Lime on established perennial pasture keeps on giving

Location: Hicks Beef, Holbrook, NSW

Key points

- Productivity from raising soil phosphorus and strategic grazing initially increased, then plateaued.
- Introducing a program of lime application onto established perennial pasture boosted carrying capacity by 30%
- "It's a combination of phosphorus and lime – we wouldn't be getting these results from one without the other."
- Regular soil testing monitors change in soil pH and prompts re-liming.
- The long-term objective is to maintain pH_{Ca} of the 0-10cm layer above 5.5 to increase pH in subsurface layers and encourage deeper root systems.

Enterprises: Australian Beef Composites and Red Angus seedstock herd plus commercial beef cattle production

Owners: Tom, Kate, Andrew and Anne Hicks

Introduction

Financial analysis of livestock production response to acid soil amelioration from 1980 to the early 2000s, investigated by NSW Department of Primary Industries (NSW DPI), questioned the economic benefit of liming perennial pasture. Lime application at that time had a long payback period. 'It did not pay' for livestock producers facing relatively high lime prices, low land and livestock commodity prices and very high interest rates.

Twenty years on and significantly higher land and stock prices have livestock producers rethinking the role for effective management of soil acidity.

Photo 1. Tom Hicks (left) with Nick McGrath, project officer from Holbrook Landcare Network, says that he has been surprised at how quickly phalaris/subclover pastures have responded to a program of topdressed lime.

Background

Tom Hicks, his wife, Kate and parents, Andrew and Anne, operate a commercial beef cattle and seed stock herd of 1500 females on an aggregation of 3,600 ha on the hillslopes south-east of Holbrook. With an average annual rainfall of 650 to 700 mm, phalaris and subclover pasture is the mainstay for the operation.

Soils range from red loams to severely acidic grey soils and lighter granite soils on the hills. The most acidic soils have pH_{Ca} of less than 4.5 to depth and exchangeable aluminium levels in the surface 10 cm of up to 24%.

Acid soil management practices have been sporadic, with lime only applied to the most acidic paddocks at the standard rate of 2.5 t/ha, immediately before sowing pasture.

The Hicks' strategy for business growth was through buying land and increasing pasture productivity by sowing perennial pasture, building soil phosphorus (P) levels and fencing newly purchased blocks to improve grazing management.

Tom said, "increasing soil P was the priority as it gave us quick payback."

Fertiliser was one of the inputs cut during the Millennium Drought. The impact on soil P reserves was highlighted via a soil testing program instigated by Holbrook Landcare Network from 2010.

"Soil tests showed that we were mining soil P, so our post-drought production recovery efforts included a fertiliser and soil testing program to increase soil P from around 10 to 14ppm (Colwell) to critical P values of 30 and subdividing the new blocks we'd bought," Tom said.

Benchmarking, land value and livestock prices prompt rethink on acid soils

The Hicks' involvement in a benchmarking program indicated that despite reaching optimal soil P targets on their improved pasture, productivity was below that of comparable businesses.

Carrying capacity across their operation had plateaued at 22,000 dry sheep equivalents (DSE). This was below that of top businesses, with similar livestock operations in the benchmarking group.

Tom said that the standout difference between their business and the best performers was the use of lime to manage soil acidity.

Fast forward to 2017. Encouraged by their agronomist, Sandy Middleton and consultant, John Francis, the Hicks began an acid soil management program, applying lime to degraded pasture before resowing.

"Increased land prices in the last decade means that we need to improve our return on investment by increasing productivity on the land we already have," Tom said.

The plan was to topdress lime in spring at rates to increase pH_{Ca} in the top 10 cm to above 5.5 and wait 18 months for the lime to dissolve and increase pH before sowing pasture.

"We prefer to direct drill pasture and cultivation to incorporate lime is not an option on most of our country," said Tom.

"We expected it would take time for the topdressed lime to work, so were surprised to see a response from subclover after the autumn break and couldn't justify spraying out and resowing pasture," he said.

Benefits from topdressed lime

Improved health and vigour of the clover was followed by growth response from phalaris in the second year. Despite a density of only one to two phalaris plants per square metre, the plants are vigorous and have spread, now making about 40% of ground cover on those early limed pastures.

Photo 2. Tom Hicks noticed that lime topdressed onto pastures with a good subclover density produces growth response in clover first, which then drives recovery of phalaris plants.

In just five years, the combination of P nutrition, grazing management and acid soil management has increased carrying capacity 30% to 32,000 DSE.

These observations compare with 25% more stock and 28% increase in liveweight recorded at the long-term lime experiment (MASTER site) conducted by NSW DPI near Wagga Wagga from 1992 to 2006. Researchers attributed those productivity gains to increased pasture growth, especially in winter and spring, and higher quality feed on the limed pastures.

