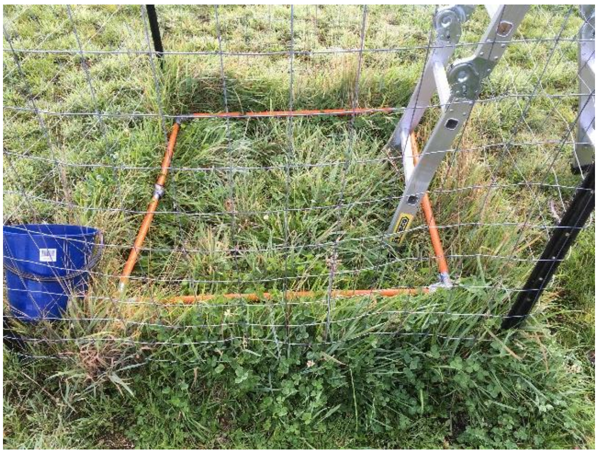
Soil Acidification on Pastures Demonstration Trials – Final Results

Reducing the effects of soil acidification on predominately sandy soils

Reason for trial

Up to 50 per cent of Australian agricultural land is below the optimal pH level. This can result in considerable loss of productivity due to factors such as an increase in less desirable pasture species, restricted nutrient availability, inhibited root growth and development, reduced vegetative growth and less palatable pasture.



Much of the coastal farming region in the north east of Tasmania sits on top of accumulated wind-blown sand which has a natural tendency towards acidity. Most landholders on these farming soils, to counteract acidity, have a liming program they adhere to. Some areas of the Fingal Valley also have acidity issues and farmers in both regions were asked the be involved with the trial. After an initial expression of interest to landholders in late 2018, fifteen landholders put their hands up to host a demonstration trial. Over the trial period a few have discontinued due to re-renovating these paddocks.

Farms involved spanned from Pipers Brook, Waterhouse, Tomahawk, the northern side of Winnaleah (sandier profile) and near Avoca-Fingal.

Trial Design, Products and Rate:

Suitable pastures were identified that exhibited relatively low pH levels and were representative of the paddock. In December 2018, lime was simply applied (spreader truck) in one strip 50 m long x 40 m wide (2000 m2) for each individual farm location. The rest of the representative paddock was the control (untreated) with testing undertaken as close to the lime plot as possible. One reinforced cage (1 x 1 m) was installed for both the limed and unlimed sections. This allowed pasture within the cages to be cut and measured for dry matter and other tests to approximate grazing by stock.

The two lime products used was superfine blended ag limestone and a prilled lime (Calciprill). Only one of these products was used at each trial location.

Fairly high rates were applied to hopefully get a response. The fine lime was applied at five tonnes/ha at four sites and calciprill at 620 kg/ha on the others. The recommended rate for application on sandy/loam sands to increase pH by .1 for Calciprill is 60 kg/ha.

Testing

Initial soil tests in November 2018 were followed by testing in August 2019, May 2020, November 2020, May 2021, 2022 & 2023. Samples were initially taken through the soil profile at 0-100 mm and 100-200 mm but reviewed further into the trial as there was little response with the 0-100 mm sampling. Note: All pH levels mentioned are in water.

Dry matter levels were captured using a plate meter (when ungrazed) and by cuts within the 1 x 1 m cages. These were weighed pre and post drying.

Other Testing: Feed tests

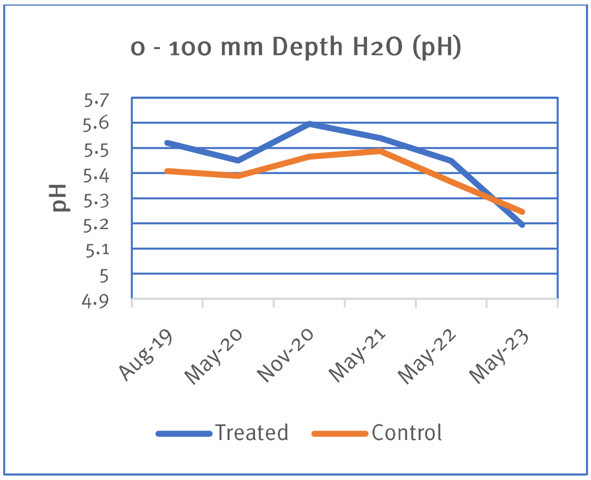
Plant Composition Analysis (May 2020, 2021, 2022) was conducted using a 1 m x 1 m square quadrat mesh with 10 cm x 10 cm squares (100 squares in total) and five tests per plot.

