Supporting Focus Farm Sites

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Project title: Managing Soil Acidity on Eyre Peninsula

Eyre Peninsula Natural Resources Management Board & Department of Environment, Water & Natural Resources.

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EXEcutive Summary

Soil acidity is a significant issue on an estimated 178,000 ha agricultural lands of lower Eyre Peninsula (LEP) and eastern Eyre Peninsula (EEP) (Forward 2013). Although soil acidification is a natural process it can be accelerated through agricultural production practices. A target surface pH of 5.5 (CaCl₂) is recommended to reduce the risk subsoil layers becoming acidic. An estimated 125,000 ha on Eyre Peninsula have surface soils below the critical pH value of 5.0 (CaCl₂) (Forward 2013). Also of concern is the number of LEP surveillance sites with subsurface layers below pH 5.0 (CaCl₂) (Masters 2015).

Soils which are prone to acidification include the ironstone and sandy soils on Lower Eyre Peninsula that are naturally acidic and red brown earths in the Cleve/Mangalo Hills. The latter are highly productive soils that are naturally neutral pH but due to high fertiliser inputs with intensive cropping frequency has seen acidification occurring.

The Eyre Peninsula Natural Resources Management board recognises soil acidity as a significant issue in these areas and has included as a soil condition action target (Target A) in the regional NRM plan. In response, the board; with funding support from the Australian Government and the Department of Environment, Water and Natural Resources, have developed projects around this target. These have been delivered by PIRSA Rural Solutions SA in the 2013/14, 2014/15 and 2015/16 financial years. The aim of these projects is to increase awareness of the extent, impacts and treatment options of low pH soils in the acid prone areas of Eyre Peninsula. This has been achieved through targeted soil sampling, publication of newspaper articles, holding workshops and the establishment of three sites demonstration the benefits of applying lime.

Lime application is considered to be the most cost effective way to address soil acidity. To address annual acidification it is estimated that 36,000 tonnes of lime is required to be spread on soils prone to acidification on Eyre Peninsula each year (Forward 2013). The required lime rate to counteract annual soil acidification under agricultural systems in this region has been estimated at 80 to 200 kg lime/ha/year. Soil pH changes identified by surveillance sampling suggest that given rainfall in recent years and current farming systems, this rate is now estimated to be 240 kg lime/ha/year on average, with much a higher requirement (340 to 400 kg lime/ha/year) on intensively cropped sites which do not contain a legume rotation. Although Eyre Peninsula has large deposits of relatively cheap, quality lime sand only half the amount required to meet the annual acidification rate was sold in 2015/16. This does not include the lime required to raise pH levels on already acidic soils to target levels.

Landholders at 4 workshops in the region in 2014/15 identified that the key barriers to increasing lime applications are; limited capacity to spread more each season and freight costs (particularly for landholders near Cleve). These landholders also identified a big opportunity in precision pH mapping to accurately map spatial variation of pH within paddocks, reducing the cost and increasing the effectiveness of liming applications within paddocks.

In 2015/2016 a number of activities were undertaken with support from the NREP “Managing Soil Acidity on Eyre Peninsula” project. These included;
- Development of YouTube video “Managing acidic soils for improved production on Lower Eyre Peninsula” which can be accessed online at: https://www.youtube.com/watch?v=niDuHniciVMs
- Demonstration to a total of 33 landholders, 12 agribusiness and 4 government staff of the Veris pH Detector soil pH mapper on 8 paddocks (totalling 371 ha).
- Validation of Excel based “Lime Replacement” model using paddock management data to model the impact of different crop rotations and fertiliser use on regional acidification rates.
- Continued monitoring of lime and incorporation demonstrations at Koppio, Wanilla and Cockaleechie.

Key findings from work undertaken in this project were presented at various events during 2015/16 including;
- Acid Soils Technical Forum for government and industry, Waite (June 2015)
- LEADA spring crop walk (September 2015) and Expo (March 2016)
- Soil Science Australia (W.A Branch) “Celebrating Soils” conference, Mandurah (September 2016)
- Farming acid soils workshops (March and June 2016)
- Various articles in newsletters, papers and online.

