



Final report

The healthy soils package

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Date published: March, 2022

PUBLISHED BY
Meat & Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

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Abstract

Soil condition and health is one of the key influences on pasture growth and therefore affects the ability of producers to address feed gaps, maintain pasture production to meet the requirements of animal production, and management of the natural resource base. Indicators of soil constraints were collected, and a diagnostic process developed to help producers interpret some of the common signs they see in pasture paddocks and diagnose what the underlying problem might be. 149 core producers were trained to develop skills in soil assessment and soil management through the creation of 10 pilot discussion groups which ran a total of 63 training events. Through open day events, another 204 producers increased awareness and knowledge of soil management. The development of online resources based on indicators of soil condition and 20 producer case studies add to the healthy soils package. Other project benefits include a legacy of products and soil resources and recommendations on simplifying the phosphorous decision-making tool and future soil training is made to further improve skill development.

Executive summary

Background

Soil condition and health is one of the key influences on pasture growth and therefore affects the ability of producers to address feed gaps, maintain pasture production to meet the requirements of animal production, and management of the natural resource base. It was one of the four themes addressed in MLA's Feedbase Adoption Plan (FAP). The healthy soils package project was targeted at producers designed to improve producer's skills in soil assessment and management.

Objectives

Objectives were met by creating a simple visual assessment tool (poster) to diagnose possible soil constraints and was used to create further web-based information being an online mobile booklet and three videos. The use of a phone app for identification of visual indicators was determined not to be feasible. The confidence and skills of producers to utilise soil assessment techniques and better manage soils was completed by the creation of ten pilot soil discussion groups and open days.

Methodology

Two posters were created containing indicators of soil condition designed for producers to logically work through an assessment process in the paddock of; what do I see and when, what could this indicate and what test can I do to confirm. Ten pilot soil discussion groups, three each in NSW and VIC and two each in SA and TAS were established to deliver the objectives of building producer skills.

Results/key findings

The process of using indicators for visual learning of soil condition has high appeal to producers and is supported by the use of good images which provides a valuable legacy resource. This resource has been used in multiple formats including the creation of a learning module to assist with producer training. Pilot soil discussion groups showed success in building the skills and confidence of producers.

Benefits to industry

Improving producers' recognition of visual indicators and what it means for their soil condition will lead to better diagnosis of soil constraints, possibly more soil testing to ensure correct diagnosis and improved soil management. The exposure of 149 core producers through the program and another 204 through open days plus many others through web-based resources and case studies is important in addressing soil constraints.

Future research and recommendations

Discussion groups are thought not to be the best delivery method for producer skill development while increasing skills remains a focus of MLA training delivery. Smaller short course modules are suggested as a feeder course into PGS training packages but need to also stand alone as a training method. Recommendations to simplify the five easy steps to P tool and do a future redesign to include other macro nutrients and soil constraints such as soil acidity and sodicity will reduce complexity and make the tool more useful and comprehensive.

Table of contents

Abstract.....	2
Executive summary	3
1. Background	6
2. Objectives	6
3. Methodology	7
3.1 Visual assessment tool.....	7
3.1.1 Poster.....	8
3.2.1 Web based	9
3.2.3 Feasibility of phone app	10
3.2 Simplifying 5 easy steps of P.....	10
3.3 Building skills and confidence of producers	10
3.3.1 Pilot discussion group.....	13
3.3.2 Skills audit of the core group.....	11
3.3.3 Community of practice	30
3.3.4 Case studies	32
3.3.5 Discussion for continued support.....	32
4 Results	33
4.1 Visual assessment tool	33
4.1.1 Poster.....	33
4.1.2 Web based detailed information	35
4.1.3 Feasibility of phone app	36
4.2 Simplifying easy steps of P	36
4.3 Building skills and confidence of producers	37
4.3.1 Pilot discussion groups	38
4.3.2 Skills audit.....	37
4.3.3 Community of practice	71
4.3.4 Case studies	74
4.3.5 Discussion of continued support.....	75
4.3.6 Soil discussion group overview.....	77

5	Conclusion	79
	5.3 Key findings	79
	5.4 Benefits to industry	79
6	Future research and recommendations	80
7	References	80
8	Appendix	74
	8.1 Five easy steps (P tool) report	74
	8.2 Phone App/table feasibility study	80
	8.3 Discussion group flyer	84
	8.4 Healthy soils project expression of interest form	86

1. Background

Soil condition and health is one of the key influences on pasture growth and therefore affects the ability of producers to address feed gaps, maintain pasture production and stability to meet the requirements of animal production, and management of the natural resource base.

The Feedbase Adoption Plan (FAP) comprises awareness activities, training, related products, and supported learning programs across four themes including soil health.

The “Healthy Soils package” has been developed as part of the Feedbase Adoption Plan (FAP) and provides practical information and actions to producers and advisors on the management of common soil issues impacting pasture production.

FAP also aims to ensure on farm adoption of research and development (R&D) results from the 2010 completed Feedbase Investment Plan (FIP). There were numerous soil related research topics such as management of soil borne diseases, phosphorus use efficiency, nitrogen fixation that fitted the soil theme.

The unique components of this project were to build the skills of producers and agronomists to use visual indicators to inform about the underlying condition of their soil and pilot the use of discussion groups to help build producer skills in soil management.

The target audience was producers and particularly those with temperament types described as doer/ dependable who like details and participating in groups.

The collection of indicators of soil condition will be used to create legacy resources to allow producers to connect what they are seeing, to their soil condition. The increased awareness and improved recognition of soil constraints is to improve their soil management.

The creation of pilot soil discussion groups is to develop producer skills in soil assessment and management and provide opportunities for knowledge building and increased awareness via open events and case studies.

2. Objectives

The project objectives of the healthy soils package were:

- Produce and distribute a simple visual assessment tool (poster) to diagnose possible soil constraints.
- Create, or signpost to, detailed information linked to the simple visual assessment that provides greater levels of information. It would include a simplified version of ‘5 easy steps to P’.
- Determine if a phone/tablet based diagnostic app is feasible/desirable.
- Build skills and confidence of producers (and their advisors) to assess (using visual assessment and soil testing) and apply the appropriate products to improve soil health (address soil constraints). The skills and confidence will be built using a range of learning approaches and tools that appeal to different temperament types.

The first objective was achieved through the creation of two posters containing indicators of soil condition, with detailed information for users to follow through the diagnostic process of what do I see and when, what could this indicate and what test can I do to confirm. One thousand posters

were printed (500 of each) and 850 have been distributed. Covid prevented planned distribution through cancellation of many face to face events.

The creation of three short videos based and an online booklet are based on the soil poster and provide easy online access. The posters, online booklet and videos contain detailed soil information were created prior to MLA's soil hub and so do not directly sign post to it. A report was written on possible ways to simplify the 5 easy steps to P which is a support tool for making decisions on phosphorus fertiliser. Currently the P tool has not been amended, however several of the proposed amendments have been incorporated into the PGS training package of PayDirt.

A report was written on the feasibility and desirability of a phone/tablet based diagnostic app. While a photo recognition diagnostic app was not feasible, except for ground cover, easy access to the online mobile booklet to assist in diagnosis of soil condition was considered desirable and relevant.

Producer skills were met through the running of 10 pilot soil discussion groups. Twenty producer case study stories captured some of the leanings of those producers that were shared through Feedback magazine, Friday Feedback, and newspapers.

3. Methodology

3.1 Visual assessment tool

The tool was created to allow producers to interpret some of the common signs they see in pasture paddocks so they can begin to reflect and diagnose what the underlying problem might be. This recognition would help start them on trying to find a management strategy to correct the constraint. It was also created because producers do not take enough soil tests. They are often assumed not to take them because of cost but they are relatively low cost in comparison to fertiliser application. Another possible reason indicated in the pilot discussion groups was that the information they receive is complex and they don't understand what the numbers mean. Therefore, having images of soil conditions that producers could connect to not only soil constraints, but soil test results was a first step in achieving better soil management outcomes.


The visual assessment tool considered temperament type to improve producer engagement. The Myers Briggs Type Indicators (MBTI) SJ' or 'SP' personality types account for 80% of producers which are people who like detail and have been further refined into the temperament types called the "Dependables" and "Doers", (Nicholson and Long, 2015). These producers are observant and often see changes and are naturally curious as to what they mean.

The tool created was in the methodology used in two posters, online booklet and video which allow visual assessment of soil condition using indicator images.

The visual assessment tool was designed around three questions to diagnose possible constraints.

- What do I see and when?
- What could this indicate?
- What test can I do to confirm?

What do you see and when?



Small, stunted or dark green leaves on sub-clover plants.

Observed in early spring when clover is adequately growing.

What could this indicate?

Phosphorus deficiency


Only when phosphorus deficiency is extreme do leaf symptoms appear.

Slow and poor growth of pasture occurs from “Hidden hunger” of all nutrients before appearance of leaf symptoms.

Sub-clover leaves with adequate fertility should be the size of a 20 cent piece.

What test can I do to confirm?

- Soil test with reference to phosphorus.
- Test strips of phosphorus fertiliser.



Pictured: Hand-operated soil sampler.

Figure 1. An indicator example of small stunted or dark green leaves on sub-clover plants from poster part I.

Visual indicators were identified based on what agronomists look for and see when walking into a paddock. The visual images were collected by either taking photos or through contacting agronomists and advisors for photos. Good quality photos of some indicators were hard to access. The tool (images and assessment process) was then used to create soil posters and web-based information. The feasibility of creating an app to utilise the information was also considered.

3.1.1 Poster

Originally one poster was planned, but two were created because of the high amount of content collected. In total there were 50 images that were used to create two posters. The first poster was about what producers could see when they walked into a paddock (20 images). The second poster was based on what producers could see by looking at ground level and at plants and roots (30 images).

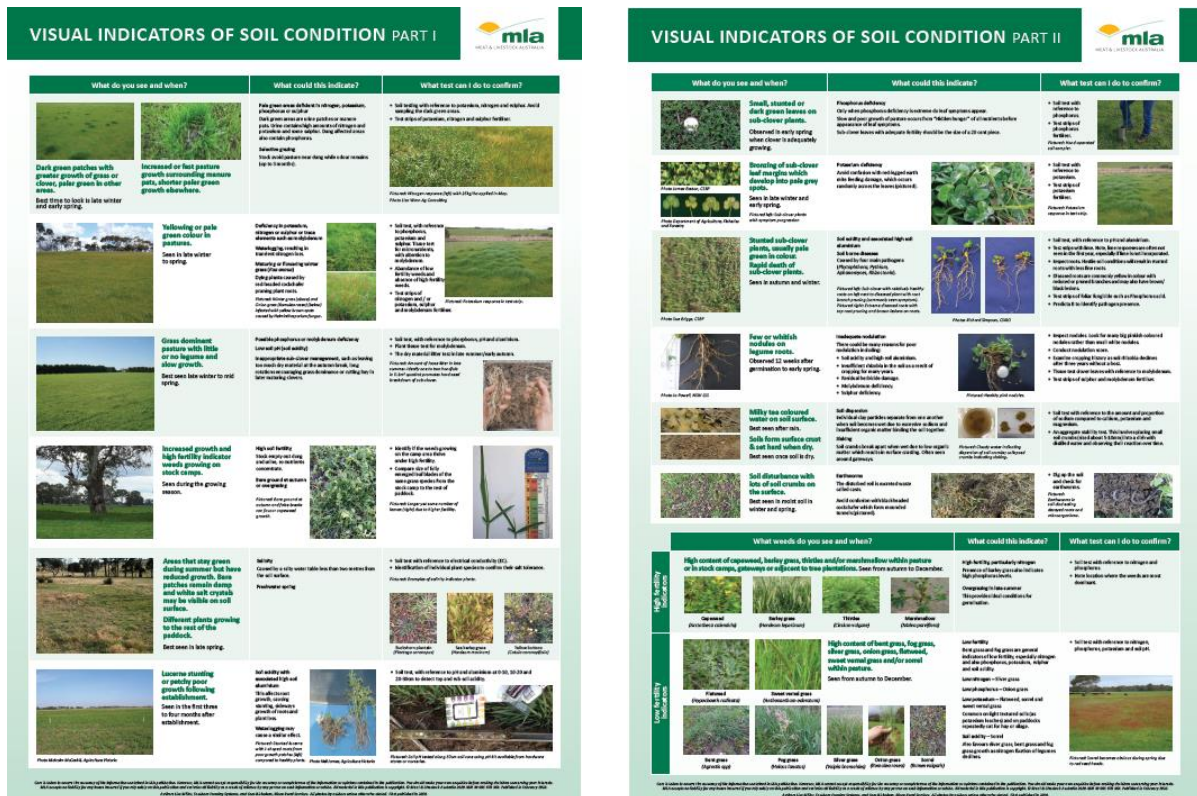


Figure 1. Posters part I and part II.

Visual appearance can be caused by multiple factors and therefore, the poster contained sufficient details to be able to know what else might be causing the pasture or plant or soil to look a certain way. The soil poster was designed to be simple diagnostic tool and designed to pique the curiosity of the producer, so that they would think “I have seen that before, I wonder what it means,” and that they would read on, to find out.

The poster was tested with producers and feedback obtained. The poster was finalised and 500 copies of each were printed for distribution to agronomists and producers.

3.2.1 Web based information

The poster was created into an online mobile friendly booklet by a graphic designer (Amour Creative) so that visual indicator images could be easily accessed from the paddock.

The booklet is divided into three sections that can be opened by clicking on the relevant heading, including:

- Paddock scale observations
- Plant and soil scale observations
- Weed observations

Three videos were created using the images collected for the poster. The videos contained further details about what causes the visual indicators.

Scripts were created for each video, and they were produced by SFS. The three videos were:

- I. Visual indicators of soil condition in the paddock Part I. This video shows common paddock indicators of soil condition.

- II. Visual indicators of soil condition Part II: Plants and pasture. This video looks at the common indicators of soil condition in plants and the pasture.
- III. Visual indicators of soil condition Part III: Soil surface and clover roots. This video looks at common indicators of soil condition that you see on the soil surface or on the roots of legumes.

The videos, online booklet and posters were created before the development of the soil hub and so do not currently signpost to the MLA soils hub.

3.2.3 Feasibility of phone app

This project output was to establish if the visual indicators collected could be used in creation of an app and to submit a report on its feasibility. MLA were keen to establish if photo recognition of soil condition could be used, as it had been in plant species identification. It was not to create an app that necessarily assesses soil health. There are already numerous assessment guides of soil health and condition which involve scoring different conditions.

The app store was checked for soil and agriculture related apps to find out what is currently available. It was notable that many of these apps were not highly rated or reviewed, perhaps indicating low uptake. There were three that were related to soil health as outlined in the report.

Desirability and need were canvassed from discussing the concept with producers and showing them the soil posters. The feasibility of an image recognition app was investigated and evaluated.

A feasibility report was submitted to MLA in August 2020 which included opportunities to pursue and is available in appendix 8.1.

3.2 Simplifying 5 easy steps of P

A task of the 'Healthy soils package (L.FAP.1902) was to review and recommend how to simplify the "5 easy steps to ensure you are making money from superphosphate" calculator, commonly referred to as the P tool.

The short review was initiated because despite it being called "easy", feedback had suggested the P tool does not meet user expectations of being easy. This feedback is confirmed by its limited use, despite it being freely available online, supported by a comprehensive explanation booklet and regularly publicised by MLA.

The review was conducted by Cam Nicholson, Nicon Ag to make suggestions on the opportunities to simplify the tool and make it easier to use. This report was based on trialling different scenarios of the tool. The ease of which to enter the required data was analysed and rated as easy, moderate, or hard information to obtain. The report is called, "Discussion on possible ways to simplify the 5 easy steps (P tool)" and is found in appendix 8.2. It was submitted to MLA in March 2020.

3.3 Building skills and confidence of producers

Building skills and confidence of producers in soil assessment and management was done through the formation of 10 pilot soil discussion groups. These groups added further opportunities to build skills and confidence by running open day events, providing soil resources, creating a source for 20

producer case studies to be written and to set up a community of practice to share communications and resources with.

3.3.1 Skills audit of the core group

The initial proposal to the groups was to do a pre and post project skills audit like what occurs in PGS training packages. This was done by some groups, but other groups evaluated skill development after each session because the project was to run over two years and because of potential change in producers' attendance.

In this project, a skill was defined as being able to do a soil related activity better than they could do before. This was either because of increased knowledge or increased practice or both. Two examples of skill audits and examples of skill related to soil management were provided to producer groups.

Examples given were:

- Identify what the key soil limitations are for feed production.
- Calculate how much fertiliser to apply from a soil test result.
- Able to sample and test soil or plant tissue and determine appropriate inputs to use (fertiliser, lime, gypsum).
- Make investment decisions based on calculating cost and return of fertiliser inputs.
- Develop a nutrient management plan.
- Calculate how much lime to apply and how often.
- Ability to observe the condition of the soil using visual indicators.
- Identify soil type and its suitability for different species.

Work plans were designed to highlight what skill development was planned to occur and the skill development method and results and methodology was to be reported after three events in the midterm milestone report and in the final milestone report.

Group facilitators were familiar with evaluation of knowledge change, but skill development was a new concept. Some groups struggled with what was a skill and how to test skill change. One group facilitator believed they could not attribute the skill change to the program because of the number of other related programs producers were involved in. Skill change was associated with training courses but not necessarily linked to an outcome of a discussion group which was seen to be more about gaining a better understanding of the topic and generating ideas.