Results

Five years after the initial lime application, variation in results across the 15 trial sites has revealed some changes in the sampling regime. Some of the observed effects have been the slow movement down through the profile of the lime products, some improved calcium availability and improvement in pasture composition.

The addition of relatively high rates of lime increased the average topsoil pH when measured 0-100 mm in depth, but didn't raise it as significantly as expected. Since November 2020, the pH has actually been declining in the limed plots with most of the lime remaining in the top 50 mm profile. (Table 1).

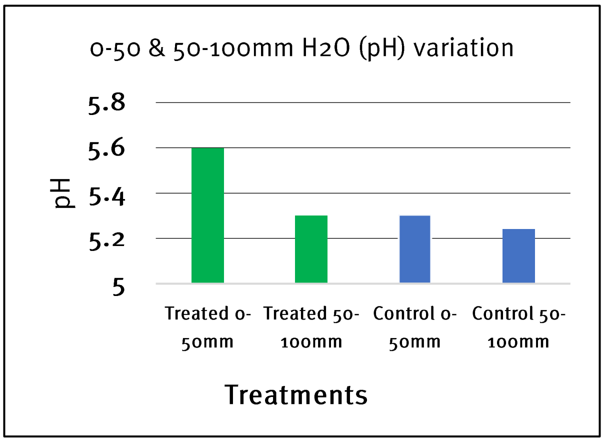
Table 1.



One conclusion is because it is surface-applied lime, it is interacting with the top few centimetres of soil/organic matter, and to date, has not filtrated throughout the 100 mm depth – therefore, diluting the effects of the lime when sampled at that depth.

To examine this result further, two additional sampling depths were included in the testing regime. One at 0-50 mm and the other at 50-100 mm depth. This extra testing highlighted the potential lime stratification effect occurring, with most of the lime remaining in the top 50 mm of the profile and not moving through to the 50-100 mm depth which exhibited a similar reading to the untreated plots (Table 2).

Table 2



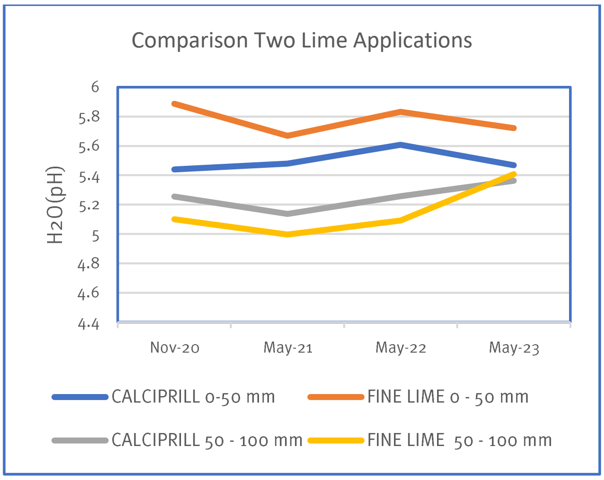
This reduction in lime drawdown has likely increased in long term pastures (15 years +), which often develop a considerable surface thatch layer (undecomposed plant matter) ranging from 25-75 mm in depth (photo 1).

Photo 1. Thick thatch layer to 60 mm in 30-year-old pasture. Tomahawk.

Initial testing at 200–300 mm was discontinued because of the lime products' slow filtration through the profile which appeared to have no effect at the lower profiles.

Comparison between the lime products showed they both followed a similar pattern. Their effect in the top 50 mm is beginning to decline over time but their effect at the 50-100 mm zone is incrementally increasing. (Table 3).

Table 3



At the 100–200 mm zone the acidity was very strong throughout, with pH 4.03 the lowest recorded. In the initial sampling at the 200-300 zone, the lowest recorded pH was 3.99. Having strong acidity at these subsoil layers will greatly inhibit extensive plant root growth, which will reduce the plants ability to draw moisture at depth.