Other “Managing soil acidity” projects linked with this NREP project to further key extension messages in the region include;
- LEADA “Case Studying successful treatment of soil acidity on Lower Eyre Peninsula”
- Advisory Board of Agriculture “Innovative and cost-effective solutions to the treatment of acid soils in SA”
- GRDC “Managing soil acidity” national project
1 INTRODUCTION

1.1 Regional Snapshot

An estimated 178,000 ha of agricultural land on Eyre Peninsula is thought to have surface and subsurface soil layers susceptible to acidification (Forward 2013). Whilst only a small proportion (6.5%) of the total area cleared for agriculture in the region, soil acidity affects significant portions of the higher rainfall (and hence greater potential productivity) agricultural land in lower Eyre Peninsula (LEP) and eastern Eyre Peninsula (EEP). Acidity is basically a measure of the amount of hydrogen ions in the soil and is usually measured using water (pH H₂O) or with calcium chloride (pH CaCl₂) with the latter considered to be more suitable for neutral to acidic soils. With increasing hydrogen levels soil pH is reduced with pH (CaCl₂) is recommended to reduce the risk of acidification of subsoil layers. It is estimated that 125,000 ha of at risk soils has surface pH below 5.0 (CaCl₂) (Forward 2013). In a recent analysis by undertaken by DEWNR, D Maschmedt has indicated that if not treated, the area of acid soils on EP will significantly increase with soil acidity beginning to develop in areas not historically considered to be acid prone (Hughes pers comm 26/07/2016).

On LEP, large areas of ironstone and sandy soils are at risk of acidification. Many of these soils contain highly bleached A2 horizons which cannot easily buffer pH change. If surface acidity is not managed these subsurface layers can further acidify. On EEP the highly productive red brown earth soils located in the Cleve/Mangalo hills are prone to acidification. Increased cropping frequency, increased use of legume crops, and increased amounts of acidifying nitrogenous fertilisers has accelerated acidification of the surface soil layer on these soils. However, many of these soils have calcareous subsoils with little risk of subsoil acidification.

Liming is considered the most cost effective way of treating soil acidity. An estimated 36,000 tonnes of lime is required to be spread on acid prone soils in the region each year to address annual acidification (Forward 2013). Estimates of lime sales in the region for 2015/16 is 15,000 tonnes (Hughes pers. comm. April 2016). Although this is twice the average annual EP lime sales from 2003 to 2014, it is less than 50% of the required amount to address annual acidification.

2 Previous Project Activities

The Eyre Peninsula Natural Resources Management board recognises soil acidity as a significant issue in these areas and have included it in the soil condition action target (Target A) of the regional NRM plan. The Board, with funding from the Australian Government and Department of Environment, Water and Natural Resources, have developed projects around this target delivered by Rural Solutions SA in 2013/14, 2014/15 and 2015/16. These projects aimed to increase awareness of the effects of soil acidity in the acid prone areas of Eyre Peninsula through targeted soil sampling programs, publication of newspaper articles, workshops for landholders, agribusiness and government staff and the establishment of three liming demonstration sites.

2.1 Surveillance sampling to measure soil pH changes.

In one of these projects “Managing soil acidity on Eyre Peninsula”, soil sampling was undertaken on 40 sites in December 2013 and February 2015 and soil pH changes of between 0.2 and 1.5 pH units (0.2 pH units on EEP sites and 0.4 pH units on LEP sites) were measured on sites where lime had not been applied since baseline sampling was undertaken in 2010. During this period the proportion of Eastern Eyre sites with pH lower than 5.5 (CaCl₂) in the 0-10 cm layer increased from 50% to 60%, with 30% of sites below pH 5.0 (CaCl₂). The proportion of Lower Eyre sites with the 0-10cm layer below pH 5.5 CaCl₂ increased from 41% to 80%, with 60% of sites now below 5.0. Also of concern is the acidification of subsurface layers, with the proportion of EEP sites with subsurface pH below 5.0 (CaCl₂) increasing from 0% to 27% and the proportion of LEP sites increasing from 23% to 72% (Masters 2015).

2.2 Estimates of lime required to offset annual acidification on Eyre Peninsula

The lime requirement to correct annual soil acidification under past agricultural production in the region has previously been estimated at 80 to 200 kg lime/ha/year, with the higher values pertaining to continuous cropping system with high N fertiliser inputs. However, the latest data from the unlimed surveillance sites, suggest an average lime requirement of 240 kg/ha/year. Also, on intensively cropped sites which do not have alkaline subsoil layers the average replacement lime requirement to counteract annual acidification is 340 kg/ha/year (on 35% of these sites the requirement is over 400 kg lime/ha/year).

