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 20cm (Figure 1). There was also a significant decrease in exchangeable aluminium percentage for all lime treatments compared to the control, to a depth of 30cm.

There was a small but statistically significant increase in Total Organic Carbon in the 5 t/ha and 7 t/ha treatments compared to the control and 3 t/ha treatments in some layers to a depth of 15cm. There was no significant difference in Phosphorus (Colwell) levels at any depth between treatments.

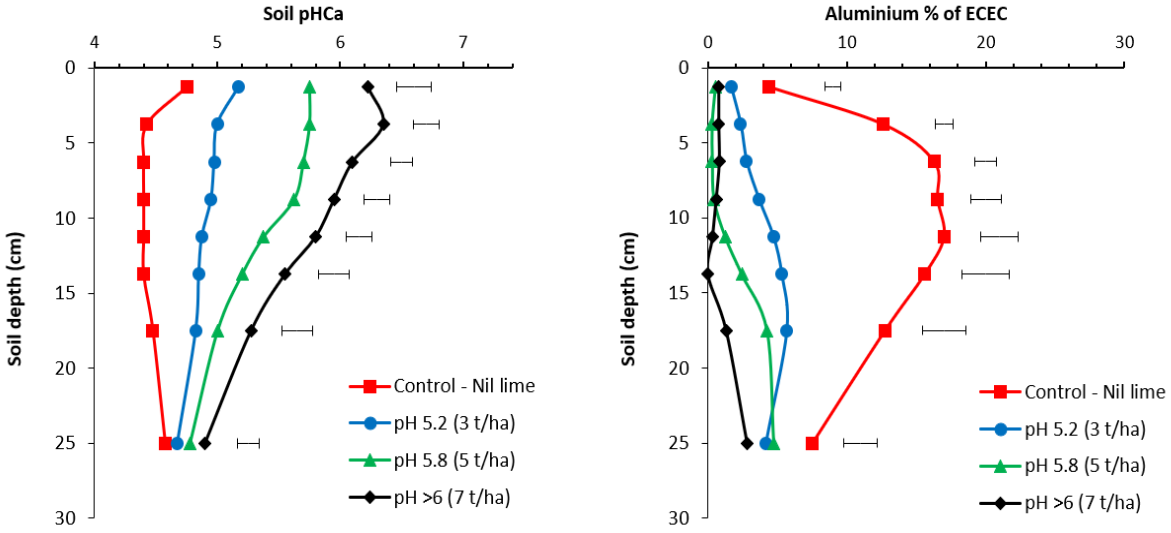


Figure 1. The soil profiles for pH_{Ca} and exchangeable aluminium percent at the Mannus PDS replicated demonstration site, sampled April 2026 (5 years post liming). Horizontal bars represent l.s.d. (P<0.05).

At the **Holbrook site**, there was a statistically significant increase in pH for all lime treatments compared to the control, to a depth of 30cm (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 statistically significant increase (by about 55 mg P/kg) in Phosphorus (Colwell) levels in the 7 t/ha treatment compared to the control at the surface 2.5cm layer only. There was no difference in Total Organic Carbon levels between treatments.