While there was agreement for the for the groups to measure skill change and conduct skill audits, there was not a requirement initially to record information for MLA activity reporting. This information started to be requested by MLA and then some groups started to provide information on satisfaction of individual workshops and knowledge change.

Groups approached measuring skill development differently (table 1). In some cases, producers were to self-rate their improvement in knowledge or skill which was is subjective and did not provide objective evidence of improvement.

At the final group session, an ORID style discussion was completed by the group facilitator using the following questions/headings:

- Recap of what was covered in each session.
- What were the key things learnt from each session?
- What unanswered questions do you still have about each topic?
- What are next steps for you to continue to learn about soil constraints & management?

A short evaluation sheet was also used to capture change in participant's confidence, knowledge or skills as a result of participating in the group over the 2 years. This sheet also asked about what soil issue/s on their own property they felt they were able to manage better as a result of participation in the group. The results are reported in table 22.

Table 1. Method of skill and other evaluation measurement used by each group.

Group Name	Skill and other evaluation methods
Holbrook LN	Producers completed an entry survey after the first event and the same survey was used as an exit survey after Event 5 and 6. The survey was developed NSW DPI Development Officer Research Officer who both presented at the first and second events and are leading experts in acid soils research in the region.
Coolac Farmer's group	A survey was developed for each subsequent workshop that specifically dealt with the relevant subject matter. At each of Workshops 2, 3,4 & 5, participants were asked to fill out a questionnaire on the level of knowledge and/or skill in the subject area to be addressed in that workshop. This was collected before the workshop proper commenced. At the conclusion of the workshop, a post-workshop questionnaire was circulated and filled out by most participants. For the sixth workshop a post workshop survey (using Survey Monkey) was used to obtain feedback from respondents.
Tablelands Farming Systems	As above.
Mid Goulburn GSSA	<p>A short evaluation sheet was used after most events to capture the change in participant's confidence, knowledge or skills as a result of attending the event. The evaluation also captured any proposed change in management practices.</p> <p>At the final group session, an ORID (Objective, Reflective, Interpretative, Decisional) style discussion was facilitated using the following questions/headings:</p> <ul style="list-style-type: none"> • Recap of what was covered in each session. • What were the key things learnt from each session? • What unanswered questions do you still have about each topic? • What are next steps for you to continue to learn about soil constraints & management?
Perennial Pasture Systems	Workshops 2 to 4 had before and after question-based surveys. The last session involved a facilitated group evaluation review of project success with four small groups.
Hamilton SFS/BWBL/ Pasture Tech group	Two workshops had before and after survey evaluations using the same questions. Some workshops involved pre and post surveys but with different

	quantitative and qualitative questions which made comparisons difficult. Microsoft forms was mainly used to collect data.
Flinders Island productivity group	Self-rating of their knowledge of the topic area before and after each workshop and recording of intention of what was something new they would try.
Tamar NRM group	Pre and post questions asked before and after workshops 1 to 3 and workshops 4 to 7. Survey monkey was used.
Meningie east healthy soils group	Pre and post project skills audit using survey monkey
Kangaroo Island Productivity group	Pre and post skills survey assessment of skills after each workshop. Post course skills assessment questionnaire.

3.3.1 Pilot discussion groups

Pilot discussion groups were chosen because it was a forum to help build skills in soil management. The discussion group could determine a suitable program to help build skills around topics that the producers were interested in.

The target group for soil discussion groups was producers categorised as “dependables” and “doers” who were most likely to attend the workshops. Both “dependables” and “doers”, like learning from each other. Another group ‘N’ types, NF- Team builders who are focused on big picture thinking were also likely to become engaged through the environmental/social aspects of “Healthy soils.”

Ten pilot soils groups were established across the southern Feedbase area which included a paid group coordinator.

Selection of groups

Group selection occurred by advertising for expressions of interest, (see appendix 8.3). An EOI form was created and sent to interested groups (Appendix 8.4). There was a lot of interest in the program with 38 groups applying (10 NSW, 7 SA, 5 Tas, 16 Vic).

Expressions of interest were collated by the Healthy Soils project manager and an MLA appointed selection panel involving three members separately read each EOI and scored it based on the following ranking criteria shown in table 1.

Geographically spread over the southern feedbase was also considered in the final selection with two groups in Tasmania and South Australia and three each in Victoria and New South Wales to be chosen. The highest ranked group scores from each region were chosen. Both successful and unsuccessful groups were phoned and received a formal written letter.

Two Hamilton based groups who applied where amalgamated with their approval (Cavendish BWBL and SFS Hamilton branch and GSSA Hamilton) technical group who had similar soil constraints and focus areas. This was done after a Gippsland group that was selected decided to withdraw in 2020 following severe drought in 2019.

Table 2. Ranking criteria used in group selection.

Critical factors	Conditions	Score
Within the FAP boundary	Yes	8
	No	0

Appropriate target audience	Most are significant red meat producers	4
	Partly red meat producers (other significant enterprises)	2
	Minimal livestock or small farm	0
	Less than 6 producers listed on EOI	0
Clearly defined and articulated soil focus area	Focus area has been clearly defined	6
	Has multiple focus areas or less defined	2
	No clear description	0
Issue has merit	Highly relevant to many producers	4
	Relevant to some producers	2
	Niche type issue	0
Proposed issue/activities has merit	Scientifically valid, possible to adopt	6
	More experimental but worth exploring	2
	Lacks scientific evidence	0
Track record (demonstrations & extension)	Completed high quality soils activities in the past	4
	Limited experience with soil based activities	2
	No experience	0
Group facilitation & agricultural expertise support	Great track record, knows the topic	4
	Ok track record or relatively inexperienced with groups	2
	No experience	0

Developing work plans

Groups were asked to submit a work plan involving anticipated skill change, activity plans and costings. A template was given to each group. This was used in a formal agreement with SFS. Groups were eligible for funding of up to \$25,000 over the life of the project to cover the costs of a coordinator for organising events, guest speakers, purchasing materials for trials and taking any measurements.

Groups were instructed that workplans could evolve over time and be amended based on landholder feedback rather than being committed at the start of the program. An overview of each group is given in table 3.

Table 3. Pilot discussion group overview

Group Details	Central Location	Soil constraints and issues focus	Group Statistics
Mid Goulburn GSSA, facilitated by local Ag consultant	The mid-Goulburn River catchment of Vic. e.g Seymour, Yea, Kilmore	Key constraints, how to identify soil constraints; soil fertility; soil acidity; soil water infiltration; soil compaction and soil carbon /organic matter in soils derived from sedimentary rock and some granite.	Core group of 12 commercial producers. Operating 7,000 ha Stock numbers 2,530 cattle and 28,400 sheep.
Perennial pasture systems (PPS), facilitated by PPS manager	Upper Wimmera region, Victoria	Soil acidity and fertility. Sub soil constraints.	Core group of 22 core producers. Operating 36,000 ha. Stock numbers 145,000 sheep and 1,100 cattle.

Hamilton branch of SFS /Cavendish BWBL/ Pasture Tech group facilitated by group facilitators.	Cavendish, Victoria	Waterlogging/drainage issues and soil organic carbon.	Core group of 15 producers. Operating 13,323 ha. Stock numbers: 121,300 sheep and 1,900 cattle. Area of crop sown per year was 4,325 ha.
Holbrook Landcare network, facilitated by Landcare co-ordinator	Holbrook, NSW	Soil acidity, in particular subsurface soil acidity	Core group of 12 producers. Operating 21,870 ha of land within a 50 km radius of Holbrook. Stock numbers: 5,750 cows, 1,950 steers, 7,700 total sheep for wool and 28,300 total adult ewes.
Coolac farmer's group facilitated by Graminus Ag consulting	Coolac, NSW	Fertility and soil protection. Improving skills to help soil management.	Core group of 10 members operation 27,800 ha on the southern slopes of NSW. Approximately 5,500 head of cattle and 53,000 sheep.
Tablelands farming Systems facilitated by Graminus Ag consulting	Goulburn, NSW	Fertility and soil protection. Improving skills to help soil management.	Core group of 14 producers operating 12,191 ha of country. Stock numbers: 32,000 sheep, 1250 cattle.
Flinders Island productivity group facilitated by RMCG consulting	Flinders Is, Tas	Soil acidity, salinity, waterlogging, fertility, and soil organic carbon.	Core group of 12 core group members operating 11,000 ha. All participants ran beef cattle. Some producers also ran sheep.
Tamar NRM group, facilitated by Landcare co-ordinator	East Tamar	Drainage, soil biology, soil test interpretation	Core group of 21 core farms operating 7,050 ha. Stock numbers: sheep 31,700 and beef cattle 2,800.
Meningie field livestock and pasture group facilitated by local shire council.	Meningie, SA	Non wetting sands, fertility, and soil pH	Core group of 15 core farm with 20 producers operating about 30,600 ha. Sheep 37,700 and cattle 5,500.
Kangaroo Island productivity group facilitated by SARDI	Kangaroo Island, SA	Soil acidity, understanding soil tests/nutritional requirements for pasture, soil health/biological activity, soil carbon (how to manage/improve)	Core group of 11 farms, 16 core participants, operating 12,000 ha. Stock: Approx. 50,000 sheep.
Total number of core group producers involved			118

How the groups worked

The methodology of the groups was to meet up to six times over a two-year period, with five groups starting in 2019 and the others in 2020. They would use a range of new and existing approaches and products to assess and improve the condition of the soils on their farms. It was envisaged that the

groups would focus on perhaps one or two soil constraints. Each group consisted of a core group made up of 10 to 12 producers but as part of the agreement, each group was to hold at least one open event and evaluate its success.

The group facilitator developed a work plan in consultation with the group, identifying the skills they wished to build and how this was to be achieved. Not all facilitators were skilled in soil management and employed advisors to deliver workshops.

Groups received three payments, the first after submission of the agreement to get started, a midterm report after running of three workshops and a final report at completion. Templates for these reports were provided. The activities of the groups are outlined below. They were varied and provide a good source of information of different approaches used in running the discussion groups.

Skill levels varied within the groups and groups seemed to attract new producers wanting to learn. There was a small but surprising number of producers with alternative views to soil health that were driven by the high appeal of regenerative beliefs rather than the science backed conventional agriculture. They were perhaps attracted to the “Healthy Soils,” name.

Holbrook Landcare Network (HLN)

The HLN group worked with its members to develop a workplan. Producers determined each topic. The group focussed exclusively on soil acidity and the core producers already had reasonable skills and were applying lime. Each workshop built on the skills and topics from the proceeding one. Two were held via zoom webinars.

Table 4. HLN group workshop details

Workshop name and date	Description of activities
Acid Soils - A new look, 25 June 2019	<ul style="list-style-type: none"> • Guest speakers: soil researcher and extension officers from NSW DPI will provide an update on the latest acid soils research including answering questions on: <ul style="list-style-type: none"> ○ Acid soils is an ongoing constraint for both graziers and croppers, how has the economics changed? ○ Is lime the only answer? ○ Incorporation - good idea but how? ○ How can we better manage our soil inputs to give us the best return on investment? • Group discussion: Several landholders shared their perspective on the economics of lime
Acid Soils Initiative workshop 13 Feb 2020	<ul style="list-style-type: none"> • This workshop built on soil acidification management knowledge from first workshop, further explored local issues relating to sub soil acidity and acid stratification in local soils. • Guest speaker: NSW DPI extension and research officer provided an update on the local acid soil trial sites. Topics also covered: <ul style="list-style-type: none"> ○ Identifying and setting appropriate pH trigger points for implement active management strategies ○ Do current liming practices address acid soil constraints below 5cm? ○ How can producers better manage soil inputs to give a better return on investment?

How to get the most out of your soil test results. 11 June 2020 (open event)	<ul style="list-style-type: none"> • Online webinar • Guest speaker: soil scientist from NSW DPI on: <ul style="list-style-type: none"> ○ How to get more out of your soil tests, ○ how to revise your soil test program, ○ when, how and where should samples be taken, what to do with your results. • Group discussion around variability in the landscape and how information can be used to formulate a sampling strategy. • Guest speaker: advisor from CSBP soil and plant laboratory demonstrated and discussed CSBP Decipher Ag, a free web based program that recorded soil sampling data in one location, and how you can use and share your data.
Soil acidity and effects in the root zone workshop 27 July 2020	<ul style="list-style-type: none"> • Online webinar • Guest speaker: Plant researcher, DPI, NSW on: <ul style="list-style-type: none"> ○ Soil acidity effects on the ability of plant roots to grow and function ○ Acid tolerant species but do they reach their potential production. ○ Soil testing 0-10cm can mask acid soil layers. ○ Liming to ameliorate aluminium toxicity.
Economics of lime for cropping and grazing systems Zoom 27/5/21 (open event)	<ul style="list-style-type: none"> • Guest speaker: consultant from Agrista, discussed the economics of lime for cropping and grazing systems. • Guest speaker: soil scientist from NSW DPI, discussed liming acid soils for livestock production. • Guest speaker: Pasture advisor from NSW DPI provided an update on the local acid soil trial sites and strategies for local conditions based on local soil data. • Paddock walk: at the local acid soil trial site.
Wrap up of the project - where to next 21 June 2021	<ul style="list-style-type: none"> • A wrap up of the MLA project, what were the findings, what worked for participants, what didn't, where to next. Opportunity for participants to be part of the next MLA PDS - Acid soils in pasture systems.

Coolac farmers group

At the first session, a feedback form was completed by a minority of participants but did not provide much feedback on the actual workshop content. Options of different topics and skills were later discussed, and the groups identified those issues most relevant to them. The only set topic was on experimenting on farm.

Table 5. Coolac farmers group workshop details

Workshop name and date	Description of activities
Workshop name and date	Description of activities
Assessing Ground Cover 17/12/2019	Location: Cooininee near Coolac, Southern NSW. <ul style="list-style-type: none"> • Brief presentation on management and measurement of ground cover • Field exercise where each participant calibrated their ability to visually estimate ground cover.

	<ul style="list-style-type: none"> • Producers then estimated ground cover over a wider area in the paddock. • The result of individual calibrations and paddock estimations were presented and discussed. • Discussion centred around the importance of monitoring ground cover when droughts were developing. In particular, the role of drought lots was widely discussed. • A fact sheet was developed for the event and circulated on the day.
Soil Test Interpretation 29/7/20 (Open event)	<p>The event venue near Gunning consisted of three parts:</p> <ol style="list-style-type: none"> 1.Presentation by Emeritus Prof. from UNE, on management of soil sulphur 2.Presentation by group facilitator on interpreting common soil tests. A laminated one-page guide to soil test interpretation was circulated to participants 3.Scenario exercises to develop interpretation skills
Soil Profile Interpretation 1 Soil Texture 19/11/20	<ul style="list-style-type: none"> • Guest speaker: Soil Scientist from CSU and NSW DPI presented an introduction to soil profile interpretation. • Soil texture activity: hands-on skill session focussed on determination of soil texture. • Using a set of standards participants learned to tell the difference between the common texture classes.
Soil Profile Interpretation 2 Sub Soil Limitations. 21/4/21	<ul style="list-style-type: none"> • Prior to this workshop, soils were sampled on the host property - cores were taken to 60 cm depth and analysed for pH and exchangeable cations. • Facilitator presentation of results of host property soils with an emphasis on factors driving soil acidification and historical context. • Guest speaker: Soil scientist from CSU & NSW DPI • field visit to the sites originally cored. Soils were cored again and participants encouraged to further exercise their soil texture classification skills.
Experimenting On-Farm 22/7/2021	<p>The aim of this workshop was twofold:</p> <ul style="list-style-type: none"> • Firstly, to increase skill level of participants with respect to recognising proper experimentation from an evidence-based perspective. • Secondly to demonstrate steps involved in setting up an on-farm trial. <p>The event included</p> <ul style="list-style-type: none"> • Facilitator presentation covered the basics of replication and randomisation in on experimentation as related to soil/fertiliser trials. This concluded with planning for an experiment that the group would implement in the field. • Field activity: the group convened in a paddock at a nearby property to mark out a trial and apply treatments (fertilisers at various rates).
Using Excel to manipulate and store soil data. 14/2/2022	<p>Aim was improving Excel skills in spreadsheeting. Participants brought their own computer with excel on it.</p> <ul style="list-style-type: none"> • List of exercises developed, ranging from a simple introduction to spreadsheeting to through basic operations – mathematical,

	<p>copying and pasting etc. with further complexity introduced – sorting data, use of index and match, use of pivot tables and array formulas.</p> <ul style="list-style-type: none"> • Activities: participants worked through each exercise at their own pace guided by two experienced users.
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Tablelands farming Systems group

The Tablelands groups had the same topics of interest as the Coolac group and subsequently was run using the same approaches and activities. Having the same approach for each group provided opportunity for feedback and improvements to be made to the following group’s workshop.

Table 6. Tablelands farming systems group workshop details

Workshop name and date	Description of activities
Assessing Ground Cover. 5/2/2020.	Location: “Merrill” near Gunning in southern Tablelands. As described in Coolac.
Soil Test Interpretation 28/7/20 (Open event)	As described in Coolac.
Soil Profile Interpretation 1 Soil Texture 20/11/20	As described in Coolac.
Soil Profile Interpretation 2 Sub Soil Limitations. 20/4/21	As described in Coolac.
Experimenting On-Farm. 23/6/2021	As described in Coolac.
Using Excel to manipulate and store soils data 10/2/2022	As described in Coolac.