Some factors which may have contributed to higher than expected acidification rates include;

- Wet winters leading to a high amount of nitrate leaching and poor N uptake by plants.
- Above average yields resulting in the removal of high amounts of base cations in product.
Increased quantity of acidifying N fertilisers being applied to boost crop growth and increase production

2.3 Barriers to adoption of treating pH through lime application

At four “Managing Acidic Soils for Improved Production” workshops held at Edillilie, Ungarra, Cleve and Koppio during 2014 and 2015 a regional snapshot and overview of soil acidity and results from soil sampling was presented to a total of 59 landholders, industry and NRM staff. A discussion session at these workshops captured landholder experiences of soil acidity liming. A summary of this discussion and participant feedback on the workshops can be found in the 2014/15 project report (Masters 2015).

Two of the main barriers for liming discussed at the workshops were;

- Spreading capacity – whilst many landholders now recognise that they have a soil acidity issue they are limited in the amount of lime that they are able to spread each year.
- Freight costs – whilst Eyre Peninsula has considerable deposits of relatively cheap, high quality lime sand, a key barrier to liming for landholders in eastern Eyre districts is the high cost of freighting lime sand from the current commercial deposits on lower Eyre Peninsula.

Key opportunities for reducing the cost and increasing the effectiveness of lime applications identified during the workshop were;

- Confirmation through soil testing of high soil phosphorus levels in acidic areas of the paddocks providing farmers with the opportunity to reduce fertiliser applications in some years, paying for the lime application.
- Adoption of paddock scale pH mapping showing the spatial variability of pH across the paddock, allowing accurate lime prescription maps to be drawn. By applying the right amount of lime to the right areas lime applications will be more effective, and reducing the total amount of lime required (and freight) compared to a uniform application rate for the paddock by pH mapping costs can be reduced.
- Increasing awareness of the additional benefits of applying lime - A key success from liming identified by landholders is improved effectiveness in weed control. Although landholders are unable to pinpoint whether this is due to increased herbicide efficacy or better crop competition against weeds, many landholders feel that improved weed control following lime application has increased crop performance. A number of growers want to expand the areas suitable for growing acid sensitive legume crops (i.e. beans) and see liming acidic areas as a key to successfully doing this.
3 PROJECT ACTIVITIES 2015/16

3.1 YouTube Video

One of the key milestones for this project in 2015/2016 was to produce a video describing the extent of soil acidity on LEP and the options for managing it. Mark Thomas, Missing Link Media was engaged to film and edit the video, with Brett Masters (PIRSA) presenting a regional soil acidity snapshot, technical information on the causes and impacts of soil acidity and management options. Rosco MacDonald, a Koppio farmer, also spoke on the benefits of liming to manage acid soils on his property.

The video was launched as part of the LEADA Spring Crop Walk at Ungarra on 7th September 2015, with 60 landholders, government and agribusiness staff in attendance and can be accessed via either of the two internet links below:

- YouTube (https://www.youtube.com/watch?v=niDuhnicVMs)

A link was to the video was also promoted on the LEADA Facebook page at this time.

3.2 Soil pH Mapping

In partnership with the state-wide Advisory Board of Agriculture project ‘Innovative and cost-effective solutions to the treatment of acid soils in SA’ funded by the Australian Government and delivered by Rural Solutions SA, soil pH mapping was undertaken on 8 paddocks (totaling 371 ha) in eastern and lower Eyre Peninsula (Table 1). Mapping was undertaken at a resolution of one sample point per hectare by Brendan Torpy (Precision Agriculture Pty Ltd, Ballarat) and Andrew Harding (PIRSA Rural Solutions SA) using a Veris “pH Detector” machine. Landholders, NREP staff and agribusiness advisors were invited to attend a demonstration of the machine at Mangalo, Ungarra, Edillilie, Wanilla and Koppio (Table 1 and Figure 1). An article on the pH mapper was also published in LEADING EDGE (LEADA’s e-newsletter).