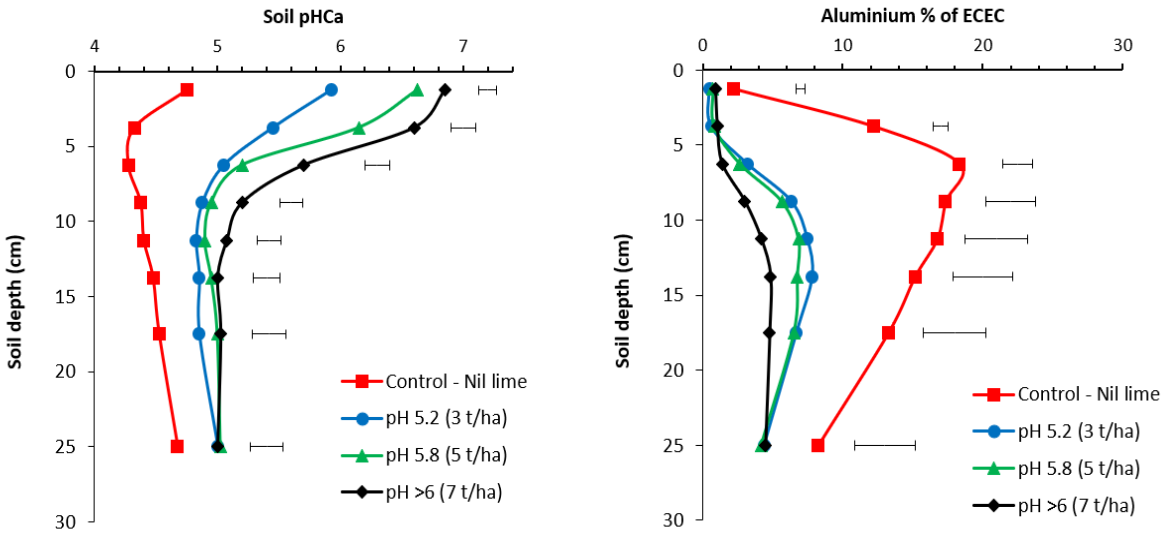


Figure 2. The soil profiles for pH_{Ca} and exchangeable aluminium percent at the Holbrook PDS replicated demonstration site, sampled April 2026 (5 years post liming). Horizontal bars represent l.s.d. (P<0.05).

The Elms West strip at the **Rosewood demonstration site** received 3 applications of lime totalling 8 t/ha and the Elms East strip received 2 applications of lime totalling 5.5 t/ha. Both were incorporated with offset discs in February 2019 (see Table 2 for more details). Interestingly, both strips are showing a similar pH profile this year (7 years post-liming) despite the additional 2.5 t/ha of lime applied on Elms West.

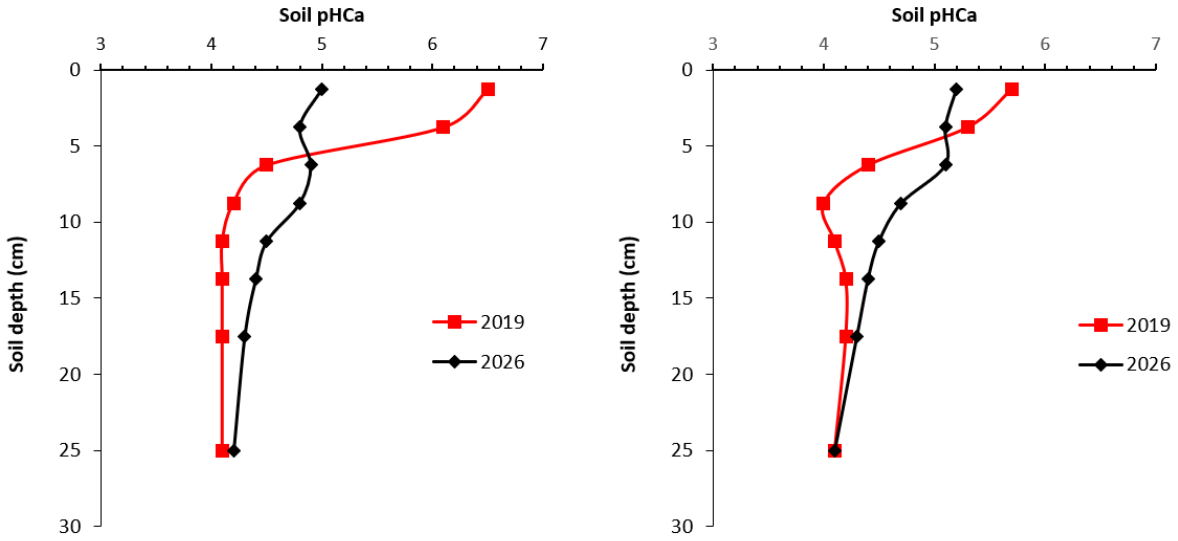


Figure 3. Soil profiles for pH_{Ca} at the Elms West (left) and Elms East (right) lime strips over 7 years.

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). The 2026 soil pH results show that pH increase has been greater in the subsurface layers where additional lime was applied.

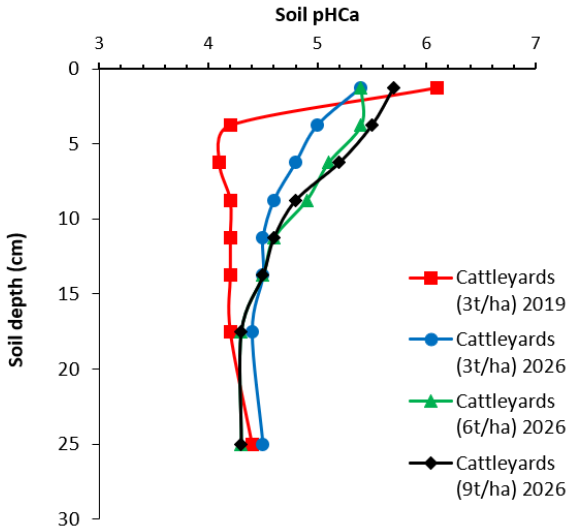


Figure 4. Soil profiles for pH_{Ca} at the Cattleyards lime strips over 7 years.