Tom said that one of the lessons from their experiences has been that increasing soil P is not enough.

"It's a combination of phosphorus and the lime – we wouldn't be getting results from one, without the other," he said.

The dry springs of 2018 and 2019 convinced Tom that they were on the right track. The lime paddocks hung on in the dry period and kicked again after November rain.

"The limed paddocks carried us through the dry," he said.

Tom has also noticed improvements in the health of the pasture, including a gradual change in pasture composition.

"We didn't have to control broadleaf weeds in 2021 and it was the first year we didn't see a response from phalaris to topdressed urea," he said.

These are all signs of a vigorous pasture, able to compete with weeds, likely driven by increased nitrogen fixation from the healthier subclover component boosting growth of phalaris. This is backed by NSW DPI research conducted near Gerogery in the early 2000s, which reported 14% increase in sub clover production two years after lime application and a 38% boost in clover nitrogen fixation.

"Our aim is to systematically lime all improved pastures and boost productivity from around 8 DSE on unlimed areas to the 14 DSE being achieved after liming", said Tom.

If the business is to capitalise on the anticipated increase in productivity, Tom said that they will need additional stock and must manage an increased workload. The options are to address soil acidity across the whole improved pasture area and increase scale or put a ceiling on stock numbers and limit the liming program to selected paddocks.

Lime rates, pH targets and monitoring soils for long-term, sustainable production

According to Tom, one of the differences in their current approach to managing soil acidity, compared with the guidelines used by his father, has been liming to a pH_{Ca} target above 5.5 in the top 10 cm.

This target is based on 18 years of soil monitoring at the MASTER acid soil site, which showed that it is necessary to maintain pH_{Ca} above 5.5 for the lime effect to move down and gradually increase pH in acidic subsurface layers.

"That means we're going hard to catch up, applying rates from 2 t/ha to 4 t/ha, depending on soil tests," Tom said.

Lime is topdressed onto pastures with reasonable clover and phalaris density, while degraded pastures are resown. Lime may be incorporated to speed up lime reaction and improve pH in the subsurface as quickly as possible, if risk of erosion is low.

Budgeting to spread 1,000 t of lime per year is a significant expense, but Tom sees that unlike annual applications needed to maintain P levels, lime is a long-term investment.

"It keeps working and is gradually improving the health of the soil - the limed paddocks are obvious, glowing green this year," he said.

Soil testing a fixture on the calendar

According to Tom, the discipline of an annual soil testing program is important to guide fertiliser and acid soil management programs, retesting paddocks to monitor P and pH and to check that their approach is working.

"Soil testing tells us the rate of lime the different soils need to keep the pH_{Ca} above 5.5," he says.

The future

Tom said that he is following the local research to be sure that their approach is ameliorating pH down the profile as quickly as possible. For example, at a field site established by NSW DPI and HLN on acidic soil nearby at Morven, changes in soil pH down the profile under different lime rate and application treatments is being monitored.

"Seeing the effect of increasing pH on root growth at Morven was an eye opener," he said.

Photo 3. Improved root growth in wheat plants (right) following incorporation of 3 t/ha of lime at the Morven field site compared with Nil lime application (left).

Tom compared the extra root growth in wheat at the Morven site to what they have experienced in their pastures. He is confident that increasing pH in the subsurface layers will improve rooting depth of pasture plants.

Tom believes that increased rooting depth will improve pasture persistence and production system, first in improved access to moisture in dry periods, as they experienced in 2018 and 2019. He is also interested in research that will predict the benefits of increased pasture growth and rooting depth on the capacity of permanent pasture systems to sequester soil carbon, which is an objective for the Hicks Beef operation.

Further reading

Burns HM and Norton MR (2018b). Legumes in acidic soils: maximising production potential in south eastern Australia. Grains Research Development Corporation, Canberra. Available at: https://grdc.com.au/legumes-in-acidic-soils

Conyers M and Li G (2006) MASTER – Soil acidity and lime responses. NSW DPI Primefact 32. Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/54374/MASTER-Soil_acidity_and_lime_responses_-_Primefact_32-final-1.pdf

Hayes RC, Dear BS, Orchard BA, Peoples MA and Eberbach PL (2008) Response of subterranean clover, balansa clover, and gland clover to lime when grown in mixtures on an acid soil. *Australian Journal of Experimental Agriculture* **59**, 824-835.

This case study is part of a project funded by the Holbrook Landcare Network, Grassland Society of NSW and NSW Department of Primary Industries, with financial support from the Australian Government National Landcare Program.

Holbrook Landcare Network

GRASSLAND SOCIETY OF NSW INC.

NSW GOVERNMENT Department of Primary Industries

Australian Government | National Landcare Program