Table 1. List of pH mapper demonstration sites and attendees

<table>
<thead>
<tr>
<th>Landholder</th>
<th>Location</th>
<th>Area mapped (ha)</th>
<th>Attendees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pugsley</td>
<td>Ungarra</td>
<td>83</td>
<td>6 landholders, 1 agribusiness</td>
</tr>
<tr>
<td>Modra</td>
<td>Edillilie</td>
<td>56</td>
<td>3 landholders, 5 agribusiness</td>
</tr>
<tr>
<td>MacDonald</td>
<td>Koppio</td>
<td>39</td>
<td>5 landholders,</td>
</tr>
<tr>
<td>Nield</td>
<td>Mangalo</td>
<td>40</td>
<td>15 landholders, 2 government, 2 agribusiness</td>
</tr>
<tr>
<td>Gill</td>
<td>Mangalo</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Puckridge</td>
<td>Wanilla</td>
<td>27</td>
<td>2 landholders, 2 government, 3 agribusiness</td>
</tr>
<tr>
<td>Holman</td>
<td>Cockaleechie</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Wilksch</td>
<td>Yeelanna</td>
<td>68</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Brendan Torpy, Precision Agriculture demonstrates Veris pH detector to landholders at Edillilie.
Soil pH maps were sent to each landholder following the mapping.

An example is the mapping conducted on the Wilksch Agriculture case study paddock (Figure 2). The higher pH values correlated with alkaline the red brown earth rises and lower pH values correlated with acidic ironstone and coarse sandy flats. Although the landholder was aware of the different soil types in the paddocks, he was surprised how clearly the map was able to define these areas. He was also surprised with how closely the pH zones on the map correlated to their capacity to grow acid sensitive crops such as Faba beans. Many of the other landholders who had pH maps produced were also surprised at the extent of soil acidity in their paddocks revealed by the mapping.

At the Modra and Pugsley sites the pH maps identified higher pH values where lime had been previously applied to portions of the paddock susceptible to acidification (Figures 3 and 4).

At the Modra site the landholder has applied a total of 5 t/ha of lime to the eastern half of the paddock over the last 5 years. This is reflected by the generally higher pH values in the eastern half of the paddock compared to the western half. The higher pH areas in the western (unlimed) half compared to the low pH zones are associated with areas of alkaline red brown earth (Figure 3).

At the Pugsley site the landholder applied 3 t/ha of lime in 2011 to the northern half of the paddock which is reflected in the generally higher pH areas compared to the southern part (Figure 4). However as the soil in this portion is likely to acidify faster than the ironstone loamy soil in the southern part continued monitoring of this area will be required to ensure that surface pH in these areas does not fall back below the target of 5.5 CaCl2. The pH maps from Wilksch, Pugsley and Modra’s sites (Figures 2, 3 and 4) formed the basis of three case studies developed within the ABA “Innovative and cost-effective solutions to the treatment of acid soils in SA” and the LEADA “Case Studying Successful Treatment of Soil Acidity on Lower Eyre Peninsula” projects.
3.3 Cost/benefit of targeted lime application

The pH maps were also used to evaluate the potential savings of targeted lime applications based on the pH data compared to a uniform application rate of 2.5 t/ha over the entire paddock. The lime application costs included the cost of lime product ($12/t), freight and application ($20/t) and $10/ha for mapping. The estimated savings afforded by pH mapping the paddock ranged from -$47 to $3,490 with an average cost saving of $2,409 (Table 2).

Table 2. Potential savings delivered by targeted lime application based on pH mapping compared to a uniform application rate of 2.5 t/ha.

<table>
<thead>
<tr>
<th>Site</th>
<th>Uniform rate applied across whole paddock (2.5 lime/ha)</th>
<th>Prescription lime application based on pH mapping (includes cost of mapping)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paddock Area (ha)</td>
<td>Tonnes Lime required (t)</td>
</tr>
<tr>
<td>Gill</td>
<td>46</td>
<td>115</td>
</tr>
<tr>
<td>Nield</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>MacDonald</td>
<td>39</td>
<td>97</td>
</tr>
<tr>
<td>Puckridge</td>
<td>27</td>
<td>68</td>
</tr>
<tr>
<td>Modra</td>
<td>56</td>
<td>140</td>
</tr>
<tr>
<td>Wilksch</td>
<td>68</td>
<td>136</td>
</tr>
<tr>
<td>Pugsley</td>
<td>83</td>
<td>208</td>
</tr>
<tr>
<td>Holman</td>
<td>12</td>
<td>30</td>
</tr>
</tbody>
</table>

The greatest potential for reducing the cost of the lime application were on paddocks with highly variable soil types, particularly those which had both acidic ironstone soils interspersed with alkaline red brown earths such as Wilksch and Gill. However, the results may not reflect the true cost benefit of targeted application as it is likely that landholders may not have applied a uniform rate of 2.5 t lime/ha across the whole paddock as they would recognise that some areas would require higher lime application than other areas.

Lime has been applied to at least a portion of the paddocks at MacDonald's, Modra's and Pugsley's within the last 3 years. Compared to applying a further 2.5 t lime/ha across the whole paddock, the saving from applying lime to only those areas identified by pH mapping are considerable.

The lowest forecasted potential savings are on those paddocks that have a very high proportion of the total paddock area which is acidic and requires lime. The Puckridge and Holman sites are examples of this (Table 2). In these paddocks the lime requirement for both the uniform application and the prescription rate are similar, with the cost of mapping the paddock actually resulting in additional costs compared to a uniform application rate.

Landholders were also asked to fill out a paddock management form for each site and the information was entered into a “Lime replacement model” to estimate the degree of acidification on the paddock resulting from crop rotations and fertiliser inputs.

3.4 Acidification Rate Modelling

Paddock rotation and fertiliser input information was collected from the landholders for 18 of the surveillance sites and used to help validate an Excel based “paddock acidification/lime replacement model”. The model is designed to input information regarding the three key paddock management decisions which impact upon the rate of soil acidification. These are:

- Crop type and yield
- Nitrogen input from legume crop and pastures
- Fertiliser applied nitrogen. In the model this is split into “seeding fertiliser” and “in-crop fertiliser” applications.

It was hoped that the model would be able to be used to forward estimate the soil pH after a number of years of a particular crop rotation and fertiliser strategy. However, whilst there was a good correlation between the predicted and measured pH change on the loamy, ironstone soils, the correlation was poor for the sites with low production levels and for the red brown earths with alkaline subsoils. The results being that the model “overestimated” predicted pH change compared to that measured in the field. There may be a number of reasons for this including the way in which the model predicts pH change. However, the assumptions around lime equivalents per tonne of crop/pasture production and kilograms of fertiliser applied are sound and the model could be an important tool for estimating replacement rates of lime required to offset acidification resulting from a particular farm management system.
3.5 Modelling Results

Depending on rainfall (nitrate leaching) and the buffering capacity of the soil, the modelling conducted on these sites suggests that replacement lime rates for 4 year crop/pasture rotations are in the order of 150 to 200 kg lime/ha/year. This requirement is driven from around 30% coming from legume rotations and 40 to 60% of the total replacement lime requirement coming from applied N fertiliser (Figure 5).

![Figure 5. Contribution of nitrogen fertiliser applications to the total replacement lime requirement to for offsetting annual acidification in a 4 year rotation with a legume break.]

In high intensive legume free crop rotations (i.e. Canola, Cereal, Cereal) the annual lime requirement to offset acidification is in the order of 250 to 400 kg lime/ha/year. This agrees with the rates derived from measured pH changes. In these crop rotations 80 to 90% of the replacement lime requirement results from applied N fertilisers (Figure 6).

![Figure 6. Contribution of nitrogen fertiliser applications to the total replacement lime requirement to for offsetting annual acidification in a 3 year cereal/oilseed rotation (no legumes).]
3.6 Monitoring of Demonstration Sites

As part of this project three demonstration sites have been established to investigate the impact of lime rates and incorporation technologies on soil pH and improved production. Baseline soil pH values on all sites were well below the critical value of 5.0 (CaCl₂) in both the surface and subsurface layers (Masters 2015). Extractable aluminium levels were also high within the profile on all demonstration sites. Plot layouts and treatments are detailed in the 2014/15 project report.

2.4.1 Wanilla Demonstration Site (Puckridge)

The liming demonstration site was established in 2014 was sown to wheat in mid May 2015.

![Picture of crop field]

**Figure 7.** Puckridge site at crop emergence – June 2015.

Plant counts were taken on the 17th of June (Figure 7) on crop rows either side of a 50 cm rule at 5 locations in a diagonal transect across each plot. The plants per metre row were averaged for the five counts and converted to a plant density based on row spacing. Plant numbers on the 3 t/ha deep mixed lime treatment were similar to the control but all other treatments were lower (Figure 8).

![Plant density graph]

**Figure 8.** Plant densities at crop germination
The lowest spring biomass was also recorded on the 6 t/ha surface applied lime and deep mixing (no lime treatments) September (Figure 9). The only treatment with much higher biomass was the deep mixed 6 t/ha lime (Figure 9).

![Figure 9. Dry matter cuts in September 2015.](image)

Despite these differences in spring biomass there was no difference between treatments in grain yield. Dry conditions from the end of August may have limited yields on all treatments and also affected conversion of biomass to grain yield on high biomass treatments.

The site will continue to be monitored with assessments of spring dry matter and grain yield in 2016/17.

### 2.4.2 Cockaleechie Demonstration Site (Holman)

The site established in 2014 was sown to canola in late April 2015. Crop emergence counts were taken at 3 leaf stage) on the 3rd of June (Figure 10).

![Figure 10. View across site at emergence – 3rd June 2015](image)

Mean plant density on the deep mixed 3t/ha lime treatment was 20% lower than the other treatments (Figure 11). This could be result of poor crop establishment occurring on the southern end of the trial (plots 1 and 6) where a bare area, possibly due to herbicide residues, has persisted over both the 2014 and 2015 seasons. There was little difference in plant numbers between the other treatments.
Dry matter cuts taken in September identified that all treatments had less dry matter than the control, with deep mixed and no lime having the lowest dry matter. There was little difference in dry matter between the other treatments. (Figure 11).

![Figure 11. Holman Dry Matter cuts, September 2014.](image)

Yield data showed that the surface applied lime treatments did not yield as well as the deep mixed treatments and the deep mixed treatments or control. (Figure 12).

![Figure 12. Holman Canola Yields, December 2015.](image)

The site will continue to be monitored with assessments of spring dry matter and grain yield in 2016/17.

### 2.4.3 Koppio Demonstration Site (MacDonald)

This demonstration site was established on the MacDonald property at Koppio in early 2015. The site was sown to barley in May 2015. Plant numbers were taken on the 17th June with showed little difference between treatments.
Dry matter cuts were taken in September 2015 (Figure 13). On the plots where a low rate of lime had been applied to the surface and on the deep mixed plots where no lime was applied crop growth was much worse than on the control plots.

![Dry Matter, September 2015](image)

**Figure 13.** Dry matter, September 2015.

The lower levels of crop growth identified at in the dry matter results on the deep mix only (no lime) plots were also reflected in grain yield with this treatment yielding about the same as the control. All limed treatments yielded much better than the control with both the surface applied and mixed 3 t/ha lime rate yielding better than 1.5 t/ha surface applied lime or 6 t/ha deep mixed lime treatments (Figure 14).

![Grain yield at harvest, December 2015](image)

**Figure 14.** Grain yield at harvest, December 2015.

At this site the yield benefit afforded through treating the soil acidity with lime may have paid for the 1.5 t/ha and 3 t/ha lime treatments in the first year following application. The site will continue to be monitored with assessments of spring dry matter and grain yield in 2016/17.
4 ADDITIONAL SOIL ACIDITY EXTENSION ACTIVITIES/PROJECTS ON EYRE PENINSULA 2015/16

The key findings from the work undertaken in this project formed the basis for a number of other projects on Eyre Peninsula looking to increase farmer understanding and awareness of issues related to soil acidity. Additional projects undertaken on Eyre Peninsula in 2015/16 include:

1. “Case Studying Successful treatment of soil acidity on Lower Eyre Peninsula” - a LEADA project - funded by the Australian Government National Landcare Program (2015/2016)
2. “Farming Acid Soils Champions” project (2015/2016) – an Eyre Peninsula Natural Resource Management Board project funded by DEWNR’s “Healthy Soils for Premium Food” program and the Australian Government’s National Landcare Program and supported by LEADA and the Cockaleechie Landcare Group

4.1 LEADA “Case Studying Successful Treatment of Soil Acidity on Lower Eyre Peninsula”

In this project two paddocks, one at Ungarra on the property of Ben Pugsley and the other at Edillilie on the property owned by Mark Modra, were used as case studies of successful treatment of soil acidity. The studies used historical soil test data, paddock yield maps, landholder observations and “real time” pH mapping of paddocks to assess the impact of the treatments applied by the landholder on soil pH and production.

Sites were selected on the criteria that the landholder had limed at least a portion of the paddock within the last 5 years and that pre-treatment soil pH data and yield maps were available. Zones of high, medium and low production were identified on a composite yield map across a number of years. To help ground truth production zones against key soil types soil samples were taken along sampling transects in each zone in March 2015. Samples were bulked according to horizon for each zone and a subsample was sent for laboratory analysis of soil pH, basic nutrition and exchangeable cations. Data from this analysis showed higher pH levels on the limed areas compared to the unlimed areas.

Both sites were also mapped using the Veris pH detector machine in June 2015. Maps reflected differences in soil type and the impact of previous lime applications on soil pH.

Although direct yield improvements from treating soil acidity could not be established at these sites the landholders are confident that liming these areas has provided agronomic benefits that indirectly may have delivered yield benefits. Landholder’s observations after liming these sites are that two of the key benefits have been;

- Improved nodulation of legume crops.
- Improved weed control. Although the landholders are unsure whether this is due to improved herbicide efficacy by changing soil pH or because crop competition has been improved by liming.

Both of these production improvements are enough for the landholders to consider that liming these sites has been worthwhile.

4.2 NREP “Farming Acid Soils Champions”

This project was implemented in early 2016 and completed in June 2016 had the objective of developing a group of farmers to champion the cause of managing acid soils in Lower Eyre Peninsula. This was to be achieved through providing the landholders involved in the project with the knowledge and skills to identify areas of their farm which may be acidic and to develop an action plan for these areas.

An initial workshop was held in at Cummins on 30th March 2015 which gave landholders an overview of the causes of soil acidification and the impacts of soil type and farming systems on the rate of acidification. A mapping exercise showed participants how they might use an aerial photograph and soil pH kit to identify zones of varying pH within a paddock. Following this workshop each landholder had a selected paddock mapped by Kym I’Anson using a Veris “pH manager” mapper. A site report containing pH maps and a lime prescription map was sent to each landholder. Analysis of the potential cost savings on the liming operation from mapping the paddock compared to a uniform lime application rate was also undertaken for each site delivering an average potential saving across all sites of $2,247.

Where landholders returned paddock management information (9 of 16 sites), this data was entered into the lime replacement model. Based on the relevant local crop rotations and recent seasonal conditions the estimated lime requirement to offset acidification rates ranged from 175 to 340 kg lime/ha/year with an average of 264 kg/ha/year. A second workshop on the 21st of June 2016 gave landholders an opportunity to discuss the results of their pH mapping and review a number of the tools developed for managing soil acidity including a “lime replacement model”, “lime calculation tool” and “lime comparison tool”. Further information on this project can be found in the “Farming Acid Soils Champions” final project report (Masters 2016)
Further extension activities delivered under the Eyre Peninsula acid soils projects are detailed in Table 3 below.

<table>
<thead>
<tr>
<th>Event</th>
<th>Location</th>
<th>Date</th>
<th>Type of Extension Activity</th>
<th>Number of Attendees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Acidity Technical Forum</td>
<td>Plant Research Centre, Waite</td>
<td>June 2015</td>
<td>Workshop</td>
<td>50 government and industry</td>
</tr>
<tr>
<td>&quot;Celebrating soils&quot; Conference</td>
<td>West Australian branch of Soil Science Australia, Mandurah, Western Australia</td>
<td>September 2015</td>
<td>Conference</td>
<td>&gt;100 delegates</td>
</tr>
<tr>
<td>Presentation of results of pH mapping particularly with regard to the two LEADA “Case Studying Successful Treatment of Soil Acidity” sites</td>
<td>LEADA Spring Crop Walk</td>
<td>September 2015</td>
<td>Field Day</td>
<td>60 landholders, government and industry</td>
</tr>
<tr>
<td>Overview of soil management issues affecting Eyre Peninsula including a snapshot of soil acidity in the region and current local projects looking at addressing soil acidity</td>
<td>GRDC Southern Panel Field Tour</td>
<td>October 2015</td>
<td>Field Walk</td>
<td>15 GRDC panel members</td>
</tr>
<tr>
<td>pH mapping article</td>
<td>LEADING Edge (LEADA’s e-newsletter)</td>
<td>October 2015</td>
<td>Media Release</td>
<td>Distribution to 80 LEADA members</td>
</tr>
<tr>
<td>pH mapping article</td>
<td>Port Lincoln Times</td>
<td>01/12/2015</td>
<td>Media Release</td>
<td>Distribution across Lower Eyre Peninsula</td>
</tr>
<tr>
<td>Managing Acid soils media release</td>
<td>Published on NREP Website and in Stock Journal</td>
<td>March 2016</td>
<td>Media release</td>
<td></td>
</tr>
<tr>
<td>Farming Acid Soils Champions Project</td>
<td>LEADING Edge e-newsletter</td>
<td>19/04/2016</td>
<td>Media Release</td>
<td>Distribution to 80 LEADA members</td>
</tr>
</tbody>
</table>

5 CONCLUSIONS

A major outcome of this project has been increased understanding of the rates of acidification under current farming practices within the region. Previous estimates of acidification rates for the region were between 80 and 150 kg/lime equivalent/ha/year. However, based on the pH changes measured on 40 surveillance sites over a 5 year period it is estimated that within the current farming practices and rainfall in these years, the average replacement lime requirement to counteract annual acidification is around 250 kg lime/ha/year. On intensively cropped sites without a legume rotation, this figure is even higher at around 350 kg lime/ha/year on average, with some sites well in excess of 400 kg lime/ha/year.

These estimates have been supported by modelling using the Excel based “lime replacement” tool.

Factors which might have contributed to the increase in soil acidification rates include:
- Increasing levels of agricultural production with higher rates of removal of base cations
- Increased use of acidifying nitrogenous fertilisers as gains are made in crop production, particularly in Lower Eyre Peninsula where there are limited options for profitable legume rotations.
• Wet winter conditions leading to increased nitrate leaching
• Increased legume crops and pastures within the current rotation

Key findings from local soil acidity have been presented to more than 100 landholders and agribusiness in Lower Eyre and 30 landholders and agribusiness in Eastern Eyre. Whilst many landholders are aware that they have a soil acidity issue and are aiming to apply sufficient lime to bring surface pH levels above the target of 5.5 (CaCl2) they are limited in their capacity to increase the amount of lime they can spread each year due to cost. This is a larger issue in the Cleve district with higher freight costs.

There were some opportunities identified by landholders for to help offset the cost of lime applications including:
• Soil sampling identified high phosphorus levels on many of the surveillance sites. This is likely to result from uniform fertiliser application rates in areas which, due to soil acidity, have poor crop growth and fertiliser use efficiency. This creates an opportunity for landholders to reduce fertiliser rates in some years to pay for lime applications.
• Many growers in Lower Eyre Peninsula are looking to expand the areas where profitable legumes, such as faba beans, might be grown. They hope that by increasing soil pH and exchangeable calcium levels they might be able to achieve better root nodulation and crop growth.
• A number of growers have reported improved weed control following liming, whilst they cannot be certain if this is the result of increased herbicide efficacy or improved crop competition they are confident that the benefits are enough to justify applying lime.

However, the biggest opportunity for improving the effectiveness and reducing the cost of lime applications is the adoption of precision pH mapping. This technology can accurately identify the spatial variation of pH within a paddock and allows variable rate lime prescription maps to be developed to enable appropriate lime rates to be applied to the required areas. Work undertaken on Eyre Peninsula in 2015/16 saw cost savings of around $2,500 per site on average, compared to applying a uniform application rate of lime across the whole paddock. These savings are consistent with the savings achieved in case studies in other areas of the state.

Further work could be undertaken to provide farmers with the knowledge and skills to undertake pH mapping on their own property and create lime prescription maps using simple and readily available tools such as an aerial photograph and soil pH field kit.

Although there was little yield benefit from lime applications compared to the untreated areas at Wanilla and Cockaleechie, the yields were higher than the control at Koppio demonstration site. At this site the yield benefit afforded through treating the soil acidity with lime may have paid for the 1.5 t/ha and 3 t/ha lime treatments in the first year following application. A further project titled “PH Mapping for Effective Management of Soil Acidity” and funded by the Australian Government National Landcare Program will be undertaken by LEADA in 2016/2017.

6 REFERENCES AND ABBREVIATIONS USED IN THIS REPORT


Abbreviations Used in this Report

AI - Aluminium
DEWNR – Department of Environment, Water and Natural Resources
EP - Eyre Peninsula
EEP - Eastern Eyre Peninsula.
LEP – Lower Eyre Peninsula
LEADA - Lower Eyre Agricultural Development Association.
mg/kg - Milligrams per kilogram, a measure of analyte concentration in soil
N – Nitrogen
NREP - Natural Resources Eyre Peninsula
PIRSA- Primary Industries and Regions South Australia
RBE - Red Brown Earth
t/ha - tonnes per hectare