Pasture

Differences in pasture growth were observed at the Holbrook topdressed lime trial site on March 25 (Figure 5 and 6).

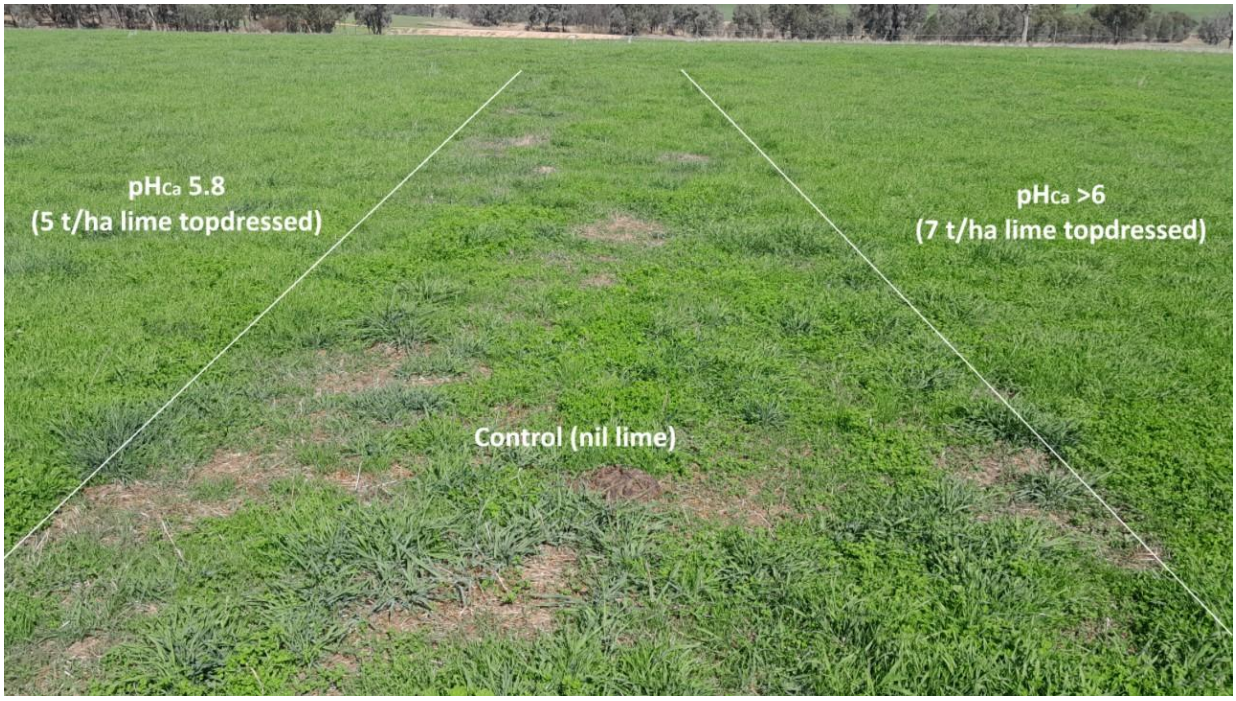


Figure 5. Control plot (nil lime) showing less dry matter than the limed plots at the Holbrook demonstration site. 25th March 2026.



Figure 6. Four control (nil lime) strips clearly visible in the top image (day of lime spreading, 8th February 2021) and the bottom image (25th March 2026) at the Holbrook demonstration site.

Autumn pasture dry matter (DM) was measured at the **Holbrook topdressed lime trial site** on April 1 (Figure 7). There didn't appear to be a difference in plant composition between treatments, and with summer active species such as crumbweed/goosefoot (Dysphania pumilio) still patchily abundant throughout the plots, it was decided to not measure composition as the numbers would most likely be distorted anyway. The results showed that all three lime treatments had significantly more dry matter than the control treatment (nil lime), by about 600 kgDM/ha (Figure 7). There was no significant difference in dry matter between the different lime treatments.

The result is similar to that measured at the Mannus site in April 2024, and follows the same trend of observed pasture differences at the demonstration sites in the Autumn of recent years. In fact, we have observed pasture differences at these sites more often in the Autumn than the Spring in recent years.