For the dry matter (DM) results there was no difference between treatments. The average across all farms pre-grazing was 1605 kg/ha for the limed plots and 1610 kg/ha in unlimed plots.

Note: During the earlier dry conditions when the trial was first established these numbers would have been lower.

Feed tests were conducted across all sites with some improvement in metabolisable energy (ME) for the limed plots (10) compared to unlimed (9.7). Whether this was due to the improvement in pasture composition or to calcium uptake by the plant is difficult to gauge. There was no difference between treatments for both crude protein and neutralising detergent factor (NDF) percentages. NDF measures the plant material that is indigestible for livestock such as cellulose. Even though there was no noticeable increase in the quantity of dry matter produced, feed quality appears to have improved.

The most representative paddocks of the regions were assessed for pasture species composition in May 2020, 2021 and 2022 by a pasture specialist.

The aim was to identify potential beneficial changes to pasture species composition from liming. On the limed plots there was a noted increase in occurrence of certain clover species and a reduction in grass and flat weed species. Naturally occurring legumes that have adapted to acidic conditions, such as *Lotus spp.*, increased in the unlimed plots.

Some sites were not assessed for composition due to 80-100 percentage dominance of Yorkshire fog grass which were unlikely to change in composition in the short term of the trial.

See (Tables 4 & 5 next page) for pasture composition change.

Table 4

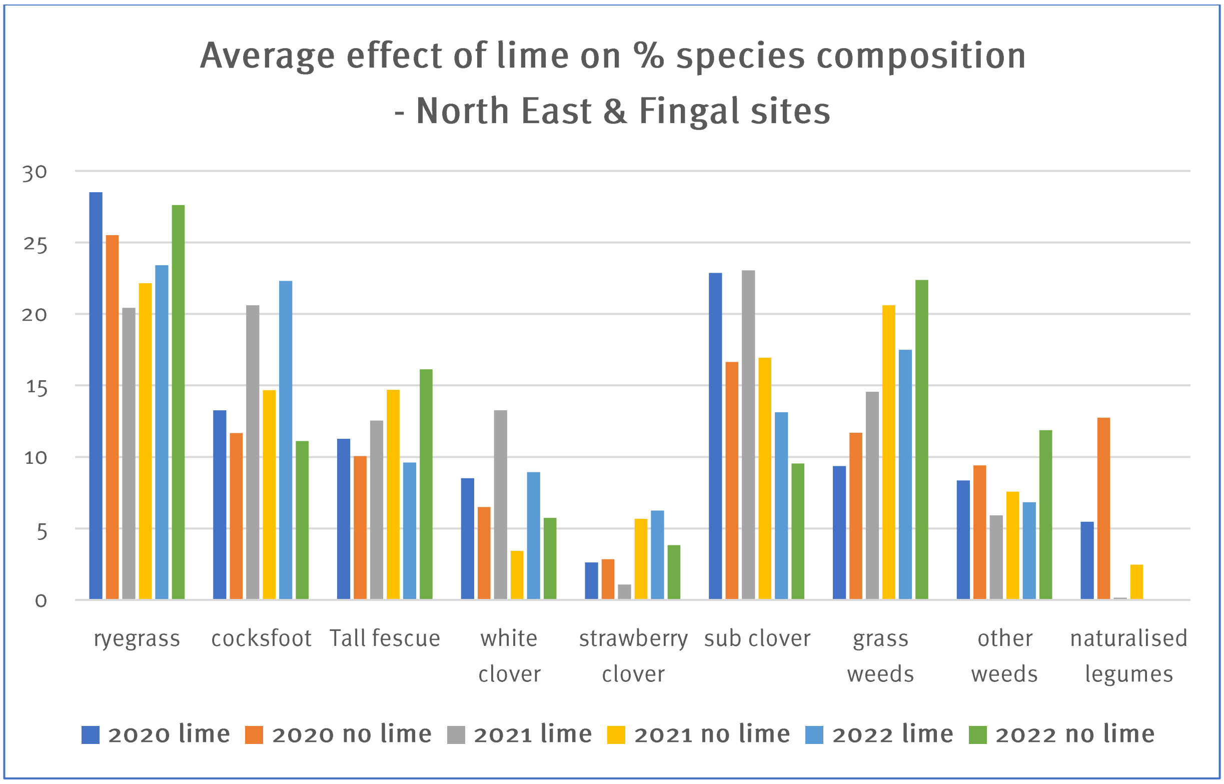
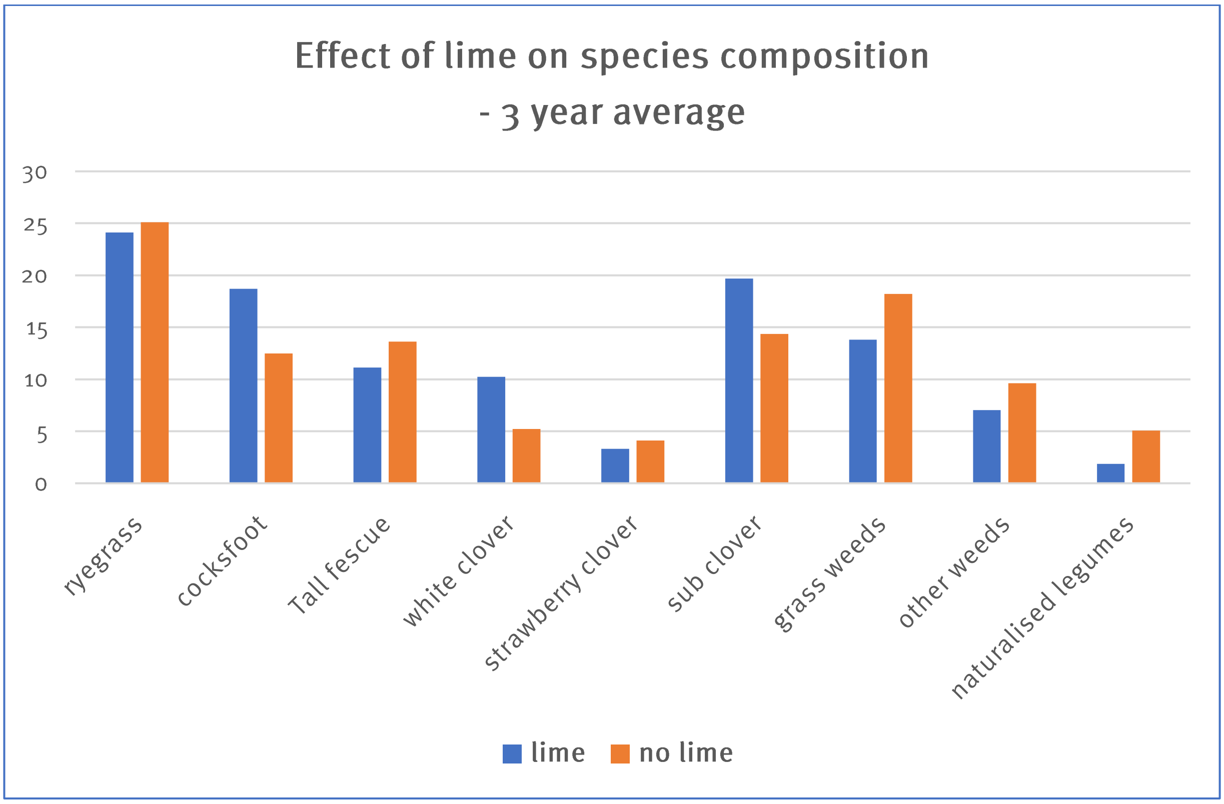


Table 5



Summary

These pasture liming demonstration trials, across 15 farms initially, used fine lime and prilled lime products, and exclusion cages, to identify improvements in pasture productivity and soil pH. After five years of trial monitoring the main changes observed have been an improvement in pasture composition, and improved pH effect within the top 50 mm of the soil profile, exhibiting an increase in calcium availability. It has also demonstrated the relatively slow movement of lime through the profile when surface applied.

Sectioning the 0-100 mm depth testing zone into 0-50 mm and 50-100 mm zones provided greater insight of how surface applied lime can remain in the top layer (0-50 mm) zone with slow filtration down to the 50-100 mm profile zone. This effect has possibly been further exacerbated with the presence of a thick thatch layer in the longer-term pastures which is likely to inhibit the downward movement of the lime and other top-dressed nutrients.

Thatch build-up is particularly prevalent in long term pastures in coastal regions, which are exposed to salt-laden winds which deposit small supplies of salt on these pastures and inhibit microbial activity. This can result in a lack of organic matter breakdown at the soil surface. Over many years this thatch can build up to some depth. Other surface applied nutrients are likely to be held in this thatch layer as well. The contrary argument for maintaining the thatch layer is it assists with good groundcover protection from wind and water erosion, as well as providing a buffering effect in soil temperature and moisture levels as well as capturing carbon, even though this is semi-decomposed matter.

The sectioning of the 0-100 mm testing into 0-50 and 50-100 mm later in the trial greatly assisted with highlighting changes at these particular depths.

It is noted that at one of the sites which was a low fertility, acidic pasture, there was three to four times higher concentration of some of the macronutrients in the top 50 mm of soil than at 50–100 mm.

Even though the higher metabolisable energy (ME) levels in the limed plots from feed testing may appear small, this can have significant benefits in terms of livestock weight gain and animal production generally. Every incremental change in ME is significant for pasture digestibility/quality. An increase in favourable pasture species and the indication of higher

feed quality in the limed strips should translate to an increase in liveweight gain and potentially higher stocking rates.

Dry matter production between the treatments was very similar with no gain in quantity of feed from adding lime in isolation.

The improvements in pasture composition observed across the trial sites is encouraging. Both white and sub clover frequencies continued to improve in the limed plots over time. With sub clover in particular, the plants were observed to be larger in leaf and visually healthier in the limed plots. Sub clover is an annual and the increase in available calcium within the top 50 mm has improved germination rates. This is likely due to the lime's effect on reducing aluminium and manganese toxicity which can inhibit seed germination. It was particularly noticed at a low fertile paddock that the frequency of sub clover in the limed plot was approximately a 40 count compared to no plants found in the unlimed plot adjoined to it. This could also be the case for the perennial white clover seedlings which also increased in frequency for many sites.

With the increase in clovers and therefore diversity, there was also a decline in weedy grasses and flat weeds. Naturalised legumes such as Lotus species which have adapted to more acidic conditions were also more prominent in the unlimed plots. Cocksfoot showed some improvement in the limed areas. Phalaris plants were only present at one site, so the result in the table shown is not representative across any of the other locations. Even so, Phalaris species do well on higher calcium available soils.

From observations so far, it appears pasture composition may be more sensitive to topsoil pH and calcium availability than the laboratory tests show. In some of the poorest, acidic pastures there was a definite visual change in pasture species where the lime had been spread in comparison to the unlimed areas, especially for white and sub clover. For example, one site had no white clover recorded beyond the limed section.

A surface applied prilled lime on broadacre pastures is not cost competitive with the commonly used quarried/ground superfine blended lime. However, if the prilled lime is incorporated below the surface during a pasture renovation phase or by other incorporation methods, the rate of application required to gain the same benefits is reduced by three quarters. This incorporation could make it more cost competitive. Due to being prilled its other potential advantage is blending with the fertiliser mix during sowing or when top dressed. Therefore, avoiding the extra spreader truck run.

As these regions experience consistent winds, broadcasting prilled lime is easier to apply and not be blown off target as can occur for superfine blended lime. But as mentioned, broadcasting prilled lime is still not cost competitive.

As an anecdotal story, a farmer near Tomahawk mentioned they used a prilled lime at the lower rate when resowing a pasture and said that it was an easy product to use in combination with fertiliser at the sub-surface layer and was pleased with germination rates from the newly sown pasture.

Acknowledgement:

Thank you wholeheartedly to the landholders who got involved in the project and allowed NRM North staff and external advisors to visit their farms to undertake the necessary assessments. Their participation is much appreciated.

To Eric Hall, thank you very much for always being available when required and for his wise inputs.

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This project is supported by NRM North through funding from the Australian Government's National Landcare Program.