Mid Goulburn GSSA (Grassland Society of Southern Australia)

The MLA and GSSA Pasture Update Fertilisers & Lime – “facts & fiction” that was held in Euroa on March 2019 was used to create awareness of project and recruit participants from mid-Goulburn branch area. The first session on planning contained a facilitated session aimed at finding out what issues/topics (relating to soil management) the group were interested in exploring and these topics were themed and developed into work program.

The sessions were designed to build on information/skills from previous session rather than be stand-alone topics.

Soil profile assessments (0-60cm) were undertaken on three group members farms that were visited. Producers were able to look at the soil profile cores and assess physical properties, look for root growth down the profile and had the laboratory test results (from samples taken prior to each session) to guide the assessment and discussion. As a result of this fact sheets called “Know your soils” were produced for each of these different soil types.

Fertiliser test strip kits were made available after Session 1 for producers to evaluate the impact of different fertilisers (P, K, S, moly), lime, nitrogen or gibberellic acid on their own pastures. Several group members set up fertiliser test strip which they followed through the year and took pasture

assessments (see MLA Friday Feedback article on the Plunkett family). A “Setting up fertiliser test strip” fact sheet with instructions was provided to group members and SFS to distribute to other Healthy Soil groups who were interested. A video (You-tube) was also produced to demonstrate how to set up test strips.

Table 7. Mid Goulburn GSSA group workshop details

Workshop name and date	Description of activities
Planning Session at Seymour AgVic 1/5/2019	Focus was on: <ul style="list-style-type: none"> • Soil testing - starting point to collect objective information about the state of soils on your farm. • Refining your fertiliser program – planning requirements for different paddocks. • Activity: Demonstration of <i>Decipher Go</i> software to collate historical soil test information and analyse trends by CSBP extension officer and program developer from, Decipher. • Guest speaker: Benefit/cost of mapping nutrient & pH variation within a paddock to use variable fertiliser & lime rates with speakers from Precision Agriculture. • Group facilitator presentation: Using soil test/leaf test/fert test strip data along with other paddock information (pasture species, stocking rates) to prioritise where to spend your fertiliser/lime budget to optimise return on investment. • Facilitated discussion on the group’s main concerns relating to soil health and soil factors they thought might be constraining pasture production. This information was used to develop a program of topics, tools and skill training to be covered over the next sessions.
Understanding your soil profile 28/8/2019	Focus was on: <ul style="list-style-type: none"> • Identifying possible constraints • Variability in nutrients & pH within paddocks – hill country Topics on management of hill country covered by facilitator, AgVic extension officer and Precision Agriculture included: <ul style="list-style-type: none"> • Soil assessment (top & subsoil) in the paddock – using “Soil Profile checklist.” developed by group facilitator to guide producers through the relevant tests to do for each soil layer to identify if there were any constraining factor and what the options were for dealing with it. • Identifying soil constraints to pasture growth and water infiltration in sedimentary hill country. • Indicators of healthy soils. • Soil test interpretation. • Presentation: Nutrient & pH maps prepared by Precision Agriculture. • Farm visit: Kilmore East.

<p>Soil test interpretation & planning fertiliser/lime requirements.</p> <p>6/11/2019</p>	<p>Topics covered by facilitator and AgVic extension officer:</p> <ul style="list-style-type: none"> • Soil test interpretation (producer’s interpret own soil test results) and planning fertiliser/lime requirements. • Cost comparison of different products. • Soil profile assessment (granite soil) and management options using case study factsheet. • Farm Visit: Avenel, granite soil profile assessment (granite soil) & management options and inspection of fertiliser test strip trial.
<p>What carbon farming & carbon neutral means & options to achieve it.</p> <p>Carbon Farming workshop Open event</p> <p>6/12/2019</p>	<p>Seminar topics:</p> <ul style="list-style-type: none"> • “Going carbon neutral - The Red Meat Industry’s CN30 initiative” - Supply Chain Sustainability Innovation Manager, MLA • “How to make the farm carbon neutral – where do methane, nitrous oxide, trees and soil carbon all fit in?”- Professor of Livestock Production Systems & Director of the Primary Industries Climate Challenges, University of Melbourne. • “Whole farm approach to reducing emissions intensity,” Managing Director Lawsons Angus
<p>Soil management on alluvial flats and sedimentary hills</p> <p>14/12/2021</p>	<p>Topics covered by facilitator and AgVic extension officer:</p> <ul style="list-style-type: none"> • Soil profile assessment (alluvial flat & sedimentary hill soil) and management options. • Soil acidity - subsoil acidity • Soil requirements for different species. • Leaf analysis <p>Activities:</p> <ul style="list-style-type: none"> • Farm visit: Whiteheads Creek • Soil assessment (topsoil & sub soil) out in the paddock using “Soil Profile checklist.” • Identifying soil constraints to pasture growth & water infiltration in sedimentary hill country & creek flat using case study factsheet. • Soil test interpretation • Lime rates
<p>Soil biology Review of program</p> <p>28/2/2022</p>	<ul style="list-style-type: none"> • Guest speaker on soil biology -What species are there, how to measure them, how to encourage the beneficial ones – Microbiologist, University of Melbourne. • Review/evaluation using (ORID technique) to evaluate the whole program.

Perennial Pasture Systems (PPS)

A panel group from the PPS group overviewed the project and developed the work plan. Most sessions were recorded and made available to group members who were unable to attend specific workshops. All workshops were held inside as the group felt producers are working in paddocks every day and would only do paddock visits if there was something of value to be seen. Soil cores and materials needed for activities were brought to the workshop offering some time saving in having to also visit paddocks. This group had planned to make their fifth workshop open to the public, but this did not occur due to Covid restrictions on numbers.

Table 8. PPS group workshop details

Workshop name and date	Description of activities
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What lies beneath, soil types and constraints 24/7/19	<ul style="list-style-type: none"> • Guest speaker: Soil scientist from Federation University. • Inspection of 1m soil cores taken from common sites
Soil constraints to legume production 21/8/19	<ul style="list-style-type: none"> • Guest speaker: from NSW DPI • Practical identification of nodulation level.
Soil acidity and lime use 19/3/20	<ul style="list-style-type: none"> • Guest speaker: Soil acidity researcher from Southern Farming Systems (SFS) • How to use pH field kit and demonstration. • Participants brought in their own soil, and all given a field test kit to identify pH. • Sharing of visual indicator posters and images indicating soil acidity
Soil test results – How to read them and what to do with the information. 3/3/21	<ul style="list-style-type: none"> • Guest speakers: Agricultural consultant and soil scientist Federation Uni • Participants collected and brought in and worked through own soil test. • Launch of new farm soil test data hub.
Soil biology and testing 8/4/21	<ul style="list-style-type: none"> • Guest speaker: Microbial ecologist, Agriculture Victoria • Due to Covid, the guest speaker presented to the group remotely and group facilitator organised questions and discussion.
Soil carbon. Review and feedback session 14/7/21	<ul style="list-style-type: none"> • Guest speaker: Agricultural consultant on soil organic carbon, how much do you need, testing for, monitoring and what to do to build. • Review of the project.

Hamilton branch of SFS /Cavendish BWBL/ Pasture Tech

An initial facilitated meeting (February 2020) attended by 11 producers was used to develop shared agreement in what constraints to focus on, what they wanted to know or be able to do better and their ideas they had to help achieve this, in terms of guest speakers, topics, activities and small-scale activities.

The facilitation process used identified the group had two main focus areas: soil organic carbon and waterlogging. producers wanted to be able to:

- Understand what benefits soil carbon may offer in their farming system
- Measure and monitor soil carbon
- Understand what you can achieve
- Know what options are to build carbon

For waterlogging producers wanted to be able to:

- Identify at risk paddocks or at risk areas
- Quantify how much of an issue it is
- Better manage wet areas

The group identified the opportunity to have a monitoring area on a participants farm to show the effects of different management on building soil organic carbon. Two paddocks separated by a road were used. One had been using natural fertilisers, reactive rock phosphate, dolomite, chook manure for 7 years, rotational grazing versus conventional area which has been set stocked and synthetic

fertilisers. (Within the areas, there are also an area cut for hay). Precision Agriculture where contracted to map soil properties on 10 hectares of each of the adjacent paddocks.

This group was severely impacted by Covid. The first two planned face to face events were replaced by webinars in 2020 and continual lockdowns in 2021 eroded confidence in when activities could be run. There was nearly a 12 month gap between the third and fourth workshop.

The running of the last session is worth noting. It involved the guest speaker providing a short introduction to the topic, then the group was asked what they wanted to get out of the morning. This was written up on butcher's paper. The guest speaker was able to pull information from his previous presentations to discuss the key points in further detail. This enabled the workshop to be led by the group and their questions. At the end of the session group facilitator reflected on each item on the butcher's paper with the group and checked whether they were satisfied the question had been answered or clarified the take home messages.

Table 9. Hamilton group workshop details

Workshop name and date	Description of activities
Soil Carbon Webinar April 2020	<ul style="list-style-type: none"> • Guest speaker: Ag consultant presented on: <ul style="list-style-type: none"> ○ How do you know if your soil carbon level is any good or not and whether it's worth building? ○ How does carbon get built up over time and how long does it take to build soil carbon? ○ How often should we look to measure changes? ○ What's the status of carbon in grazing systems? Is it cost effective to build soil carbon in a grazing system? ○ What are some tactics graziers should consider building soil carbon?
Waterlogging Webinar June 2020	<ul style="list-style-type: none"> • Guest speaker: Ag consultant presented on: <ul style="list-style-type: none"> ○ Influences of waterlogging ○ What's typical of the district and how it is measured? ○ What are the risks? ○ What's the impact? ○ What can we do about it?
Drainage session at Digital Innovations Smart Agriculture (DISA) workshop May 2021 (open event)	<ul style="list-style-type: none"> • The group collaborated with the local DISA festival committee to engage a highly regarded workshop speaker for the festival program. • The group identified that they wanted to learn more around using technology to manage waterlogging by implementing drainage. • Guest speaker: Drainage specialist from Southern Precision spoke about how to analyse, design, and implement drainage options. • Answering many questions (as a group and one on one) about drainage options.

Soil Carbon Workshop, November 2021	<ul style="list-style-type: none"> ● Guest speakers: SFS extension officer, carbon manager from PrecisionAg and the farm’s producer. <ul style="list-style-type: none"> ○ Reinforcement of key messages from initial soil carbon workshop ○ Benefits of building soil carbon ○ How to build soil carbon? ○ Understand what you can achieve. ○ How to measure and monitor Carbon levels? ● Discussed demonstration site and Precision Agriculture testing results, answering can we influence soil carbon with management, and can we measure change?
Dirt and Water field day March 2022 (open event)	<ul style="list-style-type: none"> ● Guest speaker: farm producer and soils extension officer from Ag Vic. <ul style="list-style-type: none"> ○ Paddock session to demonstrate and discuss: ○ Soil interactions – water infiltration, water holding capacity ○ Sub soil amelioration – Soil pits, paddock conditions pre and post treatment, why sub soil amelioration? results to date, machinery ● Guest speaker: Southern Precision consultant on where to start with drainage? Included mapping waterflow working out drainage options. ● Guest speaker: Wolverine ditcher contractor on “What are its’ capabilities?” ● Demonstration of the Wolverine in action to dig drains.
Sustainable Soil Organic Carbon workshop March 2022	<ul style="list-style-type: none"> ● Guest speaker: Ag consultant to discuss: <ul style="list-style-type: none"> ○ How do we maintain a sustainable soil carbon level in our farming system, when there is so many variables? ○ What can we control? ○ Importance of soil organic matter in a healthy farming system ○ Nutrient cycling

Flinders Island productivity group

Feedback from group producers helped the facilitator develop a work plan and further topics were identified during the project such as:

- Dealing with salinity and sodicity
- Relationships between soil conditions, pastures, and animal health
- Soil carbon, carbon sequestration and emissions
- Bringing information from a range of sources together for farm planning and decision making

The group used a combination of delivery methods and four workshops included field walks. The days were open to all Flinders Island producer. Producers were provided with support resources, which could be of value to other Tasmanian producers. It should be noted that there were additional costs in travel and time to bring in guest speakers to the island via a ferry or plane.

Table 10. Flinders Island productivity group workshop details

Workshop name and date	Description of activities
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<p>Soil assessment (pH, structure and soil biology) 29/11/19</p>	<ul style="list-style-type: none"> • Workshop: How to visually assess indicators of soil condition and health. • Roundtable discussion on soil health aspects. • Field walk: Green Valley Farm where visual and in field soil assessment methods were demonstrated, discussed, and trialled by participants. Used the Little River Landcare Group Inc., NSW RASH kit (Rapid assessment of soil health) and manual.
<p>Soil test interpretation Pt 1, salinity and waterlogging, pastures and forage. 11/2/2020</p>	<ul style="list-style-type: none"> • Workshop: How to read a soil test, how to approach a farm nutrient budget and how to assess fertiliser requirements. • Field walk: Killarney farm to assess a recently renovated paddock that was affected by waterlogging and salinity. • Discussion of how to identify and manage salinity, diversity in pasture species, fodder crops and pasture weed management. • Handouts included: A guide to soil test interpretation, Forage shrubs, Pasture weeds and pastures, Map of salinity affected areas on Flinders, assessing saline areas, Measuring salinity, Managing salinity, Diagnosing and managing waterlogging. • Other resources emailed: Soil test interpretation guide. https://www.soilwealth.com.au/resources/fact-sheets/soil-nutrition-and-compost/soil-testing-and-interpretation-for-vegetable-crops-a-guide/. Even though the guide was produced for vegetable growers, the clear format and easy to read content was considered helpful for livestock producers.
<p>What can emissions tell us about livestock productivity, pasture / feed quality and soil health? How to improve productivity based on results of an emission assessment? 27/11/2020</p>	<ul style="list-style-type: none"> • Workshop guest speaker: Tamar NRM on Panorama farm emissions case study. • Field walk: to talk further about management approaches used at the Panorama case study farm to reduce emissions and look after soil health. • Handouts: <ul style="list-style-type: none"> ○ Emission Reduction Fund Factsheets: ‘Beef cattle herd management’, soil carbon and ‘Sequestering carbon in soil in grazing systems’ ○ Extension materials produced for Tasmania under the Emission Reduction Fund’s Extension and Outreach program: http://www.tasfarmingfutures.com.au/tasfarmingfuturesabout ○ RMCG 2014 booklet “Making Cent\$ from Carbon” ○ Reducing livestock emissions case study as presentation: Flinders Island Carbon Audit, Panorama farm greenhouse gas emissions.
<p>Soil test interpretation refresher. Trace elements when to use. 18/3/2021</p>	<ul style="list-style-type: none"> • Group met online with guest speaker from RMCG, for the soil test interpretation workshop, landholder had sent soil test they wanted to understand better beforehand; reports were brought up on the screen and discussed. • Facilitated face to face session on trace elements. • Handouts included: <ul style="list-style-type: none"> ○ Map of Flinders showing soil associations and property boundaries and accompanying descriptions, land capability report ○ Nutrient removal rates by pastures, fodder and livestock (table) ○ Factsheets on copper supplements and costings, grass tetany ○ PPT presentation slides “Linking soil and animal health”

Major soil types on Flinders Island and, and how to best use them for grazing 24/5/2021	<ul style="list-style-type: none"> • Workshop discussion: on specific challenges related to the major soil types used by grazing enterprises. • Field walk: at “Coral Glen” and “Panorama” farms. The field walks were designed to cover the main soil types and visual investigation of soil profiles and soil tests and pastures to discuss whether, how and why management approaches may be adjusted to maximise soil health and productivity.
Using soil, land capability and other spatial data to make management decisions 18/10/2021	<ul style="list-style-type: none"> • Guest speakers: From RMCG • Each landholder brought a laptop or tablet to access LISTmap and work on their own farm maps. • Land Information Systems Tasmania, LISTmap training – Farm mapping of soils, land capability, risks and using spatial datasets including natural resources, salinity acid sulphate soils, property boundaries (cadastre), aerial imagery and survey information. (LISTmap is a free Tasmanian online mapping application that allows landholders to create and update their own customised property maps).

Meningie – Field Livestock and Pasture Group

The facilitators developed the work plan in conjunction with producer consultation. Workshops generally involved a farm walk, and a demonstration site was established for the group to follow progress of and discuss results.

Table 11. Meningie field livestock and pasture group workshop details

Workshop name and date	Description of activities
Soil Innovation 10/5/2019	<ul style="list-style-type: none"> • Introduction to program, before skill assessment. • Field Trip to look at soil improvement technologies. • Topics included: EM38 mapping, soil cores across soil types, deep ripping, plozza plough, and spader demonstration. • Discussion of local soil limitations.
Soil test interpretation 30/10/2019	<ul style="list-style-type: none"> • Farm walk: inspection of deep ripping test strips, comparison of soil test parameters under native vegetation and dryland lucerne, salt tolerant dryland lucerne, understanding soil pH & soil test interpretation, relating soil test parameters to pasture production. • Activity: assessing soil acidity. Each producer provided with a soil acidity kit and resources.

