth

The levels of available aluminium clearly reflect the changes in pH due to amelioration in the highly acidic 5-20cm depth. The high rates of lime and incorporation clearly show reductions in Al levels, to levels which may not result in reductions in plant growth.

Grain Analysis and Yield

Harvest was conducted by Kalyx using a plot header. A sample from each plot was kept for grain analysis.

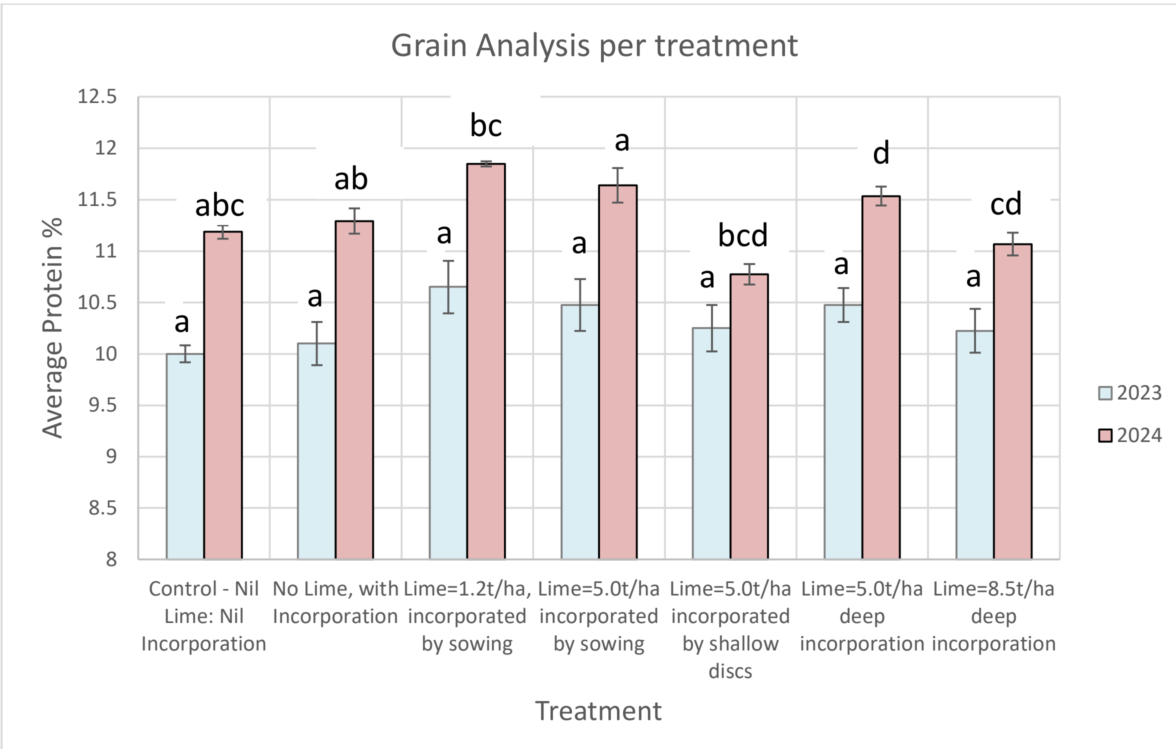


Figure 12 Grain quality analysis from 2023 and 2024. Protein values with the same letter are not significantly different. P<0.05). Bars are measures of standard error (SE).

While there was little difference in protein results in 2023, during 2024 the 5.0 t/ha lime applied with deep incorporation was significantly higher than several other treatments including the control, the 1.2 t/ha applied and the 5.0 t/ha incorporated by sowing. While the reason for this is unclear (no nitrogen data was collected to provide insight), it’s likely that improved nitrogen use efficiency in the treatments where acidity had been ameliorated led to higher grain protein. This was more evident in 2024 than 2023, due to the drier spring which caused moisture to be more limiting. It is also likely that water use efficiency may have shown a similar trend had moisture measurements been taken.

While 250 kg/ha urea was applied to the crop in 2024, the crop was potentially nitrogen limited at different growth stages given the high yields extracted in 2023.

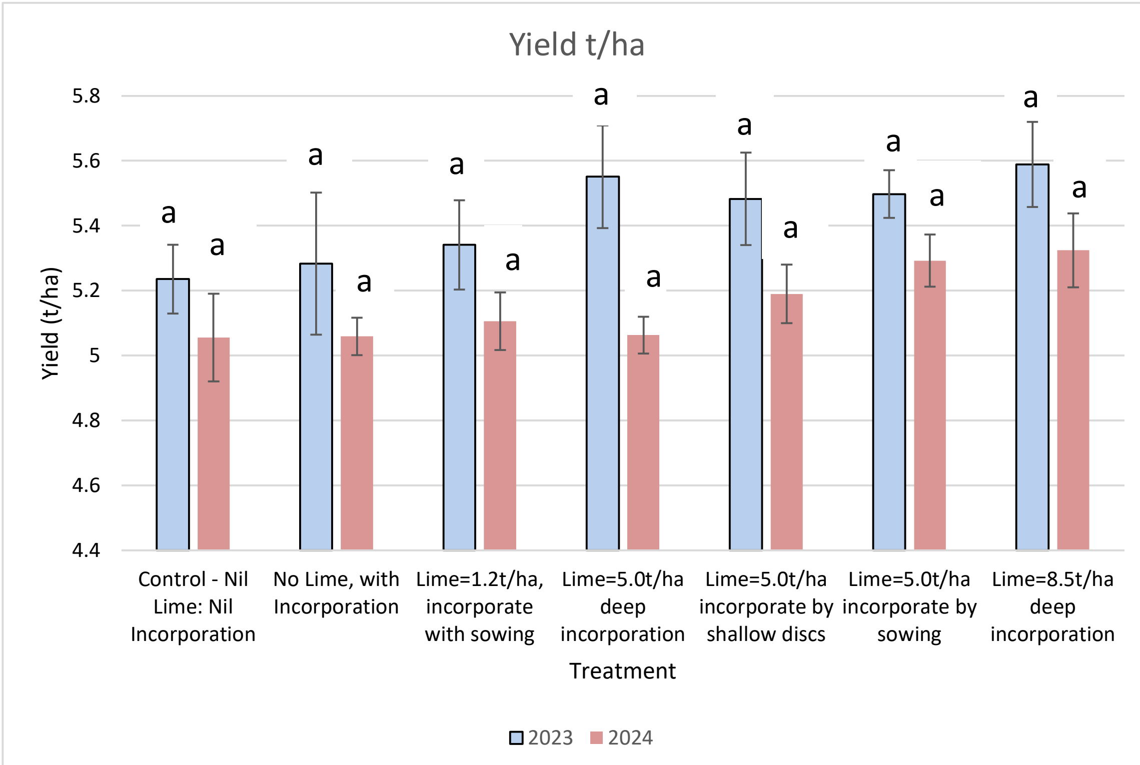


Figure 13: Yield response from treatments in 2023 and 2024. Yield values with the same letter are not significantly different. P<0.05). Bars are measures of standard error (SE).

Although the lime moved to the targeted depth through incorporation in some treatments, there was no significant effect of lime application on yield in 2023 or 2024. Due to waterlogging and slug damage at the trial site in 2022, yield was unable to be measured, and Figure 11 shows yields 2023 and 2024 only. Overall yields were higher in 2023 compared to 2024, and there was a non-significant trend for higher yield in the 5 t/ha incorporated by sowing and 8.5 t/ha deep incorporation treatments across both years of the trial.

The 2024 replicated trials produced yields ranging from 5.05 t/ha (nil lime, nil incorporation) to 5.32 t/ha (8.5 t/ha lime, deep incorporation), which was slightly lower than observed in 2023, when the nil lime, nil incorporation treatment yielded 5.23 t/ha and the 8.5 t/ha lime, deep incorporation treatment yielded 5.59 t/ha. Both the 2023 and 2024 growing seasons had high yield potential, with minimal disruptions and timely rainfall. This helps explain the relatively small (approximately 0.3 t/ha) yield difference between the control, and the deluxe treatment; had the season been drier, with plants under considerably more moisture stress, it's likely that the nil lime control treatment would have yielded comparatively lower, due to the toxic effects of aluminium.

Fusarium crown rot & slugs

Riverine Plains has been managing another GRDC investment looking at the link between cereal stubble, subsurface acidity and crown rot. A disease assessment was done on the control, 5 t/ha incorporated by shallow disc and 5 t/ha applied lime with deep incorporation plots from this trial, The control came back with a highlevel while the other two had a low level. Unfortunately, all samples from the control plots were grouped together, so it was unable to be determined if there was a correlation between subsurface acidity and crown rot levels, which may have impacted yield.

In 2022, when the trial site was decimated by slugs and then waterlogging, it was observed that the treatments that received lime with deep incorporation were less impacted by slugs. This was confirmed with NDVI imagery, however no further analysis of slug populations or damage between treatments was completed and this may be a future area for investigation.

Economic Analysis

An important aspect of any major change in a farming system is determining its economic viability. The application of lime and its incorporation is a major cost for farmers, and the production benefits need to be considered over the longer term, especially when high application rates are being considered.

As part of this investment, we assessed the usability and relevance of some common tools that can calculate the effect of lime on soils, as well as the economic impact of the change. When researching tools it was found that there is currently no suitable tool for assessing lime application rates and incorporation in the Riverine Plains—while a scenario analysis was completed using the Acid Soils SA calculator tools (https://acidsoilssa.com.au/index.php/home/resources/), the pH values were in 0.5 increments, which was too broad to represent the issues being investigated in this trial. We also looked at LimeAssist tool (https://limeassist.sfs.org.au/), however this tool only addressed the cost of incorporation, without considering the long-term effect (benefit) of the incorporation.

Costing assumptions used in the analysis are listed in Table 3 below.

***Table 3** Costs used for calculating amelioration options at the Riverine Plains and GRDC Best practice liming trials, Lilliput*

	Frequency of application	Lime cost# ($/ha)	Spreading^ ($/ha)	Incorporation* ($/ha)	Total cost ($/ha)
Nil lime, nil incorporation		0	0	0	0
Nil lime, incorporated by shallow discs		0	0		
1.2 t/ha applied lime, incorporated by sowing	3 years	90	24	0	$114
5 t/ha applied lime, with incorporation by sowing	6 years	300	80	0	$380
5 t/ha applied lime, incorporated by shallow discs	6 years	300	80	50	$430
5 t/ha applied lime, with deep incorporation	9 years	300	80	150	$530
8.5 t/ha applied lime, with deep incorporation	9 years	510	136	150	$796

#Based on a lime cost of $60/tonne
^Based on a spreading cost of $16/tonne

In the Riverine Plains, moderate rates of lime are typically applied to a paddock every 3–5 years, with the cost of liming considered over its years of effectiveness. A key message is that liming is an investment and the costs of application incurred in year 1 will increase paddock productivity for many years after. Figures 8 and 9 show the cost of liming for the selected treatments, the potential increase in productivity for canola and wheat, and how long it would take to break even. While this is a very simplistic approach, which doesn't factor in the potential for a cumulative effect that decreases the years to break even, it's clear that the time to break even is accelerated when lime application results in a yield increase.

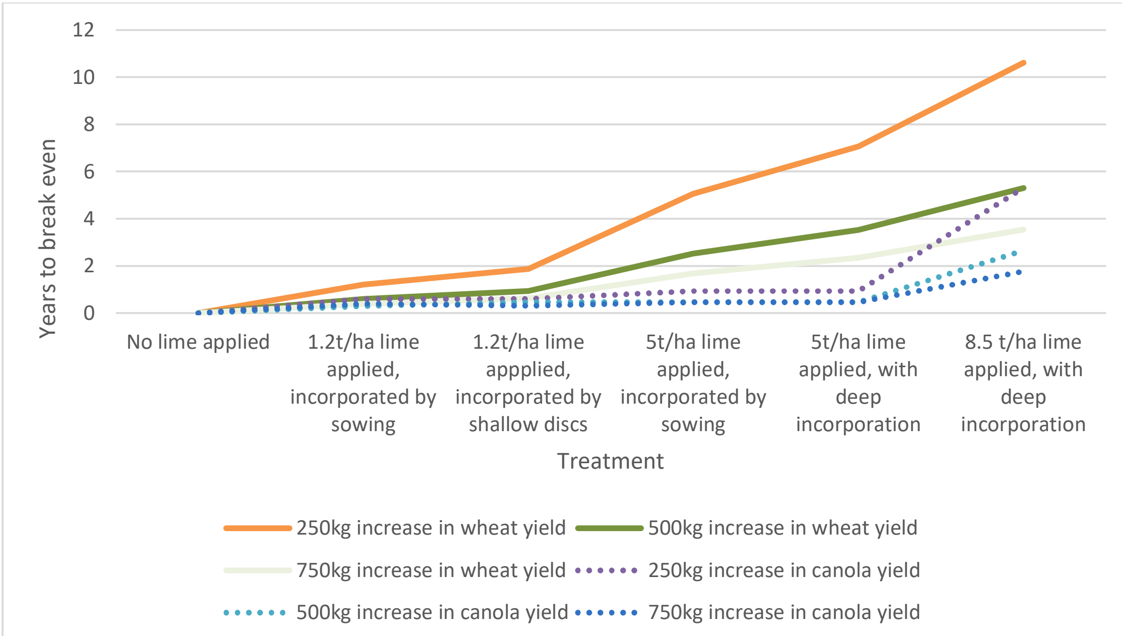


Figure 14 Potential increase in canola and wheat yield and years to break even for selected treatments at the Best practice liming trial, Lilliput

Demonstration Trials

The demonstration trials tested the impact of lime from different lime sources. Treatments included a coarse, soft lime from Mt Gambier, a fine lime from Galong—both applied 3t/ha and incorporated by sowing—and a nil lime. The demonstration strips were harvested in 2024 only with a plot header, with one strip harvested in each plot (strip length 40m).

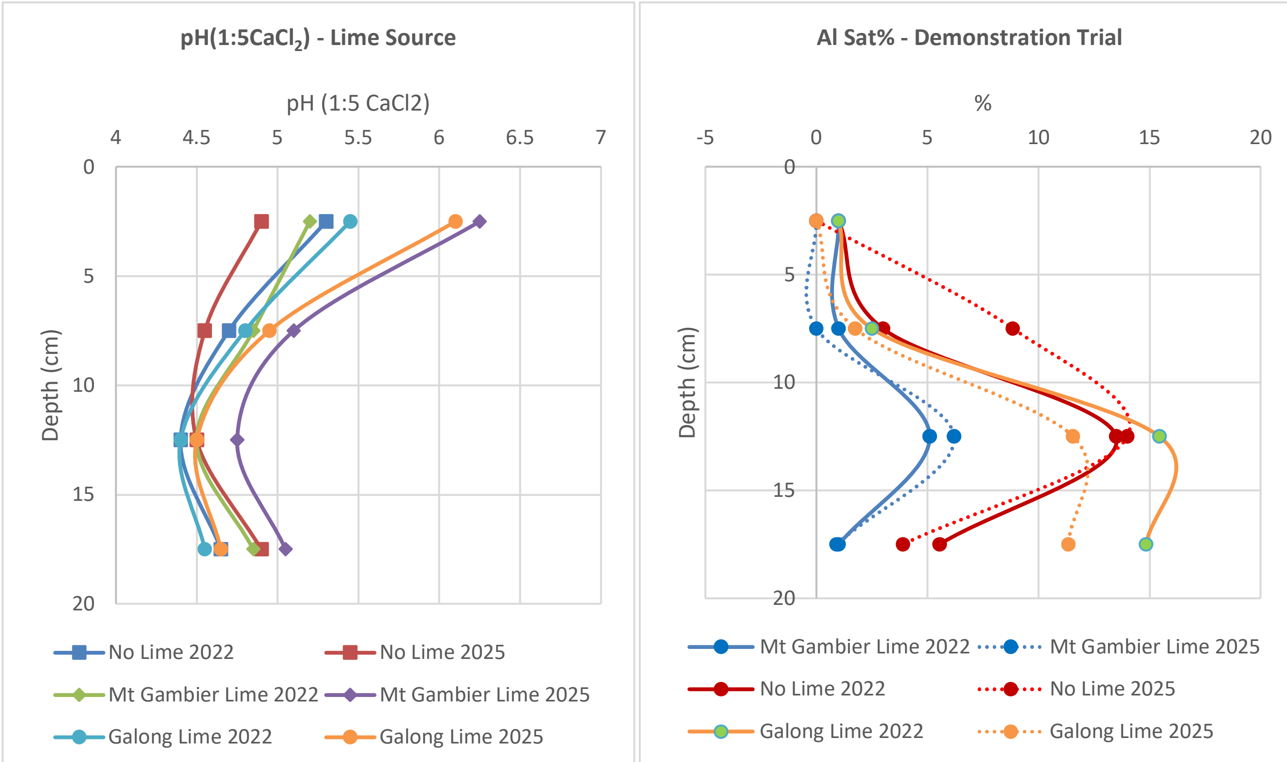


Figure 15 Soil pH and aluminium saturation in the liming source demonstration at Lilliput, 2022–2025.

The pH testing results clearly show the reduction in pH in 0-5cm layer where lime was applied compared to the nil treatment. From these results it is difficult to draw any conclusions (particularly as it is non replicated) as to whether one source of lime is better than the other.

CONCLUSIONS

The 2024 season produced yields ranging from 5.05 t/ha (nil lime, nil incorporation) to 5.32 t/ha (8.5t lime incorporated by tiger). The growing season had minimal disruptions with rainfall once again not limiting the season. The final soil analysis completed in January 2025, has demonstrated that lime with incorporation results in statistically increased subsurface pH values and reduced aluminium in the soil.

While the results are showing that the correct rate of lime, incorporated to the depth of target is fixing the pH of the soil we are not seeing this reflected in yield responses.

During the 2024 growing season and early in 2025, the extension messages to growers were well received with post communication with farmers giving evidence that the message is being heard. The top three take away messages of what farmers have heard at our breakfast meetings held in February 2025 where one was linked with a field day on subsoil acidity were:

- lime needs to be incorporated,
- the application of rate of lime needs to meet the target pH, which is 5.8 and
- importance of soil testing, furthermore incremental soil testing.

SOCIAL MEDIA POSTING

Riverine Plains uses social media to showcase all our research and has done for this project. Our website contains all of our project descriptions and the liming demonstration can be found here:

Best practice liming to address sub-soil acidity in NE Victoria - Riverine Plains

Our social interaction between April 2024 and March 2025 on the topic of Liming were 17 posts with 12667 impressions (number of views)

The trial book article has been written and will be published in June 2024.

There were two blogs written on the topic of subsoil acidity and were released on 16/12/24 and 15/1/25. They were titles Identifying & ameliorating subsurface acidity (https://riverineplains.org.au/news/evaluating-lime-rates-incorporation-methods-subsurface-acidity) and Lime incorporation to ameliorate subsurface acidity (https://riverineplains.org.au/news/lime-incorporation-strategies-lilliput)

KNOWLEDGE TRANSFER EVENTS

Riverine Plains hosted a field day at a neighbouring property to the trial as part of the Riverine Plains Innovation harvest wrap up series in February 2025. The morning showcased results from all Riverine Plains trial sites and had a discussion with farmers about the 2024 seasons. The purpose is to gain an understanding of their successes as well as their challenges for the season. Following this we highlighted the key results from the liming demonstration paddock. There was a display of machinery including a Horsch tiger, speed tiller and a lemken multi disc from both machinery dealers, local farmers and the field day host. The group of 42 farmers, advisors and industry representatives had the opportunity to walk through the machinery on display and ask those using them specific questions. There was a display of soil cores that had been taken by AgriSci and Dr Cassandra Schefe presenting the cores with pH indicators applied. Feedback received from this specific event as well as the other 2 harvest wrap ups held was that farmers didn't realise sub surface acidity was still a problem and how extensive the issue was.

Unless farmers are seeing a massive yield reduction in their property they are not soil testing at 5cm increments to understand if they have an acid throttle.

Images from the harvest wrap up and liming event held in February 2025

SOCIAL MEDIA ACCOUNTS:

Facebook:	https://www.facebook.com/theGRDC
Twitter:	https://twitter.com/theGRDC
YouTube:	http://www.youtube.com/user/theGRDC
LinkedIn:	http://www.linkedin.com/company/thegrdc

Is there any reason why this report cannot be communicated on social media? No. Riverine Plains uses all of the above media channels and has posted regularly about this project.

<u>If no, please provide the following</u>:

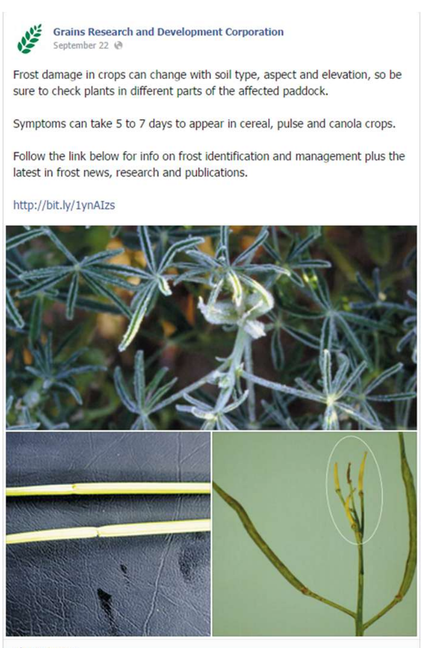
1. Who is the target audience for this content? (e.g., growers, adviser, researchers, policy makers, etc.)
    a. *Growers and advisors*

2. At what time of year is this content most relevant to the target audience?
    a. *When the grower is planning on liming. Some plan these pre-harvest, most would do it around February.*

3. On which of GRDC's social media accounts would you like this content posted? Please provide text (2-3 sentences for Facebook and LinkedIn and 140 characters for Twitter), images, graphs, or charts that support the content. Where applicable, please include any relevant Twitter handles (usernames) for project staff.
    a. *(Insert info here)*

PROJECT SOCIAL MEDIA ACCOUNTS

Facebook:



Twitter:

Contact the social media team at socialmedia@grdc.com.au with any questions.

Please note that publication of content to GRDC social media accounts is at the discretion of GRDC's social media team.