Spring pasture measurements were collected at the site on the 28th September 2026. The paddock had a light grazing in early September (12 days grazing) and was locked up for 14 days prior to measuring and there was sufficient dry matter in the paddock (3630-4090 kg DM/ha). For all measurements (DM and composition) there was no statistically significant difference between the treatments.

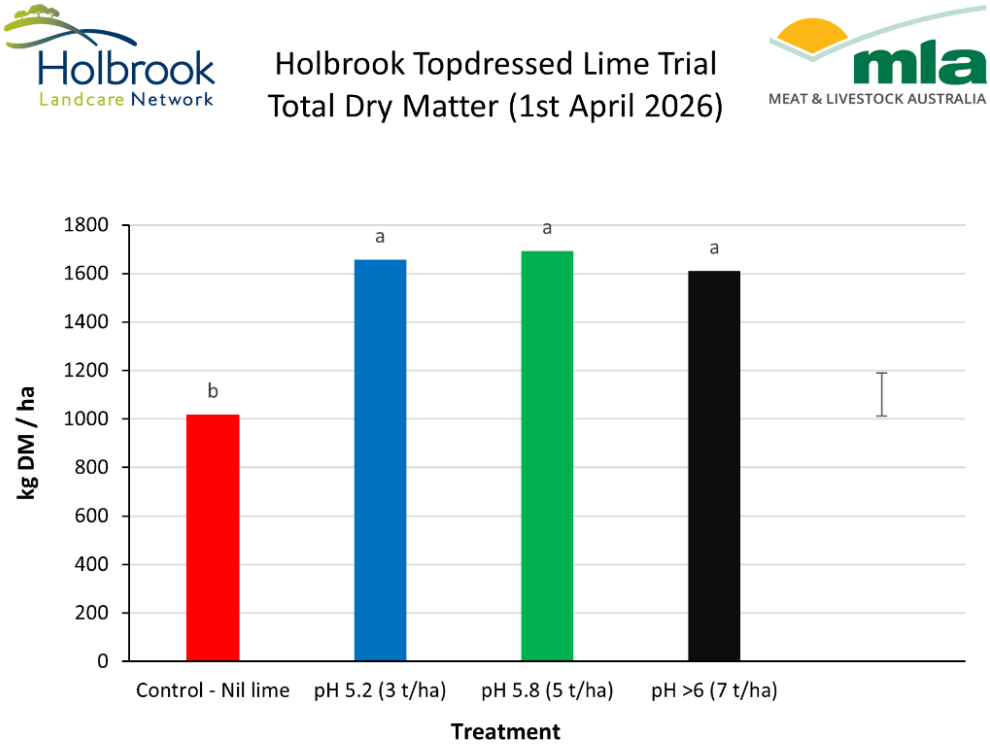


Figure 7. Total dry matter (DM) measured at the Holbrook demonstration site on 1st April 2026. Vertical bar indicates least significant difference (L.S.D) (P<0.05). L.S.D = 178. Different letters above bars indicate a significant difference between treatments (P<0.05).

At the **Mannus topdressed lime trial site**, slight differences in pasture growth were observed in early April. The differences appeared similar to what was observed in the Autumn of 2024 and 2025 – a higher percentage of living plant material in the limed treatments compared to the control treatment (nil lime). The dry matter difference didn't appear as large this year however, and so pasture measurements were not conducted.

Spring pasture measurements were collected at the site on 15th October 2026. The paddock had been locked up for 50 days prior to measuring. The results showed the target pHCa 5.2 (3 t/ha) and target pHCa >6 (7 t/ha)

treatments had significantly more dry matter than the control treatment (nil lime), by 1050 kgDM/ha and 610 kgDM/ha, respectively (Figure 8). There was no significant difference in pasture composition.

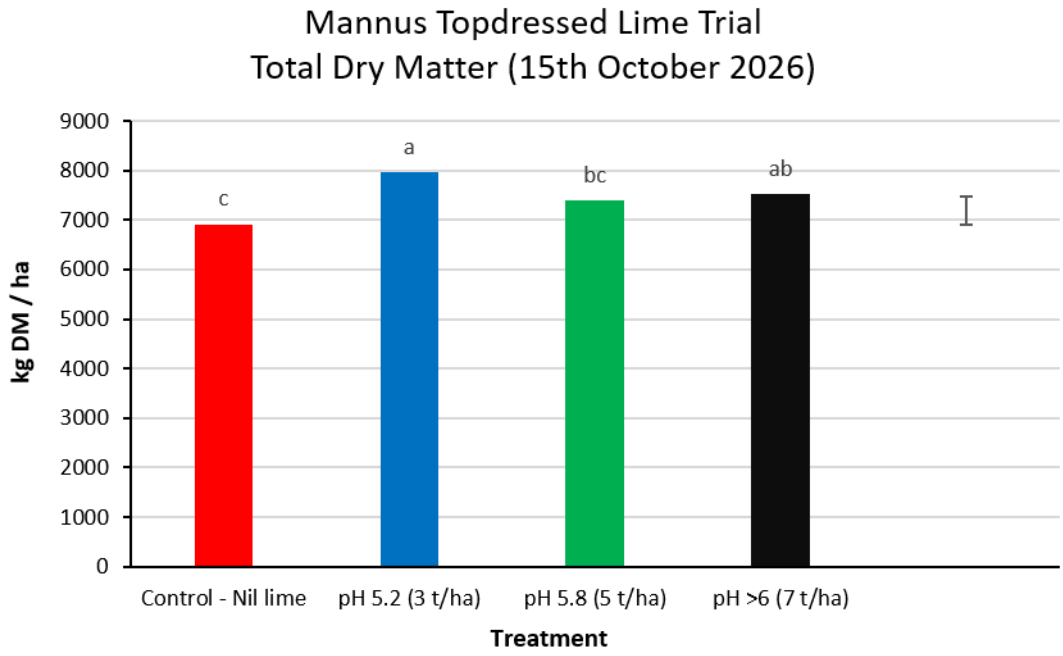


Figure 8. Total dry matter (DM) measured at the Mannus demonstration site on 15th October 2026. Vertical bar indicates least significant difference (L.S.D) (P<0.05). L.S.D = 566. Different letters above bars indicate a significant difference between treatments (P<0.05).

Pasture dry matter (DM) and species composition were assessed at the **Rosewood demonstration site** on 14th October 2026 (Table 3). In the Cattleyards paddock, an area of about 70 x 10m was fenced off (same location as 2025) to exclude cattle from the 3 lime treatments for approximately 68 days prior to measuring. Cattle were grazing in the Elms (West and East) paddock at the time of measuring.

Similar to 2025, pasture DM and subclover composition in the Cattleyards paddock was highest in the 6 t/ha strip compared to the 3 t/ha and 9 t/ha strips. The reason for 6 t/ha strip outperforming the 9 t/ha strip in not known. 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.

Table 3: Pasture dry matter (DM) and percentage subclover composition at the Rosewood case study site.

Paddock	Pasture dry matter (kgDM/ha)	Subclover % of DM
Cattleyards (3 t/ha)	3350	16
Cattleyards (6 t/ha)	4000	34
Cattleyards (9 t/ha)	3230	12
Elms West	1840	66
Elms East	1350	51

Summary

Key findings from 2026:

- Topdressed lime treatments at the Mannus demonstration site have significantly increased pH in the surface 20cm and significantly decreased exch. aluminium in the surface 30cm, 5 years post liming.
- Topdressed lime treatments at the Holbrook demonstration site have significantly increased pH in the surface 30cm and significantly decreased exch. aluminium down to 20cm depth, 5 years post liming.
- Differences in Autumn pasture growth between the limed treatments and the control treatment (nil lime) were observed at the Holbrook and Mannus sites, similar to the Autumn of 2024 and 2025. At the **Holbrook site**, pasture DM results showed that all three lime treatments had significantly more dry matter than the control treatment (nil lime), by about 600 kgDM/ha.
- At the **Mannus site**, Autumn differences in dry matter didn't appear substantial enough to measure. Spring (October 15) pasture DM results showed the target pHCa 5.2 (3 t/ha) and target pHCa >6 (7 t/ha) treatments had significantly more dry matter than the control treatment (nil lime), by 1050 kgDM/ha and 610 kgDM/ha, respectively.
- In the Cattleyards paddock at the **Rosewood (non-replicated) demonstration site**, the 6 t/ha strip had the greatest dry matter production (4000 kgDM/ha) compared to the 3 t/ha (3350 kgDM/ha) and 9 t/ha (3230 kgDM/ha) strips. Subclover composition was also greater in the 6 t/ha strip (34%) compared to the 3 t/ha (16%) and 9 t/ha (12%) strips.

Acknowledgements

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Further reading

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