<p>Soil test interpretation 5/8/2020 (Open event)</p>	<ul style="list-style-type: none"> • Guest speaker senior soil scientist from PIRSA Rural Solutions. • Farm walk: Included three soil pits across a range of soil types, soil laboratory analysis and interpretation with • Activity: understanding / being able to read and interpret a soil test. Some farm businesses provided a soil sample that was analysed at an accredited laboratory and worked through the soil test in the workshop. • This information was added to and contrasted with the soil test results from the soil pits. • Discussion: of soil constraints, physical & chemical features, water holding capacity, and optimum management for feed production. • Demonstration: Soil acidity demonstration site, and interpretation of Veris and EM mapping.
<p>Soil organic carbon 4/3/2021</p>	<ul style="list-style-type: none"> • Guest Speaker: PIRSA Senior Soils Consultant – Soil carbon focus • Monitoring and interpretation workshop session about the potential to build carbon and soil nutrition in local soils under a range of land uses. Included information on a range of new soils tests available through APAL Laboratories, and interpretation of soil tests taken by participating landholders on a range of soil types and land uses. • Group discussion: of management and soil amelioration options on sandy soils to optimise feed production. Including paddock components • Activity - understanding / being able to read and interpret a soil carbon components of soil tests, and what this means in our local landscape. Soil test discussion results from participating farm businesses. • Inspection: Look at several soil profiles to discuss soil carbon, and soil limitations to pasture production.
<p>Establishment of Aqua till demonstration site 18/8/2021</p>	<ul style="list-style-type: none"> • Aquatill is a form of direct drill seeding technology using a jet of high pressure water to form a seed bed as a minimum disturbance form of seeding in sandy soils susceptible to erosion and organic carbon loss. • At “Green Plains” farm a demonstration site with Coorong Tatiara Local Action Plan and the SA No Till Farmers Association was set up comparing the establishment of the Aquatill Machine (SANTFA) with a SA Bar Double Disc Seeder (Angas Agriservices). • The demonstration site also incorporated four treatments: <ul style="list-style-type: none"> ○ Control – using water only ○ UAN – liquid nitrogen fertiliser ○ Seed wet – wetting agent ○ Liquid trace elements • Group facilitator carried out site monitoring including emergence counts and photo points.
<p>Improving grazing production on non-wetting sands 23rd September 2021 (Open event)</p>	<ul style="list-style-type: none"> • Guest Speaker: PIRSA Senior Soils Consultant – Non wetting sands focus • Discussion: of three soil pits across the landscape identifying soil chemical and physical limitations to plant growth and encouraged the group to consider what amelioration techniques they would like to try during the roll out of the MLA Improving grazing production on non-wetting sands project. This included revegetation to reclaim saline areas and weather station telemetry for weather, groundwater, soil moisture, soil salinity monitoring.

Kangaroo Island productivity group

After agreements were finalised, most group members were burnt out by the 2019 summer bush fires on Kangaroo Island. This delayed the start of the project.

The facilitator developed the work plan in conjunction with producer consultation and to fit in with another soil acidity project funded by federal government. This enabled the group to provide funds to the producers to implement a soil management project that would be utilised through workshops and field visits.

All participants were allocated \$500 to undertake a mini project on their property (\$2000 of Healthy soil project funds but majority from Australian government Smart farms project). Almost all participants chose to focus on soil nutrition to gain a greater understanding of their soil pH and soil nutritional status.

Table 12. Kangaroo Island productivity group workshop details

Workshop name and date	Description of activities
Soils 101 (note workshop 1A and B run twice due to impact of fires and covid) June 2019	Farm visit: 1A Parndana 1B Dudley Activities – Participants were involved in hand texturing of soil, pH testing, soil descriptions, inspection of soil pit.
Soil testing and set up of producer soil investigations September 2019	Soil investigations used for discussion in workshops and farm visits.
Soil pH and nutrient mapping, soil cover/erosion Oct 2019	Activities – PrecisionAg soil mapping, ID and management of soil pH, soil testing and interpretation of results. Maintaining ground cover/grazing management. Farm walk: Good on property discussion with the landholder re good farm management practices to improve soil health.
What are our weeds telling us in relation to soil health? Aug 2020	Discussion: Management of soil constraints. Farm walk: To visually ID weeds and look at soil constraints
Soil biology (open event) Oct 2020	Guest Speaker: soil microbiologist Agriculture Victoria: <ul style="list-style-type: none"> • knowing “who is there” in the soil and “what they are doing” • soil biological testing its value and interpretation • practices that help soil biology and build carbon. Activity: Great Undies challenge. Participants brought along “undies” they had buried to monitor soil biological activity which generated a good discussion with the presenter about soil health, biological activity and what had happened to the ‘undies’
Soil Carbon and soil pH + participant projects (open event) May 2021	Guest Speaker: From Primary Industries & Regions South Australia (PIRSA) discussing results from KI soil carbon and pH benchmark sites (what’s the data telling us). Reporting on individual soil projects.

Tamar NRM (Natural Resource Management) group

This group was overseen by an appointed technical working group who met on four occasions to advise on the project direction. The group asked if they could split the discussion groups into two lots of three. They believed from experience, that producers would commit to attending three workshops but not necessarily six workshops. Also with repeating events, producers that missed a topic in the first round could pick it up in the second round. As this was a pilot, this approach was accepted.

The second set of three workshops saw variations (as requested from feedback on the first set of workshops). This group used multiple farm venues to add variety to management techniques producers were exposed to.

There were nine presenters, some presenting at two or more events. The host landholders providing background introductions to the field day properties. The open event was held in October 2019.

Table 13. Tamar NRM group workshop details

Workshop name and date	Description of activities
Introduction soils 101 9/8/2019	<ul style="list-style-type: none"> • Producer skills identified session • Guest speaker: From DPIPW on: <ul style="list-style-type: none"> ○ Doing pH tests. ○ What makes a good soil? ○ What are the important soil physical characteristics? • Activity: Examination of soil samples at the shearing shed • Field Work: Demonstrate the DPIPW Core Drilling Rig Examine soil core sample(s): Undertake some structural assessments of soil. • Facilitated session: Discuss the skills they wanted to develop, add more, and discuss how they might build these skills. Gathered interest in small trial/demonstration.
Wet soil management 16/8/2019	<ul style="list-style-type: none"> • Visit Karoola farm and discuss first-hand what works in the Tamar Valley. • Guest speaker: University of Tasmania on: <ul style="list-style-type: none"> ○ Improving wet soils drainage / Living Soil Biological / Duplex soils and other challenges • Activity: Ways to measure/monitor soil (practical and hands on)
Soil testing and interpretation 23/8/2019	<ul style="list-style-type: none"> • Guest speakers: Tamar NRM and RM consulting group, and DPIPW on: <ul style="list-style-type: none"> ○ Enterprise suitability mapping, limitations, online resources, temperature sensors, etc. ○ The role of soils in pasture renovation ○ Interpreting soil reports and feed tests ○ Liming. ○ Nutrient testing and fertiliser budgeting for better soils outcomes and improved production. • Field Tests - Ways to measure/monitor soil (practical and hands on) • Discussion: Hear from the Landholders • Facilitation: Revisit the skills they wanted to develop, evaluate if they built these skills and to what extent. Exit interviews/surveys flagged.

<p>Local soils and soil health (Open event) 4/10/2019</p>	<ul style="list-style-type: none"> • Guest speaker: Tas Agronomy Plus on: <ul style="list-style-type: none"> ○ Overview of demonstration project: The Mosaic of soils occurring in the Tamar Valley. Record paddock by paddock variation and treatments necessary for improving soil health. ○ Land Capability and online resources • Guest speaker: Botanical Resources Australia on mixed species cover cropping for improving soil health. <ul style="list-style-type: none"> ○ Farm Visit: Wenlock farm covering soil mapping and land class fencing plans. • Facilitation: A session discussing the day and to understand what skills you want to develop.
<p>Introduction soils 101 Part and wet soil management 20/8/2020</p>	<ul style="list-style-type: none"> • Participant skills audit undertaken • Guest speaker: Soil scientist from Utas on: <ul style="list-style-type: none"> ○ Improving wet soils drainage / Living Soil Biological / Duplex soils and other challenges ○ Interpreting a soil report. • Activity: Bring a soil sample for examination • Field visit: to Underwood to discuss drainage and its application caring for your soils; correcting soil fertility deficiencies, nutrient testing and fertiliser/amendments budgeting for better soils and productive outcomes; protecting waterways (leaching, landslip).
<p>Soil suitability, testing and soil biology 10/9/2020</p>	<ul style="list-style-type: none"> • Guest speaker: on: <ul style="list-style-type: none"> ○ Soils and Microbiology intro ○ Soils and pasture renovation ○ Soil samples ○ Enterprise Suitability Mapping, Limitations, Online Resources, Land Capability-List Map • Discussion group session hearing from the Landholders • Activity: Field tests - ways to measure/monitor soil (practical and hands on) • Farm visit at "Oakbank" property to visit paddock sampled for microbiology and visit pasture renovation projects with pasture consultant.
<p>Soil biology Part 2 24/9/2020</p>	<ul style="list-style-type: none"> • Guest speaker: Tas Agronomy Plus on soils and biology (part 2); the complex interactions between soil structure and soil biology, the value of a biologically active soil and diversity in pasture; • Group discussion • Farm visit: revisit soil trial at "Wenlock" property • Skills audit revisited. • Facilitated reflection on project.

3.3.3 Community of practice

The objective of the soils community of practice was to provide communication structures between groups and get groups and producers to exchange ideas, learnings, and insights. This objective was met by running of a regional event and a website page.

Regional event

The regional event called "Sharing Information on Soils," was held online on July 27th, 2021. See appendix 8.5 for the flyer invite. Three topics featured in the webinar which reflected common

interests from the three groups, fertilisers (alternate and conventional), soil acidity and soil organic carbon. These topics were narrowed down as the top common themes, groups were focusing on. Each topic had a main presenter discussing a given scenario and answering questions from the audience.

Producer representatives from six groups participated by sharing some of their key learnings and asking any unanswered questions the group had for redress by the main speaker. Therefore, each topic was followed by two short producer presentations. The event was delivered online due to the difficulty in getting producers together because of border lockdowns.

The presenters were:

1. Soil Fertilisers:

Main Presenter: Dr Mark Farrell, Principal Research Scientist at CSIRO Agriculture & Food
Producer Presenters were from GSSA mid Goulburn and Coolac Farmers group.

2. Soil Acidity:

Main Presenter: Dr Jason Condon, Senior Soil Scientist with Charles Sturt University
Producer Presenters were from the PPS group and Holbrook Landcare Network

3. Soil organic carbon:

Main Presenter: Dr Sue Orgill, NSW DPI

Producer Presenters were from the Hamilton Tech Group and Meningie field livestock and pasture group.

The webinar was split into three sections and made publicly available and advertised through SFS EUpdate, SFS tweet and via the participating 10 soil groups. They are accessible through SFS YouTube channel:

<https://youtube.com/playlist?list=PLK9krBQH4BIOYMFvaEdyedLZ9yb9egnL4>

To help the producers present, the group facilitators helped them fill out a template containing the following questions:

Recap of what was covered in each session (dot points, 1-2 lines max for each session).

What were the key insights (key learnings) from each session? (Split into three types of responses).

What I can easily do something about?

What I could do something about but it will take time?

What I can't do much about – just have to manage around it.

What unanswered questions do we still have about each topic covered?

Some groups also used this methodology in their final workshop evaluations.

Sharing of resources

Emails were used to keep facilitators up to date with useful products for sharing with their producer members until a resource sharing page was created on the SFS web site under the Healthy soils project. The project page allows the storage of useful resources created during the project and products the groups have nominated to share with each other. The webpage was made available in early 2022 and shared with the producer group members.

Having the webpage on SFS allows the site to be maintained and updated and when new information is added it is sent to group facilitators. The site is open to the public.

3.3.4 Case studies

The creation of case studies was for producers to share their learnings, successes, and failures with soil management with other producers with the objective of getting other producers to adopt similar practices. Therefore, the case studies were used for the purpose of raising awareness and building knowledge and confidence through the experiences of the case study producer. The case studies were to be a representation of the groups focus area and reflect what the group were working on.

Information collected from the producer was focused on:

- What you did and why? The Recipe.
- What was the benefit and how did you quantify the benefit?
 - What tests did you do?
 - What evidence based information do you have that it worked or didn't work?
 - How much did it cost to do?

The stories were to be published in MLA's Feedback magazine, the Weekly news update or given to regional papers. Two case studies were written per group involving two different producers. These were outsourced to journalists to write. They were interviewed over the phone and their stories written.

Facilitators were given the task for finding suitable and willing producers to participate. The approach to finding suitable producer stories did not always work well. Sometimes the volunteers were new to farming and so possibly felt compelled to assist or wanting to promote management practices they were passionate about but hadn't necessarily been backed by science.

A better approach in hindsight would have been for the two key messages to be established between the group facilitator and the program manager and then the most qualified producer approached to have a case study written. This would allow the producers who had good examples of soil management to be featured.

3.3.5 Where to next for groups

One of the concerns for the groups, was that groups formed to undertake the program might abruptly finish at the completion of the discussion group and lose any momentum gained in support for continued learning. It was desirable for the groups and individuals to continue in some capacity to further their skill development, preferably becoming enrolled in Profitable Grazing Systems (PGS) programs. Therefore there was a deliverable to encourage groups members to engage in other MLA learning programs such as PGS training packages.

Initially plans were made to visit all groups and speak to producers, but this only occurred with Victorian based groups where the project manager was based due to travel restrictions from Covid.

The opportunities for potential continued support by MLA were provided to facilitators via email and asked to share with their producer members. The main opportunities promoted was either participate in an MLA producer demonstration site (PDS) or undertake a producer training package through PGS. The most relevant PGS training package was PayDirt but other PGS courses were also promoted although not publicly yet available including "Resowing for success" and pasture manipulation.

Some facilitators who were also consultants were not keen on their groups undertaking the PayDirt training package. They felt that soil testing and interpretation was their “bread and butter”, and that training of producers would remove the need for this service. However, they were happy to promote other PGS courses and even become coaches.

4 Results

4.1 Visual assessment tool

The components of the visual assessment tool which make it a successful product are twofold:

- A simple logical process of assessment producers and agronomists can use.
- The use of high-quality indicator images.

The high-quality indicator images were difficult to find or access despite that everyone has access to a phone to take good photos. Visual indicator photos are a valuable extension resource. Having the photos has allowed creation of multiple products (posters, booklets, online training) which are discussed below.

Some visual indicators used link to FIP research (Managing soil borne root disease project - B.FDP.0033 and the nodulation component in Alternative legumes in mixed farming systems B.PSP.0013 and this adds value to the extension of their research outcomes.

4.1.1 Poster

Two A1 sized posters were created with a diagnostic process to assess what soil or plants could indicate about soil condition. 500 copies of each poster were printed and available from March 2020. Approximately 75 copies of each poster are left to be distributed at events. It is available from the soils hub for download at [soil-poster_small.pdf \(mla.com.au\)](http://soil-poster_small.pdf(mla.com.au)).

The process of diagnosis is simple and works well. Indicators have been used in numerous agronomist workshops as part of the more sub-clover package (L.FAP.1904) and the Less weeds package (L.FAP.1901), to highlight soils condition impact on both sub-clover and weeds. The indicator images have been very well received and are useful for generating discussion about what the issue might be causing and usually agronomists then discuss their experiences.

Table 14 shows feedback sought about the posters, and it was positive. They were some negative comments regarding the posters size, which they thought limited its use in offices. However, they indicated they would use it for display purposes in lunchrooms or office walls. It was also useful for display in agricultural farm supplies.

Table 14. Feedback obtained about the poster

Who	What do you think of the posters?	What is your reaction to them?	Would you use the posters and where?	Suggested changes or improvements
Highly regarded producer,	Great photos (a must), Clear descriptions. A series of smaller ones	Like	Will put on office wall if smaller	A little difficult to follow side to side

approx. 50 years old.	would fit better for on walls			
Farm Manager, approx. 30 years old.	Easy to follow. Eye catching with all the different photos	Like - info I am interested in	Yes would use the posters, great visual reference with photos & great flow chart	None
Farmhand, approx. 55 years old.	Informative, easy to follow, clear to read	Like	Yes, office or lunchroom	None
Young producer, approx. 18 years old	Eye catching. Good size posters for the office wall. The info is detailed but easily readable.	Big like	Yes, around work/lunchroom so we're always looking at them + visitors can look	None - they are very appealing
Agronomist, approx. 30 years old	Readability good. Some photos could be clearer, such as clover photos	Maybe an indicator on what way it flows, with an arrow	Main offices, where daily meetings occur	Move some to a phone app for in field & reference
Producer's partner, approx. 50.	Clear & concise. Easy to read	Like - very appealing	Yes, displayed in a high traffic area where staff have easy access to them	None
Producer, aged about 60. Actively seeks out information.	Although they contain some very useful information (some of the sub clover stuff was new to me, and everyone seems to wonder about patchy grass), I don't think they would be used very much.	The main issue is where to put them! Two big posters with a lot of information are not going to be put up in kitchens, where they would get maximum exposure, and they would even battle to earn their keep in an office.	One poster, and smaller, would have more chance, and a simpler subject, such as "Pasture Plants of South Eastern Australia", could be made more like an art work.	Most people now use the internet for information, and paper products like posters and books need to appeal in a different way, and could still be extremely useful.

The poster size made postage expensive, and distribution of the poster has mainly been through events. Many major events planned for distribution were cancelled due to Covid e.g Grassland Society of Southern Australia annual conference in 2020 and 2021 and Sheep Connect 2021. The main sources of distribution have been:

- Healthy Soil discussion groups
- PayDirt PGS courses
- Agronomy workshops for retailers to display in stores: (More sub-clover, Less Weeds and Persistent and productive pastures (L.FAP.1903)
- SFS field days
- Conferences: Meatup forum, Gawler and MLA Red Meat and AGM, Tamworth, BWBL coordinator training days, SA Livestock producers conference
- Landcare soil events
- Educational institutions: Marcus Oldham college, Longerenong Agriculture college, Melbourne Polytechnic

MLA further utilised the information and created a glossy fold out A4 document which was more practical to send out and signposted readers to the MLA soils hub.

4.1.2 Web based information

A requirement of the visual assessment tool was to link to more detailed web information. The visual indicator assessment tool has been used to create numerous online tools including an online booklet and three videos. Information has also been used by MLA to create an eLearning module and a hard copy booklet.

The online mobile version of the visual indicators makes access easier in the paddock.

[soil-poster-book-mobile.pdf \(mla.com.au\)](http://soil-poster-book-mobile.pdf (mla.com.au))

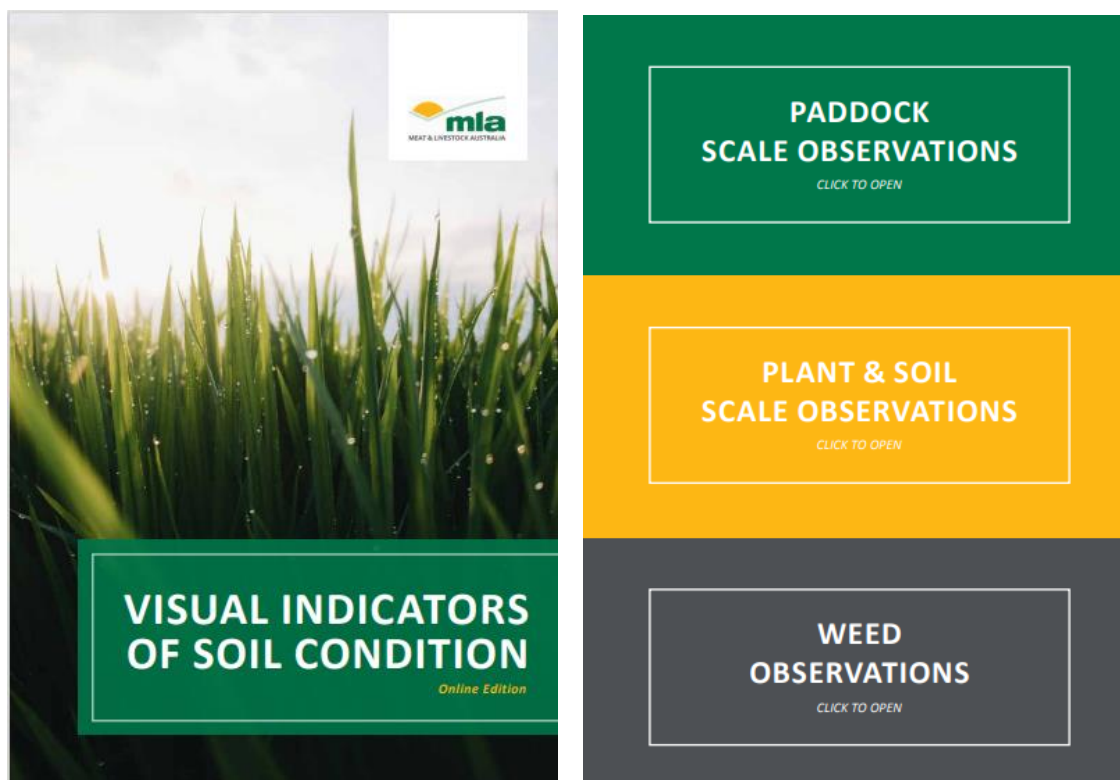


Figure 2. The front cover of the online booklet and contents page to select relevant section.

This was further developed into a hard copy by MLA as they kept getting requests for a hard copy version which indicates its popularity. The InDesign files used by the graphic designer were provided to MLA.

The three short videos created have also proved popular and have been viewed extensively.

[Visual indicators of soil condition Part I: In the paddock - YouTube](#)

[Visual indicators of soil condition Part II: Plants and pasture - YouTube](#)

[Visual indicators of soil condition Part III: Soil surface and clover roots - YouTube](#)

Video hits are shown in the table below which shows the high numbers of interest in the soil videos. A public comment below the videos was: *Informative and kept the interest up. Very relevant. Great resource.*

Table 15. Total Video hits since video release in September 2020 to end of March 2022

Video name	MLA YouTube 29/3/2022
Part I: In the paddock	1587
Part II: Plants and pasture	1053
Part III: Soil surface and clover roots	757

The images and information and visual soil assessment process was used to create an online learning module called Visual indicators of soil condition, released April 2020. The uptake of this module has been 57 participants.

Indicator information was also requested by Topsoils co-ordinator for Gippsland and permission was given to use images in the creation of: "A glove box guide to identifying problems in East Gippsland funded by East Gippsland Catchment Management Authority."

Links to the products have been included in the Making more from sheep, soils module 6.

4.1.3 Feasibility of phone app

A feasibility report was an output of this project and is provided in appendix 8.2. In summary, there was desirability of producers being able to easily access visual indicators of soil condition, but the uptake of other agricultural related apps has been low. An app wasn't deemed necessary because this information could be easily accessed from the online mobile booklet created. Photo recognition for the many different type of indicators used in the assessment process was not feasible. However, photo recognition technology may be feasible for objective measurement of ground cover during summer to avoid loss of soil through summer thunderstorms or windstorms.

4.2 Simplifying easy steps of P

A report provided in Appendix 8.2 outlines the recommendations to simplify the "Five easy steps to P" tool. While some producers have benefited from the "P tool" development, this seems to have been mainly in a workshop type environment and feedback has been as a stand-alone tool, it is not

easy to use. In its current format it provides a good technical background on everything known about phosphorous, soil and livestock interactions but complicates making decisions on fertilisers.

Recommendations include that there are changes that could improve its ease of use in the short term, but a redesign is needed for future use. There is opportunity with PGS course PayDirt to utilise some of the decision-making processes and information on fertiliser use.

It is worth noting that in the MLA project B.FDP.0021 Coordination of Participatory R&D for the Feedbase Investment Plan in Victoria, the Grasslands Society of Southern Australia - Central Ranges branch made the following recommendations regarding their project on Phosphorus use efficiency. They had awareness of the P tool and thought it “overly complicated, its 28 pages long” but suggested a case study of how someone using it was needed, “so, you can follow along.” They recommended in the short term:

- district look up tables for hard data (range of values) which includes district response curves pasture kg DM/ha (relevant to soil type/rainfall) to different P levels and the extra DSE/ha carried. This would allow producers to work out where they want to sit on the production curve, and it provides the amount of P inputs required to get there. Include tables of maintenance P rates/DSE.
- For the future, a soil inputs decision tool (that is not just for P but included other nutrients and lime and gypsum).

None of the recommendations have been acted upon to simplify fertiliser decisions and remains an opportunity for improvement.

4.3 Building skills and confidence of producers

In all there were 62 workshops run by the 10-pilot discussion group involving 149 core producers.

All the groups except in Tasmania were disrupted by Covid with cancellations of workshops or re-design of workshops to occur online. In some cases, this affected the momentum of the groups to build skills and maintain enthusiasm. Some groups chose to cover multiple topics and in doing so, needed to be careful to introduce ways to connect topics and allow skills to be practiced and repeat messages.

A community or practice was established to allow sharing of resources and 20 case studies produced to allow sharing of skills and knowledge of soil management between the groups.

The target number of open events was 10 or one for each group. Some groups had multiple open events, and other groups did not have any due to Covid restrictions on numbers. There were 11 open events occurred across eight groups attended by an additional 204 members. Evaluation of producer’s skill building was done by the creation of skills audits. The assessment questions used are given as provide a resource for future soil management training programs.

4.3.1 Skills audit

All ten groups collected information on producer’s skill development. While a skills audit was a requirement for all groups to provide, the method of a skill audit was not mandated and on reflection it should have been. Groups used different skill audit methodologies and some methodologies worked better than others. Audits that contained before and after test questions provided the best evidence of skill change. Self-rating of skill change provided some indication of

change but was largely subjective and possibly more a reflection in confidence. Group facilitation to establish what skills the group thought they had developed provided useful information and this allowed additional evaluation data to be collected, such as intention to adopt or practice change.

Skill development was a relatively new concept for some groups as they had mainly focused on evaluating knowledge change and had difficulty in distinguishing what was a skill from knowledge. Initially producers and sometimes the facilitators were unclear of the skills they wanted to develop.

Some groups explored topics such as soil biology because of group interest but couldn't clearly identify a skill they wanted to learn related to it. However, such sessions-built knowledge skills on how to maintain good soil biology and what science-based assessments could be made. An exception was with the PPS group whose members showed improvement in nodulation assessment.

As groups progressed, they became more focussed on identifying the skills they wanted to learn and skill collection. For example, the Tamar NRM group identified they needed to develop more skills in being able to read a soil test.

Groups that identified specific skills, for example interpret a soil test for the producers to learn were more successful at evaluating skill changes than broad soil management, like better manage soil health. Also, successful skill audits were more likely to have involved input from the presenters. The Holbrook Landcare network worked with local DPI, NSW extension staff who delivered most of the workshops to develop a comprehensive skills audit. However, sometimes there was a disconnect between the information presented by guest speakers and the skills being evaluated. Several audit questions were considered too complex for the group to answer or had more than one answer and so didn't help capture useful information.

Information on skill change was logistically more difficult to measure for outside events or where webinars were held.

Therefore, development and implementation skill audits were deemed to be hit and miss for the collective groups and require tightening up for any future programs. Future programs should require the upfront submission of the skills audit which is approved. Also, guidelines and instructions provided in terms of the skill audit's requirements and methodology. These requirements should include the following factors which contributed to successful skill audits:

- clearly identified skills from producers that they want to develop.
- realistic skill development that could be achieved in the given timeframe.
- audits that were objective, meaning producers needed to be evaluated through observation to do something and competency rated or use before and after questions rather than self-rating.
- presenters informed of the skill changes to be achieved, so they can tailor information accordingly.
- workshops focused on providing information and opportunities to practice skills.

4.3.2 Pilot discussion groups

Holbrook Landcare Network

Over the project, 113 producers attended 6 workshop events all focused on building skills related to soil acidity management. The project coordinator expressed that they found it challenging, to deliver six workshops on the same topic to producers who were already using lime to treat soil acidity.

There was some repetition of content at each workshop this made it difficult to get the core group to attend all the workshops. To try and keep engagement, different delivery methods were used including online/face to face workshops/gathering in the field. However, maintaining the single topic focus, the key messages were able to be delivered and explored in detail over the six workshops. Producers commented on the benefit of having the same key messages discussed over the course of the workshops. Their learning was evident in the group's skill and confidence building (table 16) as reflect by the recorded pre and post project workshop survey. The greatest impact the healthy soils discussion group had on the practices of participants was the uptake of the key messages on acid soil management. Proven skill increase was demonstrated by:

- an increased number of producers now use soil tests and in particular, fine increment (5 cm intervals) sampling to identify subsurface soil acidity in their paddocks. This was a key recommendation commonly discussed at the workshops.
- increased number of producers that are confident at interpreting soil test results and now apply lime when soil pH reaches a critical value. The critical value to apply lime has also increased along with the target pH with the majority now targeting the recommended pH_{Ca} of 5.5.

The added benefit of having the open workshop open to other general producers, was that they were able to hear how the leading group of farmers are managing soil acidity and learn from them. There was also a strong participation of younger producers (20–40 years) attending workshops. This demographic was generally eager to learn and haven't been exposed as much as the older generation to acid soil best management practices. Overall, there were plenty of comments from event attendees that they will improve the way they manage soil acidity on their farm, and it is expected that there will be a regional change as a result of these workshops.

The healthy soils discussion group helped build awareness of the impact of acid soils and the need for producers to manage this issue. The core group of producers had input into the development of an acid soils strategy for Holbrook Landcare. These outcomes may not have been as effective without the delivery of this project.

Table 16. HLN workshops quantitative and qualitative evaluation results

Workshop name	Producer number	Quantitative and qualitative feedback
Acid Soils - A new look,	21	The entry survey (see below) highlighted some knowledge gaps that were addressed in the second workshop – primarily that most producers were waiting until their pH level was between 4.3 – 4.8 before they made the decision to lime.
Acid Soils Initiative	11	<p>Intentions:</p> <ul style="list-style-type: none"> • Review soil test results • Changing pH target up to 5.5. Review current lime application • Incorporation of lime into soil • Apply more lime • Soil rising in 5cm increments. Liming to 6.0pH • Not deep rip! • Use pH target of 5.5 as my trigger for reapplying lime. • Need more information on interpretation methods <p>22% workshop exceeded expectation, 56% workshop met expectation, 22% partially met expectations</p>

How to get the most out of your soil test results. (open event)	14	Feedback not collected due to webinar online
Soil acidity and effects in the root zone workshop	10	<p>Survey results:</p> <ul style="list-style-type: none"> • Are you thinking you need to change your pH trigger - 100% yes. • Constraints to change - 65% economic, 25% not enough knowledge. • Are you monitoring your soil sample results over time 0-10cm - 100% yes. • Are you monitoring your soil sample results over time 10-20cm - 75% no. • Are you considering changing your soil sampling regime after attending this workshop - 75% yes. • Has your knowledge increased from attending this workshop - 100% yes.
Economics of lime for cropping and grazing systems (open event)	47	<p>Participation feedback was positive. Engagement from younger farmers wanting to be part of the acid soils discussion group. Impact of seeing the trial site response to variable rates lime and the correlating production outcomes from each plot. Survey data is reported in table 17.</p>
Wrap up of the project - where to next	10	<p>Practice change from two producers was noted via direct discussion with participants who were now aiming at pH 5.5 or above.</p> <p>Participants want to see more on:</p> <ul style="list-style-type: none"> • The economics of lime, what this means to DSE capacity • What are the implications of applying high rates of lime on perennial pasture composition and production • Acidifying rate comparison of livestock vs cropping • Economics of liming. Incorporation vs no incorporation. Pasture composition vs acidification. Best practice liming system.
6 workshops	113 producers	

Comparison of the entry and exit survey responses (table 17) collected in workshops 5 and 6 identified the changes in skills and confidence of the core producers to assess soil acidity and how to effectively ameliorate it, and how well the key messages were disseminated amongst the core group. Overall, the changes in skill level and the method used to measure these changes were both considered successful.

Table 17. HLN group data from before and after skill assessment surveys and the change in the number of correct answers

Survey questions	Before	After	Change
Producers are confident in their decision to lime or not lime	57%	68%	11%

Producers apply lime now when soil test result's reach critical pH	38%	72%	34%
Producers now sample in 5cm intervals (or intend to in the future)	0%	19%	19%
Producers target pH _{Ca} 5.5 or higher when liming	45%	66%	21%
producers use a trigger pH of >5.0 as a critical value to apply lime	11%	58%	47%
Producers use a trigger pH of ≤4.8 as a critical value to apply lime	42%	89%	47%

At the last workshop there was interest by some of the core group to continue learning. There was positive feedback on the project process, and although most of the group didn't get to all of the workshops, they did comment on the quality of the workshop content and the benefit of reinforcement of the key messages.

Coolac farmers group

In six workshops, there were 57 participants. The group covered multiple topics but with a focus on physical skill development to improve implementation of tasks rather than necessarily knowledge. As a result of this approach, there were some unique workshops such as Experimenting On-Farm and use of excel for soil data storage and monitoring. Workshops were well attended except for the final workshop, which was on using excel, and this was despite producers requesting the topic.

Table 18. Coolac farmers group quantitative and qualitative evaluation results

Workshop name	Producer number	Evaluation data
Assessing Ground Cover	10	<p>Only 5 respondents but the key results from this survey, in terms of skills development, were that all participants reported an increase in their knowledge of the ground cover monitoring by attending the workshop and taking part in the associated exercise.</p> <p>In addition, all participants planned to use that information. All participants rated the workshop as exceeding or far exceeding their expectations.</p> <p>Action/strategy producers identified they will undertake:</p> <ul style="list-style-type: none"> • Apply going into summer • New Grid Measure • Monitor ground cover to make management calls • Judging ground cover (x2 comments)
Soil Test Interpretation (Open event)	14	<p>14 respondents.</p> <p>Most members of this group had not had much exposure to many of the concepts presented, as a result the improvement in knowledge and skills in the area was profound.</p> <p>There were significant improvements in participant knowledge on all questions.</p> <p>It was evident that participants had improved knowledge and confidence in all other areas of soil phosphorus and sulphur covered.</p>

Soil Profile Interpretation 1 Soil Texture	11	Only five participants took part in the survey – some leaving before the end of the workshop due to pressing engagements. For those that did fill out the surveys it was clear that in most subject areas there was an improvement in knowledge. But not as profound as that in previous workshops. In one question the change in knowledge decreased by 20% at the end of the workshop. The low levels of responses did not reflect the involvement and enthusiasm with which the group participated in the exercise.
Soil Profile Interpretation 2 Sub Soil Limitations	10	8 respondents to this survey revealed that progress for this group was patchy – and depended on the level of knowledge before the workshop. Hence, for questions 1, 5 & 6 where knowledge was relatively high – no significant progress was made. In contrast, for all other questions there were greater levels of improvement. Participants still scored low in the areas of sub surface acidity and its importance – especially questions 2 and 3. So while the average correct response increased from 48% to 62%, the results were disappointing given the effort that went into organising the guest presenter and historical overview.
Experimenting On-Farm	8	All responded and there was a clear improvement in this group's understanding of key issues relevant to experimental and evaluation of evidence. All participants understood the need for replication and randomisation of treatments and all, but one regarded themselves as confident to carry out their own on farm trial. Most could also recognise an appropriate simple experimental design. All participants engaged in some part of the practical exercise of setting up a simple fertiliser trial.
Using Excel to manipulate and store soils data	4	This was a highly successful exercise as all producers informally agreed that they had learned worthwhile skills in manipulating and analysing data using excel. However, it was not well attended. Comments from post workshop survey on insights/skills gained: Using the sort and if commands to make analysing data faster; dragging formulas, google excel issues, locking cells; Ranking livestock; I am less frustrated using excel now; Pivot tables, index & match, array formula; New and simpler formulas.
6 workshops	57 producers	

Table 19 shows the Coolac farmers group data from before and after skill assessment surveys and the change in the number of correct answers. Most of the following were multiple choice. The data shows that workshops effectively increased skills, with only three questions indicating poor understanding or no change in answers. Workshop 6 was evaluated in conjunction with respondents from the Tablelands Farming Systems due to low attendance numbers.

Table 19. Coolac and Tablelands group data from before and after skill assessment surveys and the change in the number of correct answers.

Survey questions	Coolac Producer group			Tablelands Farming Systems		
	Before	After	Change	Before	After	Change
Workshop 1 Assessing Ground Cover						
How would you rate your knowledge? (1=low, 5=high) Score median answers	2	4	+2	2.25	4	+1.75
Workshop 2 Soil Test Interpretation						
The "Critical Value" is the level of soil nutrient at which pasture growth is % of maximum? (Correct Answer: 95%)	0	100	+100%	62	96	+34%
The "Critical Value" for Olsen Phosphorus (P) is? (Correct answer 15 mg/kg from 5, 10, 15, 20, 25 or don't know)	25	92	+67%	50	96	+46%
The "Critical Value" for Colwell P depends on what other measurement? Correct answer PBI	17	85	+68%	58	71	+13%
When your soil Colwell P is well below critical, how much P is required to increase 1ppm? (Correct answer 2.7 kg P/ha from 0.7, 1.7, 2.7, 3.7, 4.7, don't know)	0	100	+100%	38	100	+62%
I don't have a PBI, what is my estimated critical Colwell P value for a Granite based soil? (Correct answer 30 mg/kg from 10, 20, 30, 40, 50, don't know)	25	85	+60%	50	96	+46%
The Critical Value for Sulphur (KCl-40) test is? (Correct answer 8 mg/kg from 2, 4, 6, 8, 10, don't know)	8	92	+84%	27	79	+52%
I have my soil test results and I would like to know my Cation Exchange Capacity (CEC), this is calculated by doing what to the exchangeable cations? (Correct answer a from a. adding them b. multiplying them c. don't know)	17	69	+52%	17	69	+52%
Workshop 3 Soil Profile Interpretation 1 Soil Texture						
I can identify horizons (layers) in my soil profile by? (correct answer d from a. colour b. texture c. structure d. all of the above e. don't know)	20	60	+40%	50	83	+33%
The red colour in soil is created by? (Correct answer Iron oxide, (Rust))	40	100	+60%	42	100	+58%
Soil Texture is an estimate of the relative amounts of? Correct answer c. from a. soil: air: water b. soil: nutrients: water c. sand: silt: clay d. gravel: soil: water e. Not sure)	60	40	-20%	42	83	+41%
A handful of moistened soil kneaded into a ball is called a? (correct answer b from a. polyp b. bolus c. polus d. bolyp e. don't know)	40	60	+20%	58	100	+42%

The length of a ribbon of soil is related to the percentage of? (correct answer b. from a.silt b. clay, c. sand d. organic matter)	40	60	+20%	67	83	+16%
Which soil type holds the most water - rank highest (1) to lowest (4): (correct 1, 3, 4, 2 from 1. Clay Loam 2. Loamy sand 3. Heavy clay 4. Sandy clay loam)	60	100	+40%	42	75	+33%
Rank the following from coarsest (1) to finest (4): (correct answer 1, 3, 4, 2 from 1. Gravel, 2. Silt, 3. Clay, 4 Sand)	0	60	+60%	25	75	+50%
Workshop 4 Soil Profile Interpretation 2 Sub Soil Limitations						
The length of a ribbon of soil is related to the percentage of: (correct answer clay from silt, clay, sand, organic matter)	75	75	0%	75	75	0%
Analyses of the sub soil allows us to? (correct answer d; a know how readily fence posts will rust b. know how deep our soil is c. pH d. exchangeable cations f. all of the above)	25	50	+25%	87.5	94	+6.5%
When analysing sub soil samples, we are mainly interested in? (correct answer e from a. Phosphorus and sulphur b. nitrate, c. better calculate nutrient requirements, d. understand limitations to plant growth and survival)	13	37.5	+24.5%	0	44	+44%
To convert pH in water to pH in CaCl ₂ we need to approximately? (correct answer b; a. Multiply by 0.8 to 1 b. subtract 0.8-1.0 c. divide by 0.8-1.0 d. add by 0.8-1.0 e. Not sure)	38	62.5	+24.5%	6.5	87.5	+81%
Which paddock is most suitable to sowing lucerne into? (correct answer d based on survey for pH depth profiles)	75	75	0%	56.5	87.5	+31%
To increase pH in the subsoil, by a unit over about 25 years at 15-25cm depth surface pH needed to be maintained about? (correct answer d from a. 4.5 b. 4.8 c. 5.2 d. 5.5 e. Not sure.	63	75	+12%	25	44	+19%
Workshop 5 Experimenting On-Farm						
Demonstrations are just as good as experiments?	71.4	85.7	+14.3%	37.5	87.5	+50%
Replication of treatments in field trials is always necessary?	71.4	100	+28.6%	62.5	100	+37.5%
Randomisation of treatments within replicates always produces better experimental designs?	28.6	100	+71.4%	25	100	+75%
Consider the following designs – three Urea treatments Nil, 100 kg/ha, 200 kg/ha by three replicates	14.3	71.4	+57.1%	62.5	87.5	+25%
I am confident that I could conduct a well-designed experiment on-farm?	28.6	85.7	+57.1%	25	75	+50%

Table 20. Combined data from Coolac and Tablelands farming systems group for workshop 6 - using Excel to manipulate and store soils data

Questions	Before	After	Change
1. How would you rate your ability as an Excel user (1= low, 5= high) Score median answer:	3/5	4/5	+1
Answers	Yes	No	
3. Did you learn any new ways/methods/tools to help you utilise excel in your business? Yes or No	7	0	
4. Do you think that knowing more about how excel will improve your management of data? If so...how? Yes or No	7	0	
6. Would you recommend this workshop or one like it to others in your network? Yes or No	7	0	

Tablelands farming systems group

In six workshops, there were 92 participants.

Table 21. Tablelands farming systems group quantitative and qualitative evaluation results.

Workshop name	Producer number	Evaluation data
Ground Cover	16	<p>The key results from 6 respondents of this survey, in terms of skills development, were that all participants reported an increase in their knowledge of the ground cover monitoring by attending the workshop and taking part in the associated exercise. In addition, all participants were either likely to use the information from the event or planned to use that information. All participants were satisfied that the workshop met their expectations.</p> <p>Action/strategy producers identified they will undertake:</p> <ul style="list-style-type: none"> • Awareness of Ground Cover • Differentiate between "ground cover" and herbage mass • Practice measuring and recording ground cover • Use drought lots more frequently • More aware of need for regular measurement
Soil Test Interpretation (Open event)	33	<p>Many members of the TFP group had previously attended annual meetings to consider soil analysis results as part of the Tablelands Farming Systems soil club. And many of the concepts had been covered at those events.</p> <p>However, from 26 survey respondents there were significant improvements in participant knowledge on all questions asked – with the exception of the question – “The critical value for Colwell P depends on what other measurement” the correct result was 58% before the workshop and 71% after the workshop. It was evident that participants had improved knowledge and confidence in all other areas of soil phosphorus and sulphur covered.</p>

Soil Profile Interpretation 1 Soil Texture	15	12 survey respondents demonstrated significant improvements in knowledge for each of the questions. This was knowledge rather than skills based – the skills part of the exercise – determining soil texture was not included in the audit.
Soil Profile Interpretation 2 Sub Soil Limitations	16	16 survey respondents showed there were significant improvements to knowledge in some areas – e.g. suitability of lucerne, conversion of pH results (from extracted in water to CaCl ₂ solution) and importance of pH and exchangeable cations at depth. However, there was not much of an improvement in answers to questions 1 and 2 – where starting knowledge was already at quite a high level. In some areas many participants were still confused – particularly with respect to the last question dealing with the time frame of sub-surface pH amelioration.
Experimenting On-Farm	8	From 8 respondents it was clear that the group improved their understanding of the need for some level of rigour when evaluating information from trials. All participants recognised the need for randomisation and replication after the presentation. There was a large increase in the number of participants who felt confident in conducting their own trial – this was no doubt aided by the hand-on aspect of the exercise. All but one participant recorded that the workshop either met or exceeded expectations.
Using Excel to manipulate and store soils data	4	Evaluation results were combined with Coolac producer group and reported in table 19.
6 workshops	92 producers	

There were several products developed to deliver sessions that could be further developed by MLA and made widespread. These included:

- Ground cover summary factsheet
- A soil test interpretation – two-page guide

Mid Goulburn GSSA group

Seven members attended every session and the other five attended three or four sessions. The facilitator commented that attendance was very good pre-Covid (i.e., Sessions 1-4 in 2019) but there was a break in the program when they could not meet face to face due to Covid-19 restrictions and when the program resumed, attendance numbers for the last two sessions fell.

Table 22. Mid Goulburn GSSA group quantitative and qualitative evaluation results collected at the final session and at the open event.

Workshop name	Producer number plus advisors	Evaluation data
Planning Session	12 + 8	No evaluation data was collected as this was a planning session to develop the work program.

Understanding your soil profile	12 + 3	<p>Value of event: 8.2/10</p> <p>New information gained /skill identified by producers:</p> <ul style="list-style-type: none"> • How to do sub-soil testing. • Benefits of deeper soil tests. • pH/Al changes down profile. • Different tests for Al (% versus extractable). • Importance of sub-soil health. • Variation in soil fertility & pH across the paddock. • Rate of lime movement in soils. <p>Management change proposed by producers:</p> <ul style="list-style-type: none"> • Apply more fertiliser and lime. • Re-evaluate use of lime. • Get both deep and standard topsoil tests done for some paddocks. (Never seen a subsoil sample/profile core taken). • Do more soil tests more often. • Do more rotational grazing. • Review phalaris varieties for different soils. • Sow more deep-rooted perennials (phalaris) as cope well with dispersive subsoils.
Soil test interpretation & planning fertiliser/lime requirements	12 + 1	<p>Management change proposed by producers:</p> <ul style="list-style-type: none"> • Work out kg P/DSE for maintenance rates. Sulphur levels need attention, potash test strips needed. • Pay more attention to soil test results before making decisions on rates. • More targeted applications to suit paddock needs. • Compare different fertiliser options on price \$/kg nutrient (x 2 responses). • Get paddocks tested before going ahead, work out exact rate required to get pH & Al to correct level. • Feel more confident in calculating what we need on a paddock/soil test basis -helps discussion with agronomists rather than accepting advice without question. • Will do a leaf analysis for moly/trace elements (only relied on soil tests for them). • Will be more discerning in relation to type & amount of fertilisers. • Apply MAP as a cheaper source of P (don't need S). • Keep using soil tests to know how I'm progressing with pasture improvements.
What carbon farming & carbon neutral means & options to achieve it. (Open event)	70	<p>Value of the event:</p> <ul style="list-style-type: none"> • 64% of people said the event exceeded/very much exceeded their expectations while the remaining 36% said it met their expectations. <p>Statistics of attendance:</p>

		<ul style="list-style-type: none"> • Of the 70 participants that attended 50 producers, 20 were advisers (private and government)/ researchers/analysts/ company representatives. • Producers – farmed a total of 35,00 Ha and 90% ran beef cattle, 10% ran sheep for wool or prime lamb production. • Producers – farmed a total of 35,00 Ha and 90% ran beef cattle, 10% ran sheep for wool or prime lamb production. <p>Management change proposed by participants:</p> <ul style="list-style-type: none"> • Use University of Melbourne Carbon Accounting Tool. Ascertain farm emissions. Look at the websites provided with Carbon tools. Attend MLA seminar & calculate current carbon footprint. • Test soil for carbon to establish baseline. Monitor soil carbon across farm with regular soil testing. • Grow more trees in marginal areas. Map areas suitable for trees to gain multiple benefits. • Consider ways to increase soil carbon. Try to increase soil carbon & trees to become carbon neutral. • Investigate carbon markets, carbon credits - what is involved. Get a better understanding of carbon markets. • Make sure politicians understand the building soil carbon myth for southern Australia. MLA aspirational target of CN30 is good but limited tools to do this in southern Aust at present – don't continue to give QLD examples (prevention of clearing etc). • Investigate genetics for more efficient cattle (Net feed intake) to reduce emissions intensity. • Reduce size/weight of mature cows to be more feed efficient. • Investigate ways to reduce enteric methane emissions. • Improve feed quality. Improve quality of diet & achieve faster livestock growth rates. • Trial any vaccines when available. • Use the farmer feedback to inform new R&D. • Advise clients of the range of opportunities to reduce emissions. • Take the information back to Vic government to develop policy. <p>Other:</p> <ul style="list-style-type: none"> • News article about the event published in GSSA newsletter, January 2020.
Whitehead Ck -farm visit.	8 + 2	<p>Management change proposed by producers:</p> <ul style="list-style-type: none"> • Take sub soil samples to check pH/Al (surprised to see how it changed down profile). • Apply more lime to surface if subsoil is acidic too. • Check how far roots getting down. • Do leaf analysis to check molybdenum.

		<ul style="list-style-type: none"> • Use soil type/CEC chart to calculate lime rates not just 2.5 t/ha
Group event Soil biology Review of program	8 + 5	<p>Any soil issue you will be able to manage better as result of participating in group?</p> <ul style="list-style-type: none"> • Soil fertility. • Soil phosphorus. • Potash deficiency. • Nitrogen deficiency • Levels of pH/Al at diff depths. • Soil acidity - low pH/high aluminium. • Ground cover • Soil structure, dispersive subsoils • Compaction. <p>Management change proposed by producers:</p> <ul style="list-style-type: none"> • More soil testing & better decisions about fertiliser type & rate. • Calculate maintenance P & capital P rates. • Will apply potash where K low on soil tests. Didn't realise the importance of potash until this group. • Use Urea wisely to increase pasture production. • Use more tests to know what levels are at depth & use different rates of fertiliser & lime. Use different plant species for different soils. • Variable rate spreading of lime to save money/be more targeted/ don't apply to areas don't need it. • More lime. • Have now applied lime. • Use soil type/CEC chart to calculate lime rates more accurately. • More soil testing & higher rate of lime. Assess different lime sources versus cost. • Request different aluminium tests (Al% & extractable Al mg/kg). • Improve grazing management. Check pasture with pasture ruler. • Stop cutting hay. Increase deep rooted perennials & graze better to improve root depth.
6 workshops	136 participants	(122 producers, 14 extension officers)

The group successfully met the objective of “build skills and confidence of producers to assess soil constraints and apply the appropriate products/management to improve soil health.” The improvements pre and post group, on a score of 1 to 10, for some key measures were:

- Knowledge of all tests to diagnose any constraints to pasture/root growth: increased from 4.8 to 8.2
- Knowledge/skills with interpreting soil tests: increased from 4.8 to 8.3

- Confidence calculating fertiliser rates: increased from 4.9 to 7.9
- Confidence calculating lime rates: increased from 4.5 to 8.0

The progressive improvement in knowledge/skill/confidence was hard to capture, even though the same questions were asked a few times throughout the program, as group members appeared to score pre-event questions as pre-group (table 23).

Table 23. Mid Goulburn GSSA group data from before and after skill assessment surveys and the change in the number of correct answers

Survey questions	Before	After	Change
3 Knowledge/skill with interpreting soil tests (1 Lowest: 10 Highest)	5.1	8.2	+3.1
3 Confidence calculating fertiliser rates	4.9	7.9	+3.0
Workshop 4. Soil carbon Knowledge of topics (1 Lowest: 5 Highest)	2.6	3.9	+1.3
5. Knowledge of all tests to diagnose any constraints to pasture/root growth (1 Lowest: 5 Highest)	4.8	8.2	+3.4
5. Knowledge/skills with interpreting soil tests (1 Lowest: 5 Highest)	4.8	8.3	+3.5
Confidence calculating lime rates	4.5	8.0	+3.5
6. Knowledge of all tests to diagnose any constraints to pasture/root growth (1 Lowest: 5 Highest)	4.7	8.0	+3.3
6. Knowledge/skills with interpreting soil tests	4.9	8.2	+3.3

In the final session, the group were asked if there were any unanswered questions about any topic. Below is a summary of their feedback.

- They highlighted that they mainly needed to revise/discuss topics periodically to maintain knowledge and skills levels.
- On the topic of soil biology, they enjoyed the guest speaker's presentation and realised you need to be careful where you get your information from (not YouTube!) as a lot of information is not from credible scientific sources.
- The area of carbon farming/carbon neutral was quite complex, and they needed more information about carbon credits and protocols.

As a result of the group sessions, there were a number of products developed that could be further developed by MLA and made widespread. These included:

- A "Soil profile assessment checklist" tool to guide producers through the relevant tests to do for each soil layer to identify if there were any constraining factor and what the options were for dealing with it.
- A "Setting up fertiliser test strip" fact sheet with instructions was provided to group members and SFS to distribute to other Healthy Soil groups who were interested. Fertiliser test strip kits were made available after Session 1 for producers to evaluate the

impact of different fertilisers (P, K, S, moly), lime, nitrogen or gibberellic acid on their own pastures.

- A video (YouTube) was produced (by group facilitator and local Agriculture Victoria extension officer) to demonstrate how to set up test strips.
- Case study/fact sheets called “Know your soils” were produced for the 3 farms/soil types where we took soil samples down the profile.

Perennial Pasture Systems (PPS)

In six workshops, 135 producers attended where PPS members were invited. An open event scheduled for April 2021, to include non-PPS members was not able to be run due to restrictions on numbers due to covid, but all the events were well attended.

The group covered multiple topics but a common theme to most of them was testing and observing soils and many of the topic areas overlapped, for example soil acidity and its effects on legume production and soil biology, pasture growth for building soil organic carbon and soil testing. Only one event was run in early 2020, with covid delaying running of the three final workshops until 2021.

The workshop approach was well received and allowed plenty of time for questions and answers. It gave all participants time to get their questions answered and something the group facilitator felt that doesn't always happen in paddock/field day situations.

Soil cores and plant samples were collected prior to sessions 1 and 2 and used during the workshops; this was much more time efficient than trying to do a paddock-based session.

Table 24. PPS group quantitative and qualitative evaluation results

Workshop name	Participant Number	Qualitative feed back
What lies beneath. Soil types and constraints	24	It was commented by a few participants that they found parts of it hard to understand (geological process involved in soil formation).
Soil constraints to legume production	25	Checking nodulation was a new concept for the group.
Soil acidity and lime use	27	The information on soil acidity and the pH effect on plant performance has provoked a greater focus on soil testing and lime use. Some felt some of it, like lime calculation was complex but others thought this information was important.
Soil test results – How to read them and what to do with the information.	19	Resulted in a greater focus on soil testing and making sure it was accurate.
Soil biology and testing	21	Learnt that counting earthworms and species was a sufficient way to monitor.
Soil carbon. Review and feedback session.	19	Reinforced the value of perennial pastures in the grazing systems on member farms showing that productive, fertile, rotationally grazed pastures have a positive effect on soil health.
6 workshops	135	

The before and after surveys worked well to obtain objective information on knowledge and skill change and gave producers activities to do and highlighted some of the key messages of speakers. The facilitator used the guest speaker to help determine questions. All the workshop questions involved information around the information needed to test and assess soils.

Table 25. PPS group data from before and after skill assessment surveys and the change in the number of correct answers

Workshop name	Assessment Question	Before	After	Change
Soil constraints to legume production	Nodulation assessment: which clover samples have effective nodulation?	0	100%	100%
	Describe how you would sample a legume plant to assess if it was effectively nodulated?	5%	95%	90%
	What time of year would you check for nodulation?	10%	90%	80%
Soil acidity and lime use	What soil testing depths are useful for determining soil acidity within your soil? (0-10cm 10-20cm, 20-30cm)	5%	80%	75%
	How much pH variability do you think there is within a paddock with an average soil pH of 4.5? (Not much, Some, High (Correct), Very high)	75%	90%	15%
	How much pure lime would you put on this paddock with the following soil factors shown below if the aim was to remove pH constraints? Guess, Standard, Lime 3 to 4 t/ha (Correct), Lime 4 to 5 t/ha, Lime 6 to 7 t/ha	40%	60%	20%
	What is the likely acidification rate of a medium rainfall (550 to 750 mm) grazing operation of perennial pasture containing 30% clover under average production (no hay cutting)? Guess, 100, 200 (correct) 300 kg lime equivalents	25%	65%	40%
Soil test results	The term “Critical soil test value” is often used when interpreting soil tests; which of the following would best describe your understanding of the term: a) I am not familiar with this term b) The minimum amount required for adequate pasture production c) The value that soil must not exceed to avoid toxicity d) The value at which pasture production is near maximum (Correct) e) The value that will give the best animal health outcome	18%	73%	55%
	Soil testing is the best way to identify pasture trace element deficiencies? True or False (Correct)	41%	68%	27%

	Heavier textured soils require more phosphorus to raise the P level by one unit. True (Correct), False or Unsure	50%	77%	27%
	A maintenance nutrient application: a) Increases the nutrient levels of the soil b) Should increase the amount and quality of pasture grown c) Holds fertility levels at a set level, by replacing any lost nutrients (correct) d) Should not take into account any nutrients bought onto the farm in the form of feedstuffs e) Unsure	73%	82%	9%
	The amount of maintenance fertiliser required will be affected by: Soil type, Rainfall, Stocking rate, Pasture species, Grazing method, All of the above (correct), Unsure	73%	77%	5%
Soil biology and testing	Based on their size; how many different groups of soil biota live in the soil? 0, 1, 2, 3, 4 (correct)	61%	18%	39%
	How many microbial species live in 1 gram of soil? 100 - 500, 1,000 – 5,000, 10,000 – 50,000 (correct), 100,000 – 5000,000	56%	94%	39%
	Soil microbes are capable of: decomposition plants, improve soil structure, suppress soil diseases, all of the above (correct)	89%	100%	11%
	Soil biology test results can vary with: soil moisture, soil temp, soil type/texture, ag system, soil depth, all of the above (correct)	83%	100%	17%

Summary of quantitative skill change data is presented below in table 26 and shows at least 25% increase in knowledge and skills. The greatest change coming from the new skill of checking nodulation that they learnt 90%.

Table 26. PPS group summary of average percentage skill change recorded from four workshops.

Workshop name	% Change
Soil constraints to legume production	90%
Soil acidity recognition & calculation of lime rates	38%
Soil biology - recognition of indicators	27%
Soil test results – How to read them and what to do with the information	25%

Below is a qualitative group evaluation completed at the last workshop. The group identified 12 skills they had learnt (table 27). Importantly they have developed skills in accurately soil testing and identified that these were relatively easy to undertake.

Also, some of their answers suggested an improvement in confidence such as:

- Confidence to question claims without evidence.
- Accuracy in soil test so can trust results.

- Confidence to ask for better advice

The group indicated actions they will undertake over the short term and long term that will address many of their constraints and build soil health. They also recognised some of the inherent characteristics of soils they need to just live with.

Table 27. PPS group final group evaluation

<i>What skills have we gained from the six sessions?</i>	<i>What actions will we undertake that are easy to undertake?</i>	<i>What actions will we undertake that we can do but will take time?</i>	<i>What actions will we have to live with / manage around?</i>
<ul style="list-style-type: none"> • How to take a representative soil sample so we can trust the results. • Confidence to question claims without evidence (snake oil). • How to analyse a soil test. • How to identify the limiting factors. • How to examine sub clover for nodules and effective nodulation. • Can now identify some of the soil constraints. • What we need to get a healthy soil system. • Picking the ‘low hanging fruit’ to get quick improvement. • Not being afraid to ask for better advice. • Networking. • How to grow more biomass. • Considering soils as a complete package rather than just one component. 	<ul style="list-style-type: none"> • Soil testing – more frequent, care in collecting a sample (transect, GPS), comparing critical values against where you are, micronutrients, better interpretation, seek good advice then act. • Look at what is going on – count worms. • Increasing soil fertility P, N, K, S. • Plant appropriate pastures that will allow water and nutrients to flow in sodic soils. • Grow more grass. • Maintain greater groundcover. • Better planning! 	<ul style="list-style-type: none"> • Use lime to lift pH. • Increase soil fertility, but in a balanced way (capital expenditure). • Use of gypsum. • Increase soil carbon. • Pasture establishment / improvement, especially perennials. • Changing management practices. • Develop a long-term plan to reach your goals. • Get soil health right, right plant in the right place. • Manage paddocks correctly / manage ground over, which may require rotational grazing, stock containment. • Weaning off use of insecticides (use with care). • Enterprise changes due to climate change. 	<ul style="list-style-type: none"> • Soil type – minerology, sodic soils, acidity at depth. • Climate change and a more variable climate. • Government regulations. • Budget constraints. • Asset costs, market prices operating costs. • Past management decisions!!!!

Hamilton branch of SFS /Cavendish BWBL/ Pasture Tech

In seven workshops, 160 producers attended. Two open events were ran which were both well attended (37 producers in each plus agronomists).

The group had three sessions each on waterlogging and soil organic carbon. Due to the high rainfall area (600 to 700mm), waterlogging affected from 10 to 90% of their farms in an average year which generally increased in a wet year.

Covid disrupted both the momentum of the group and affected how some events were run. For example, its first two scheduled workshops had to be done online and then the group waited for restrictions to ease resulting in an 11-month time difference between workshops 2 and 3.

Having online events allowed the events to be recorded and they were made available through the SFS YouTube Channel and links made from the SFS Healthy soils community of practice page, and this enabled further reach.

The soil carbon webinar - <https://sfs.org.au/resource/soil-carbon-webinar>, since its upload (April 2020) has had 271 views. The waterlogging webinar - [Waterlogging Webinar 2020 – Southern Farming Systems \(sfs.org.au\)](#) has had 80 views since June 2020.

The last facilitated session was commented to be very successful and a great way to finish the series with the group.

Table 28. Hamilton group workshop quantitative and qualitative evaluation results

Workshop name	Number of producers	Qualitative evaluation data
Pre-planning workshop	11	Notes written up from meeting, identifying topics of interest and what they wanted to learn.
Soil Carbon Webinar	19	When asked what did they like about the event? <ul style="list-style-type: none"> • “Quick and to the point” • “Very easy to understand” • “I liked how he started from the beginning and didn’t assume prior knowledge. It provided a great overview of soil carbon in a short presentation!” • “Well run” • “It was pretty interactive given the delivery mechanism” • “Good clear presentation” • “The overall general presentation and flow of information” • “Good conversation afterwards, local and relevant, resources supplied afterward.” • “information presented”
Waterlogging Webinar	21	When asked what did they like about the event? <ul style="list-style-type: none"> • “Quick and concise”, “Cam has research and practical experience that he was able to shape into a very good presentation.” • “Good presentation” • “information was delivered well”, “Was still able to participate.” <p>Post questions allowed an understanding of group issues. What causes waterlogging on your property?</p>

		<ul style="list-style-type: none"> • Soil type, short, rooted grasses and compaction • Poor drainage • Surface moisture unable to run away • Too much rain and not enough water holding capacity and use. • Slow infiltration rates due to sodic subsoil <p>In an average rainfall year, how much of your property in a percentage is affected by waterlogging?</p> <ul style="list-style-type: none"> • 50%; 15%; 10 to 20%; 50%; 90% <p>And in an above average year?</p> <ul style="list-style-type: none"> • 80%; 20%; 10 to 20%; 60%; 90% <p>Have you considered or implemented any drainage works to alleviate the issue? If yes, please explain.</p> <ul style="list-style-type: none"> • No • Yes Surface drains, sub surface drains • Started putting in surface drainage • Surface drains and sub soil manuring • Yes have used subsurface drains for cropping paddocks
Drainage session at Digital Innovations Smart Agriculture festival workshop (Open event)	37	Do you feel waterlogging is constraining your production in your farming system? 65% said yes
Soil Carbon Workshop	19	<p>Average value rating 4 out of 5 from 11 respondents, comments that there was good discussion.</p> <p>What was your biggest insights from today?</p> <ul style="list-style-type: none"> • Organic Matter = Organic Carbon • Producer running more stock with less P • Concentrate on building OC for pasture benefit rather than neutrality • How many tonnes of growth to improve soil OC. • Target OC of 4% for this area • Disconnect between topic and practice on farm • The slow rate to build soil carbon • pH level & carbon storage <p>Comments from the post evaluation:</p> <ul style="list-style-type: none"> • “Concentrate on building OC for pasture benefit rather than neutrality” • “Good discussion” • “Target OC of 4% for this area” • “The slow rate to build soil carbon” • ” pH level & carbon storage”
Dirt and Water farm walk (Open event)	37	Generated high interest. There were three soil pits open within 100m of each other showing the variances of the soil profile and where the subsoil manure had been clearly placed. This provided

		<p>great conversation around how the soil varies and the depth of the topsoil to the clay layer.</p> <p>Post session questions:</p> <ul style="list-style-type: none"> • Rate your skills and knowledge around water infiltration and water holding capacity? Average score of 2.8 from 5.0. • Rate your skills and knowledge around implementing a water management system? Average score of 2.8 from 5.0. • After today's event are you considering any of the water management systems discussed today? 87% said yes.
Sustainable soil organic carbon	16	After today's event are you confident you understand nutrient/carbon cycling? 100% answered YES or No
7	160	

Before and after skill assessment surveys were completed in four workshops (table 29) and show a positive change.

Table 29. Hamilton group data from before and after skill assessment surveys and the change in the number of correct answers

Workshop name	Assessment Question	Before	After	Change
Soil Carbon Webinar	What are the three greatest influences on the amount of soil carbon that can be stored by a soil? (Answer: <i>Soil Type, Climate & Management</i>).	13%	70%	57%
	What two practices could you adopt on your farm to increase soil carbon? (A: Proven management ways to improve growth, reduce cultivation, permanent pastures, reduce cropping)	57%	97%	40%
	How much extra dry matter would you need to grow per year to lift stable soil carbon by 0.5%? (Answer: approx. 45 t/ha, need to grow about an extra 2t DM/ha/yr. over 22 years to achieve) a lot was acceptable.	5%	44%	39%
Drainage DISA (Open event)	Please rate your confidence in knowledge of how waterlogging is affecting the health of your soil? (Unsure, reasonably, extremely)	83%	100%	17%
Soil Carbon Workshop	What % level of soil organic carbon (0-10cm) do you think is achievable in your pastures & your soil types & climate?	20%	82%	62%
Dirt and Water farm walk (open event)	Rate your skills & knowledge on soil constraints? (Knowledgeable 5, somewhat knowledgeable 3 and no knowledge 0)	3.3 out of 5.0	3.4 out of 5.0	+0.1

Collection of data related to intention to adopt was also collected from feedback in the last session. Producers identified many achievable actions they were planning on undertaking.

Table 30. Identification of actions they could do as intent to adopt

Topic	What can I easily do something about?	What could I do something about, but it will take time?
Soil Carbon	<ul style="list-style-type: none"> • Test and see where you are at. • Look back on past soil tests to see if OC levels have, they gone up or down with current practices. • knowing the % carbon in the soil to target and soil management of organic carbon. • keep asking questions and to question what is happening. • Assessing what is the best major nutrient to use. • Put the correct fertiliser out. • Better management. • Balancing inputs and outputs of farm production” • Grow more. • More Inputs, better management • Increased biomass production. • Compost/recycled organics. • Target pH level to get more carbon storage. 	<ul style="list-style-type: none"> • Building soil carbon in the soils is a slow process. Switching from cropping to pastures will increase OC quicker but will plateau. • Increase humic fraction. • Knowing the amount of organic matter to apply to get organic carbon change over. • Best management practices seem to maintain good OC levels.
Waterlogging	<ul style="list-style-type: none"> • Zone the areas that get saturated with water most years. • Map the area’s and look at design options. • Pasture species options • where to start on a water management plan by using elevation maps and other precision technology mapping • identifying the issue 	<ul style="list-style-type: none"> • Longer term identifying the areas that require drainage. • Implement the drainage system. • using surface and subsurface drainage.

Meningie field livestock and pasture group

In six workshops, 143 producers attended. One open event was ran with 24 in attendance. Most events involved field trips and all the events were all well received.

Table 31. Meningie field livestock quantitative and qualitative evaluation results

Workshop name	Producer number	Qualitative evaluation data
Soil Innovation	21	Challenging to ensure participants filled out the skills audit. Strong landholder interest in machinery demonstrations.
Soil test interpretation	24	Comparison of soil test parameters under native vegetation and dryland lucerne was met with very strong interest from the group. In particular, the higher levels of organic carbon under the dryland lucerne pasture than uncleared native vegetation.

		We plan to undertake further work on this under a range of land uses to learn more about soil test parameters under a range of land uses and production systems.
Soil test interpretation (Open event)	35	Larger family and business groups in attendance. Interesting discussion of future areas of interest at the conclusion of the day. Quite low pH results on some sites was a surprise to some participants.
Soil organic carbon	29	Larger family and business groups in attendance, with a mix of genders and age groups. Response to this presentation was outstanding prompting these comments. <ul style="list-style-type: none"> • 'This is the best thing you have run for our group' - Angas Agriservices. • 'I have been trying to understand soil carbon for 20 years, and that is the first time I have had it explained to me in a way that makes sense' Of interest, in rapid field-testing techniques was that soil carbon was too low to measure. Strong interest in trying soil amendment techniques to overcome soil constraints.
Establishment of Aqua till demonstration site	10	This session was held during COVID-19 event restrictions, so numbers were deliberately kept low. The session was well received due to; <ul style="list-style-type: none"> • Core producers having one on one access to no till technical expert from SANTFA • The opportunity of core producers being able to learn by doing, by establishing a demonstration site comparing treatments • The opportunity of core producers to be involved in machine set up and use Group facilitator and independent advisor provided demonstration site monitoring of the site for the Meningie East Healthy Soils Group (emergence counts and photo points).
Improving grazing production on non-wetting sands (Open event)	24	100% rated the information very useful or greater (62% extremely useful and 38% very useful). What rating would you give your knowledge of limitations of sandy soils after this workshop? Increased change by 31%
6	143 producers	

The change from the skill assessment (table 32) reflected the learning pathway the group undertook over the length of this project. There was a better recognition of soil constraints, increased uptake of soil testing and skills in identifying key limitations and increased uptake of practices to overcome soil limitations across a range of soil amelioration and management techniques. This also indicates an increase in producer confidence to try new techniques to increase production. The results also show that participants had familiarised themselves with the level of soil acidity on their farm, and an

improved their understanding and importance of testing for soil acidity, as well as the importance of testing at multiple depths down the soil profile.

Table 32. Meningie field livestock and pasture group data from before and after skill assessment surveys and the change in the number of correct answers

Assessment Question	Before	After	Change
What soil constraints do you encounter on your farm?			
• Nonwetting sands	26%	100%	74%
• Fertility	15%	100%	85%
• Soil pH	12%	67%	55%
• Soil moisture holding capacity	12%	82%	70%
• Low potassium	3%	50%	47%
• Low organic carbon	3%	50%	47%
How do you identify your key soil limitations?			
• Observation	50%	100%	50%
• More or less plant growth	18%	82%	64%
• Soil testing	23%	33%	10%
• Dug a hole	0%	17%	17%
• Other, penetrometer	6%	0	-6%
If you have addressed these soil limitations, how did you do this?			
• Ploughing and cultivation	13%	50%	37%
• Wetting agents	13%	50%	37%
• Trialling different	7%	67%	60%
• Pasture cover, grazing management, fertiliser	7%	100%	93%
• Biological agents	7%	0%	-7%
• Clay spreading	7%	16%	9%
• Clay spreading	7%	50%	43%
• 2-year pasture renovation	7%	16%	9%
• Other mechanical			
Do you think your soil type varies much over your farm? Yes	7%	18%	11%
What part of the local soil profile (if any) do you think may be affected by soil acidity e.g., topsoil, subsoil, etc?			
• Future concern	14%	0	-14%
• Topsoil	22%	32%	10%
• Very little concern	28%	0%	-28%
• Both top and subsoil	36%	32%	-4%
• Not currently a concern	0	32%	32%
How would you sample a paddock to identify if you have a soil acidity issue?			
• Soil test at multiple depths	10%	50%	40%
• pH test	40%	83%	43%
• Soil test			-
	50%	32%	18%

The greatest impact the healthy soils discussion group had on the practices of participants was the:

- Improved understanding of soil limitations
- Increased interest in soil carbon
- Improved uptake and interest in soil amelioration techniques
- Appreciation of a focus point to catch up socially as a group

The group emphasised that the keys to the successful discussion group was to keep discussing with core group members what topics and challenges were of interest to them and to not underestimate the value placed on the opportunity to catch up socially as a group.

Kangaroo Island healthy soils group

After agreements were finalised, most group members were burnt out by the 2019/2020 bushfires on Kangaroo Island. The project probably should have been withdrawn allowing producers to recover but on the other hand four producers were not impacted by fire and of those impacted they still made it to some events and appreciated the opportunity to connect with others. Core group attendance was good, and the small group worked well as everyone was able to contribute to discussions. Overall group attendance was 74 and which was lower than most other groups

Table 33. Kangaroo Island productivity group qualitative evaluation results

Name and date of event	Producer number	Qualitative feed back
June 2019 Soils 101	1A – 10 1B - 6	The workshop was run twice due to impact of fires and covid.
Oct 2019 Soil pH and nutrient mapping, soil cover/erosion	13	Good on property discussion with the landholder re good farm management practices to improve soil health. “Compaction decreases soil oxygen and drainage – roots won’t grow past 300psi”
Aug 2020 What are our weeds telling us in relation to soil health?	14	Good level of questions re the topic and the farm walk to visually ID weeds and look at soil constraints
Oct 2020 Soil biology (open event)	17	Participants brought along “undies’ they had buried to monitor soil biological activity which generated a good discussion with the presenter about soil health, biological activity and what had happened to the ‘undies’ <ul style="list-style-type: none"> • Soil biology is a new science • Functions of soil microbes – decompose plant residues, improve soil structure; regulate water quality; suppress soil borne diseases • The importance of microbiology in our soils • There’s still a lot to learn about soils (in relation to soil biology) • Undies degrade in soil

		<ul style="list-style-type: none"> • Soil is a complex thing!
May 2021 Soil Carbon and soil pH + participant projects	14	<ul style="list-style-type: none"> • Interesting session – great to have local KI data • First time the whole soil carbon story has actually made sense to me • Good confirmation of things I knew • Thanks for the session and for the whole program • Thanks – enjoyed it, looking forward to getting a copy of the hard data • High clay content and high rainfall = higher soil carbon
6 workshops	74	

Self-rating of skills gained after each session showed improvement in skills gained (table 34). The highest change occurred using weeds as an indicator of soil condition. The lowest was in the final workshop with 15% change but this could be due to participants knowledge increasing from the previous events, where those topics were discussed.

Table 34. Kangaroo Island productivity group self-rating of skill improvement after each session

Event and assessment Question	Before	After	Change
Soils 101	2.4	3.1	23%
Soil pH and nutrient mapping, soil cover/erosion	2.1	2.9	25%
What are our weeds telling us in relation to soil health?	1.7	2.7	37%
Soil biology	2.0	3.0	33%
Soil carbon and soil pH	2.4	2.9	15%

A post project survey evaluation from 11 respondents showed that most participants had good knowledge and assessment skills in their related topics (table 35) and had learnt both soil assessment and management practices (table 36).

Table 35. Kangaroo Island productivity group post project survey assessment questionnaire.

Post survey questions	Survey results
The majority of soils on KI are acidic YES NO Name one treatment for acidic soils	100% answered correctly
Name one benefit of maintaining good ground cover?	100% answered correctly
Name one soil constraint a weed may be addressing in a paddock?	82% answered correctly
Name one practice that will help build the soil biology in your paddocks	100% answered correctly
Name one benefit of improving soil carbon?	73% (3 did not answer), the others answered correctly

Table 36. Kangaroo Island productivity group identification of skills learnt

Workshop topic	What producers had learnt
Soil assessment	<ul style="list-style-type: none"> • “How to take soil & leaf tissue tests” • “By measuring/testing and by meeting your major constraints – you can increase production.” • “The correlation between soil nutrients and what the soil test is telling us about nutrient deficiencies.”
Weeds as indicators of soil health	<ul style="list-style-type: none"> • “Weeds can tell us a bit about any problems there are with the soil.” • “What your weeds are telling you about soil compaction.” • “Weeds are indicators of soils issues.” • “Different weeds tell indicate different problems.” • “What weeds are trying to do – protect bare soil; boost low organic matter; correct microbial imbalances.” • “Weeds can tell me what is going on in my soils & what need improving in my soil management.” • “Weeds are a good indicator for soils in surplus/deficit in key elements and compounds.”
Soil acidity	<ul style="list-style-type: none"> • “How to help reduce acidity over time with lime sand.” • “Lime sand to fix pH.” • “The importance of pH levels in soil and it’s effects on plant production.” • “pH is a major constraint on KI & by addressing pH first, you can improve other mineral uptake in your soil.” • “pH is critical to improving soil health & fertility.” • “Where my own farms pH levels are at & what is required to improve them.”
Fertility	<ul style="list-style-type: none"> • “Fert rate.” • “There is an intricate balancing act to get all the soil nutrients right in the soil to enable plant roots to access what they need.”
Soil carbon	<ul style="list-style-type: none"> • “Keeping ground cover over summer is crucial to increasing soil carbon.” • “Changing pasture management and using perennials will improve soil health.”
Soil biology	<ul style="list-style-type: none"> • “Plant more perennials, to keep soil biology active over summer.”

The small project completed by the core group individuals also had good practice change including:

- Greater uptake of soil testing amongst participants, 10 out of the 11-farm business involved in the program undertook soil testing during the life of the project.
- Greater uptake of liming to counteract soil pH/acidity with 5 out of the 11-business applying lime during the program (note the financial impact of the bushfire’s was the key deterrent to liming).
- 7 out of 11 business changed their fertiliser regime as a result of the testing – i.e., changing fertiliser application rates.

Flinders Island productivity group

The group had a comprehensive program but had the lowest total attendance of 57 producers across six events. The facilitator found it challenging to get all landholders together at the same time as they were busy and during times where they had more availability, many other projects were also delivering workshops and field days. The events were all open to the public.

Based on landholder feedback after each event, delivery topics evolved from the initial workplan. Landholders wanted a more inclusive approach, especially acknowledging that each farm and producer/manager is different and there are many drivers and influencers of decision making on farms, not sure soil health.

Table 37 shows what new actions the producers would try following the workshop. This provides intention to adopt. Self-rating of pre and post assessment skills after each workshop was also completed and results are shown in table 37. They show that producers felt they had increased skills, and this also indicates an increase in confidence.

Table 37. Flinders Island productivity group quantitative and qualitative evaluation results

Workshop Description	Participant Number	Qualitative feed back
Soil assessment (pH, structure and soil biology)	10	New action to try: <ul style="list-style-type: none"> • pH test and dig holes • Request agronomist to discuss and explain in full soil test results and what soils need to be a healthy soil. • Look at the soils more, visually and for indicators of what is going on. • At home soil testing. • More observation.
Soil test interpretation Pt 1, salinity and waterlogging, pastures and forage	11	New action to try: <ul style="list-style-type: none"> • Be very mindful of soil testing and seeking advice on all elements that need addressing (inc. trace). • Methods to manage salt affected soils. • Liming. • Analyse soil test results to determine fertiliser applications. • Use Data Farming (NDVI) spatial maps to aid decision making. • Identify most appropriate area of farm to spend money on. • Liming to break down thatch of organic matter on acid soils. • More forward planning. • Colour code farm paddock plan for nutrient levels/pH to prioritise action
What can emissions tell us about livestock productivity, pasture / feed quality and soil health?	7	New action to try: <ul style="list-style-type: none"> • Online emission audit. • Increase live weight gain., • Use 'strip till' for pasture renovation. • Improve live weight gain • Online emission audit • Carbon audit farm
Soil test interpretation refresher. Trace elements when to use	9	New action to try: <ul style="list-style-type: none"> • Soil testing • Spread less lime & fertiliser more often. • Use additional micronutrients via liquids • Colwell P testing

		<ul style="list-style-type: none"> • Test soil before buying fertiliser
Major soil types on Flinders Island and, and how to best use them for grazing	13	<p>New action to try:</p> <ul style="list-style-type: none"> • Increase species diversity and microbiology. • tissue testing of pasture, more soils testing, more visual assessments ('dig holes'). • more testing. • more trial work, more visual assessments ('stick spade in the ground'). • more soil testing & follow through for all elements to improve pasture, not just N and P. • Question soil tests, use more tissue tests, use spray applications e.g., for trace elements.
Using soil, land capability and other spatial data to make management decisions	7	<p>New action to try:</p> <ul style="list-style-type: none"> • update farm map • use to measure paddock areas • make farm map • add infrastructure to farm map • check out other layers, learn more • soil map layer use
6 workshops	57	

The facilitator observed that group members can assess soil health via a range of visual indicators and using simple pH kits and an infield labile carbon test. This allows producers to target further soil and plant (lab) testing on paddocks that have the greatest potential for improvement and return on investment e.g., lime.

Producers also provided insights that showed they had improved capacity around soil management decision making when dealing with soil related challenges. For example:

- Investing into the worst performing areas may not be profitable, for instance If issues like salinity cannot be 'removed'. "Sometimes the best option is to manage well 'what we got'".
- The realisation that when interpreting soil tests, it is important to focus on limiting factors and look at nutrient interactions. If low pH is the issue, liming will change not only the pH but also soil structure, nutrient availability, and microbiological activity.

Getting together and exchanging information and ideas amongst group members and with guests was found to be important. The more often and intensively landholders participate and engage with others, the more they appear to get out of workshops and field days, i.e. the interaction in the group is an essential part of capacity building.

The discussion group also allowed producers to develop a shared understanding of components of soil health and realisation that soil health was not just one factor but a well-defined combination of physical, biological, and chemical soil properties. A healthy soil has the best possible condition given parent material, location, climate, plant communities (pastures, crops, native vegetation) and management.

Table 38. Flinders Island productivity group quantitative and qualitative evaluation results

Workshop name	Before	After	Change
Soil assessment (pH, structure and soil biology).	27	35	88% recorded skill increase by average of 13%
Soil test interpretation Part 1, salinity and waterlogging, pastures and forage.	33	40	55% recorded skill increase by average of 28%
What can emissions tell us about livestock productivity, pasture / feed quality and soil health? How to improve productivity based on results of an emission assessment?	27	41	86% recorded skill increase by average of 23%
Soil test interpretation refresher Part II. Trace elements when to use.	39	43	100% recorded skill increase by average of 15%
Major soil types on Flinders Island and, and how to best use them for grazing.	38	45	92% recorded skill increase by an average of 12%
Using soil, land capability and other spatial data to make management decisions.	0	22	100% recorded skill increase by an average of 23%

Tamar NRM (Natural Resource Management) group

Overall event attendance was 130 over seven workshop events (table 39). All up 21 farms were well represented over the six sessions plus the one open field day which attracted 22 attendees.

The Tamar group split the discussion groups into two groups. The downside to that was that two sets of workshops increased the reporting and monitoring effort. But it also allowed topics and skill capture in the second discussion group to be changed based on feedback.

It was learnt from the first three soil sessions, that reading and understanding soil reports was a major knowledge gap. They all agreed that taking advice from agronomists was important and heeded but knowing how to read and interpret a soil report assisted their decisions on fertiliser use and what action to take. Therefore, session four covered soil reports in greater detail. A soil biology workshop was provided in the second set of sessions by the request of participants.

Table 39. Tamar NRM group quantitative and qualitative evaluation results

Workshop name and date	Number of producers	Qualitative and quantitative data
Introduction soils 101	17	<p>The hands on tests by all participants (pH; Organic carbon) was well received.</p> <p>The 18 pH tests conducted by Glenn Brown ranged from 4.4 to 6.28.</p> <p>Many did not currently soil test and made the following comments regarding soil tests.</p> <ul style="list-style-type: none"> • I still seek advice on tests – good investment – advisers have broad experience of other farms • Complex field to understand everything

		<ul style="list-style-type: none"> • DYO vs advisers – ‘independent’ advice hard to find • Field Days – give an understanding of what questions to ask of professionals
Wet soil management	16	The day was wet and the farm visited was substantially waterlogged which generated good drainage discussion
Soil testing and interpretation	16	<p>Producer’s intentions collected after three sessions were:</p> <ul style="list-style-type: none"> • Increase soil testing and assessing soil structure • Drainage assessment • Better drainage • Regular pH checks; increase soil carbon and microbiological activity • Better drainage; Less soil disturbance • Identify soil types and specific nutrients as required. • Improve soil drainage, Map and trial area under new pivot irrigation • Soil Testing; Adding Lime • Use List map (Tasmanian gov. information database) • Trial Humic acid or molasses with fertiliser; Change to foliar urea; Look at soil mapping and nutrient budgeting • Enhance fungi survival
Local soils and soil health (Open event)	17	Open session: Results showed from 11 respondents: 45% Exceeded expectations; 45% Met expectations; 9% partially met expectations.
Introduction soils 101 Part and wet soil management	18	<p>Reading and understanding a soil report featured and options for lower cost drainage management presented. The interaction from landholders was good.</p> <p>The farm visit was a great case study in the benefits of drainage.</p>
Soil suitability, testing and soil biology	22	<p>Soil pH was discussed at length. Visited a farm under transition from forestry back to pasture-built interest in feed utilisation and soils role in pasture production.</p> <p>Building an understanding of available tools and websites was well received.</p> <ul style="list-style-type: none"> •
Soil biology Part 2	24	<p>Feedback indicated high satisfaction with the program</p> <ul style="list-style-type: none"> • Interaction and speakers’ discussion all helpful • Great sessions. • Very hands on/practical and helpful. • Be great to see follow up sessions for example demonstrate drainage work. • Good program and a worthwhile activity • It would be good to have a yearly update and refresher as a group to share our experience and results from home paddocks • Excellent sessions.

		<ul style="list-style-type: none"> • