

Managing soil acidity in permanent pastures

Background

Subsurface (5-20 cm) soil acidity is considered a major constraint to production systems in the medium and high rainfall zones of central and southern NSW. Liming practices of recent decades have often been ineffective in managing soil acidity. Low lime rates and inadequate incorporation has increased pH in the 0-5 cm shallow surface soil layer, but the soil below continues to acidify, affecting plant performance. Field research conducted by NSW DPIRD has shown that targeting and maintaining the 0-10 cm soil around pH_{Ca} 5.8 enables gradual removal of acidity in layers below 10 cm (Li *et al.*, 2019). Incorporation of the lime speeds up the rate and depth of the lime effect in the soil however, the challenge is that incorporation is not always achievable or preferred.

The 'Managing soil acidity in permanent pastures' Producer Demonstration Site (PDS), funded by Meat & Livestock Australia, aims to answer the following questions for producers:

1. What rate and frequency of top-dressed lime is required on established pastures to increase 0-10 cm pH_{Ca} around 5.8? (i.e., how do we achieve amelioration of subsurface acidity when lime is top-dressed?)
2. What is the benefit of updated approaches to acid soil management on productivity and composition of perennial pastures?

Mannus and Holbrook demonstration sites

The Mannus and Holbrook demonstration sites were established in February 2021 to monitor change in soil chemical properties to 0-30cm deep. Lime sourced from NSW crushers, with a neutralising value of 97 and fine particle size (96% passing through a 250 µm sieve) was applied using a direct drop lime spreader. Plot size was 50 m long by 3.6 m wide, with four replicates of four treatments (Table 1).

Table 1: Mannus and Holbrook demonstration site treatments and descriptions

Treatment pH _{Ca} target	Lime rate (t/ha)	Description
Control	0	Untreated soil
pH 5.2	3	Traditional approach. 3 t/ha targeting pH 5.2 in 0-10cm layer.
pH 5.8	5	5 t/ha targeting pH ~5.8 in 0-10cm layer.
pH >6	7	Once-in-a-generation treatment. 7 t/ha targeting pH >6 in 0-10cm layer. Does this treatment: • ameliorate and prevent subsurface acidification in the long-term; and/or • induce nutrient deficiencies or toxicities?

Rosewood demonstration site

The demonstration site consists of multiple strips lime strips applied by the farmer since 2017 (Table 2). Lime sourced from NSW crushers was applied using a commercial spreader. Lime strips were 300-500 m long by 100-150 m wide.

Table 2: Rosewood case study site lime strip descriptions

Paddock	Lime rate (t/ha)	Incorporation treatment
Elms West	Nov 2017 – 3 t/ha Mar 2018 – 2.5 t/ha Feb 2019 – 2.5 t/ha Total – 8 t/ha	Incorporated with offset discs (Feb 2019)
Elms East	Nov 2017 – 3 t/ha Feb 2019 – 2.5 t/ha Total – 5.5 t/ha	Incorporated with offset discs (Feb 2019)
Cattleyards (3 t/ha)	Feb 2019 – 3 t/ha Total – 3 t/ha	Not incorporated
Cattleyards (6 t/ha)	Feb 2019 – 3 t/ha July 2022 – 3 t/ha Total – 6 t/ha	Not incorporated
Cattleyards (9 t/ha)	Feb 2019 – 3 t/ha July 2022 – 6 t/ha Total – 9 t/ha	Not incorporated

Results and discussion

Soil

At the **Mannus site**, there was a statistically significant increase in pH for all lime treatments compared to the control, to a depth of 15cm (Figure 1). At the 15-20cm depth layer there was a small but significant increase in pH for the 5 t/ha and 7 t/ha treatments compared to the control. Similarly, there was a significant decrease in exchangeable aluminium percentage for all lime treatments compared to the control, to a depth of 20cm.

There was a small but significant increase in Colwell P levels in the 5 t/ha and 7 t/ha treatments compared to the control at the 2.5-5 cm layer only. There was no difference in Total Organic Carbon levels between treatments.

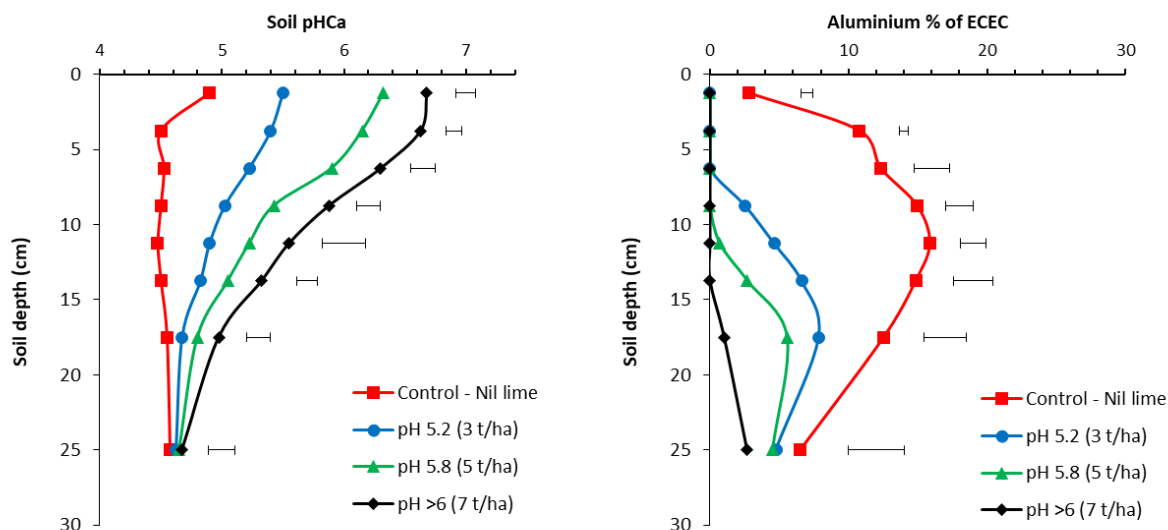


Figure 1. The soil profiles for pH_{Ca} and exchangeable aluminium percent at the Mannus PDS replicated demonstration site, sampled April 2024 (3 years post liming). Horizontal bars represent l.s.d. (P<0.05).

At the **Holbrook site**, there was a statistically significant increase in pH for all lime treatments compared to the control, to a depth of 10cm (Figure 2). There was also a significant decrease in exchangeable aluminium percentage for all lime treatments compared to the control to a depth of 20cm.

There was a small but significant increase in Colwell P levels in the 5 t/ha and 7 t/ha treatments compared to the control at the surface 2.5 cm layer only. There was no difference in Total Organic Carbon levels between treatments.

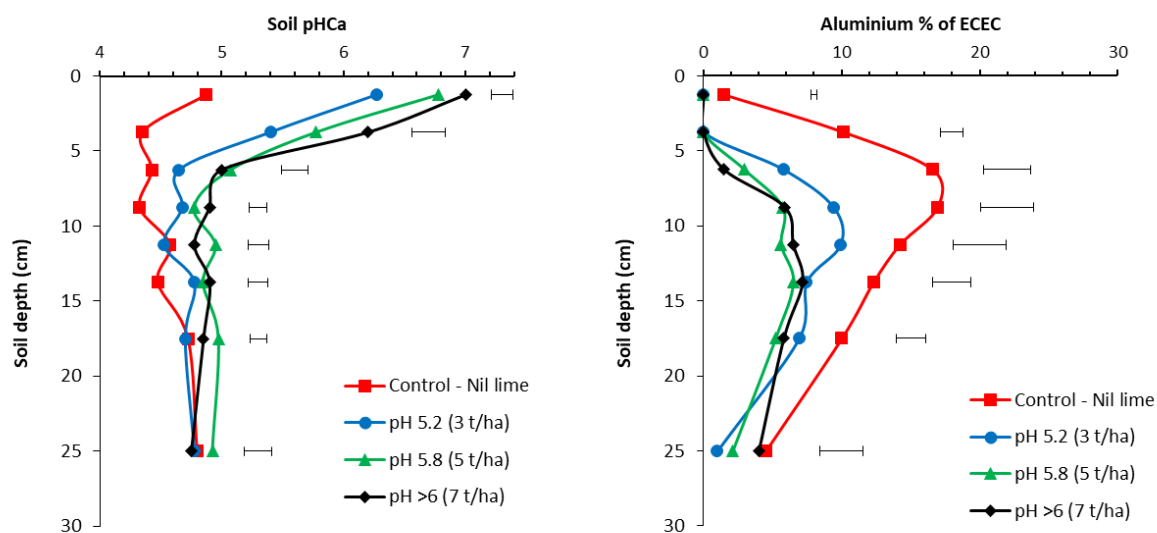


Figure 2. The soil profiles for pH_{Ca} and exchangeable aluminium percent at the Holbrook PDS replicated demonstration site, sampled April 2024 (3 years post liming). Horizontal bars represent l.s.d. (P<0.05).

The Elms West strip at the **Rosewood demonstration site** was incorporated with offset discs in February 2019 after 3 applications of lime totalling 8 t/h and the Elms East strip was incorporated in February 2019 after 2 applications of lime totalling 5.5 t/ha (see Table 2 for more details). The highest lime rate (Elms West) has had the biggest impact on subsurface pH, compared to the lower rate (Elms East), with a large increase in pH down to 20cm depth. The lower lime rate has had minimal increase in pH below 12.5 cm.

At both strips, the pH at all depth layers has decreased or stayed the same compared to last year, indicating that alkali (lime) has been 'used up' in the surface and insufficient alkali remains to neutralise acidity and increase pH in subsurface layers. It should be noted that although large amounts of lime were applied at both strips, especially at Elms West, at no point in the past 5 years did average pH_{Ca} get above 5.5 in the 0-10cm depth layer (peak pH_{Ca} of ~5.3 in 2022). This reinforces the importance of targeting and maintaining pH_{Ca} above 5.5 in the 0-10cm depth layer to enhance downward movement of alkali (lime) and increase pH in subsurface layers.

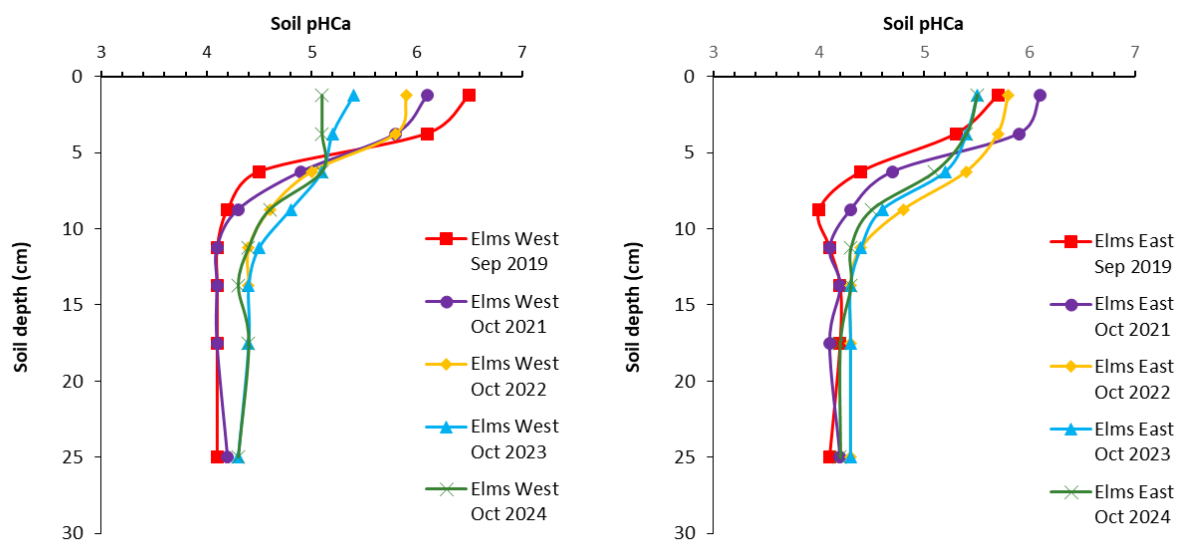


Figure 3. Soil profiles for pH_{Ca} at the Elms West (left) and Elms East (right) lime strips over five years.

The Cattleyards paddock at the **Rosewood demonstration site** had 3 t/ha of topdressed lime applied across the whole paddock in February 2019. In July 2022, an additional 3 t/ha of topdressed lime was applied to a strip (Cattleyards 6 t/ha), and an additional 6 t/ha of topdressed lime was applied to another strip (Cattleyards 9 t/ha). Both the 6 t/ha and 9 t/ha strips have an average 0-10cm pH_{Ca} of 5.8 and 6, respectively, and soil pH results from 2023 and 2024 show that pH is continuing to increase in the subsurface layers.

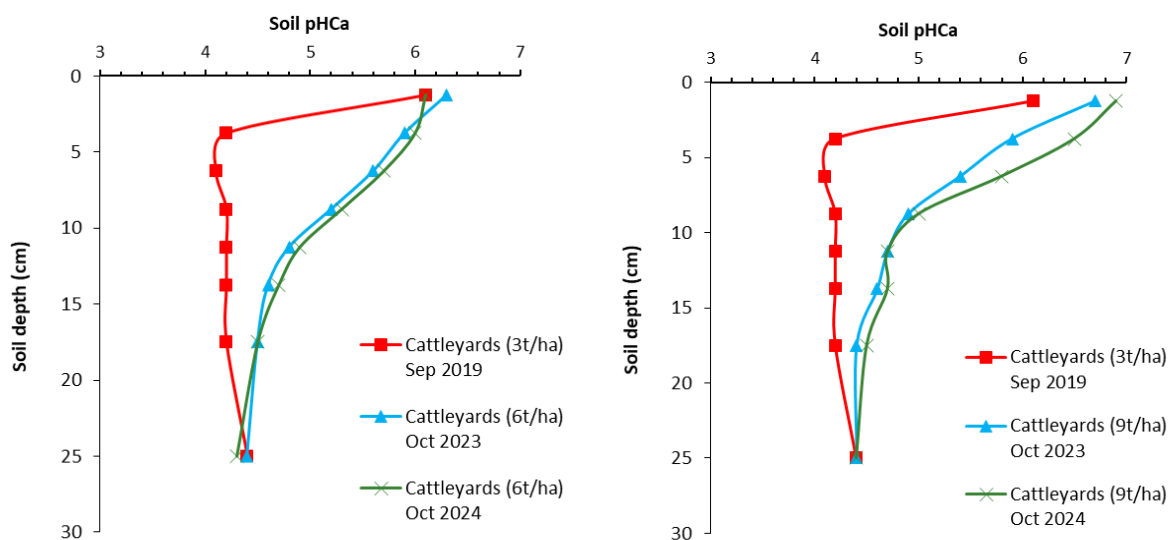


Figure 4. Soil profiles for pH_{Ca} at the Cattleyards 6 t/ha (left) and 9 t/ha (right) lime strips, 15 months (2023, blue line) and 27 months (2024, green line) after follow-up maintenance lime applications.

Pasture

Pasture measurements - dry matter (DM), species composition and nodulation scores were estimated at the **Rosewood demonstration site** on 10th November 2025. In the Cattleyards paddock, an area of about 70 x 10m was fenced off to exclude cattle from the 3 lime treatments for approximately 76 days prior to measuring. Cattle were grazing in the Elms (West and East) paddock at the time of measuring. Pasture DM and subclover composition was highest at the Cattleyards 6 t/ha strip. Subclover nodulation scores were similar between treatments in both paddocks (average score of 3 – 4). The 9 t/ha strip may have increased soil pH to a level that has created a trace element imbalance and this is a possible cause for the lower dry matter production and subclover composition than the 6 t/ha strip. Soil and plant tissue samples were collected in each of the 3 strips and they are currently being analysed at the laboratory.

Table 3: Pasture dry matter (DM) estimates and % composition at the Rosewood case study site

Paddock	Pasture dry matter (kgDM/ha)	Subclover % of DM
Cattleyards (3 t/ha)	3650	15
Cattleyards (6 t/ha)	5210	28
Cattleyards (9 t/ha)	3350	19
Elms West	1530	10
Elms East	970	11



Figure 5. Aerial view of the Rosewood demonstration site on 10th November 2025.

Like last year at the **Mannus demonstration site**, there were differences in pasture growth observed throughout the winter, with the control plots (nil lime), appearing to have less living plant material than the limed plots.



Figure 6. Aerial view of the Mannus demonstration site on 19th August 2025. Blue arrows indicate the control plots (nil lime) and the red arrows are just outside the trial (effectively nil lime).

Spring pasture measurements were collected at the **Mannus demonstration site** on 18th September 2025. The paddock had been locked up all autumn and winter prior to measuring and there was sufficient dry matter in the paddock (2630-3000 kg DM/ha). For all measurements (DM and composition) there was no statistically significant difference between the treatments.

At the **Holbrook demonstration site**, the visual difference observed between the control plots (nil lime) and the limed treatments throughout autumn and winter 2024 was not evident this year. Spring pasture measurements were collected on the 29th October 2025. The paddock had been used as a feeding out/sacrifice paddock during summer and autumn and was locked up over winter/early spring. It had a light grazing in early October (9 days grazing) and was locked up for 21 days prior to measuring and there was sufficient dry matter in the paddock (4660-4850 kg DM/ha). There was no statistically significant difference in dry matter production between the treatments. However, subclover composition was significantly higher ($P < 0.05$) in all three lime treatments compared to the control (nil lime).

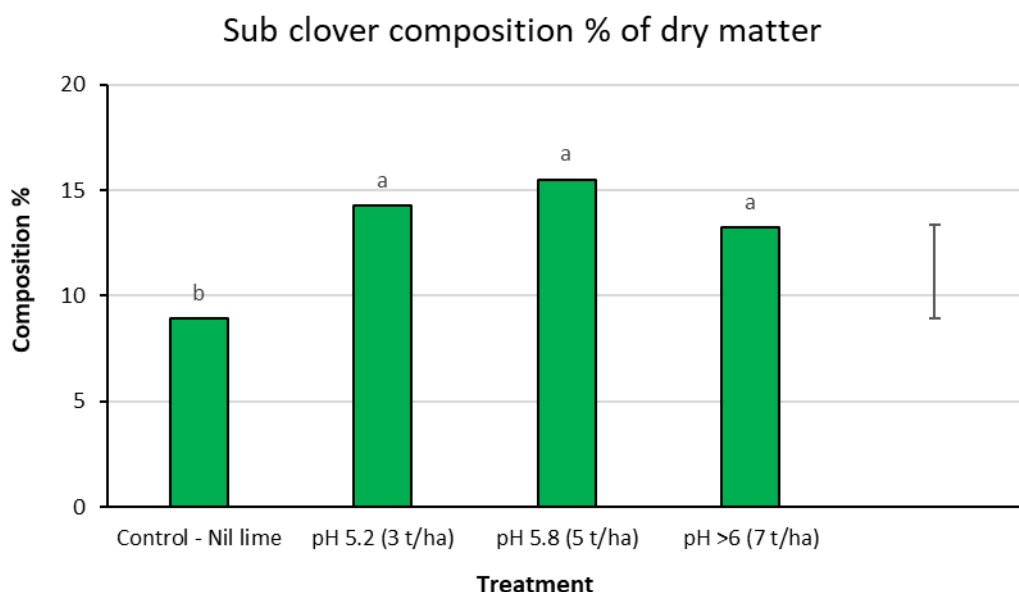


Figure 7. Subclover composition at the Holbrook demonstration site. Vertical bar indicates l.s.d ($P<0.05$) l.s.d= 4.4

Summary

Key findings from 2025:

- Topdressed lime treatments at the Mannus demonstration site have significantly increased pH in the surface 15cm and significantly decreased exchangeable aluminium in the surface 20cm, 3 years post liming.
- Topdressed lime treatments at the Holbrook demonstration site have significantly increased pH in the surface 10cm and significantly decreased exchangeable aluminium down to 20cm depth, 3 years post liming.
- In the Cattleyards paddock at Rosewood, the 6 t/ha strip had the greatest dry matter production (5210 kgDM/ha) compared to the 3 t/ha (3650 kgDM/ha) and 9 t/ha (3350 kgDM/ha) strips. Subclover composition was also greater in the 6 t/ha strip (28%) compared to the 3 t/ha (15%) and 9 t/ha (19%) strips.
- At the **Holbrook site**, there was no statistically significant difference in dry matter production between the treatments. However, subclover composition was significantly higher ($P<0.05$) in all three lime treatments compared to the control (nil lime).
- At the **Mannus site**, the control plots (nil lime) appeared to have less living plant material than the limed plots throughout the year, however there wasn't a significant difference in dry matter or composition measured in the spring.

Acknowledgements

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Further reading

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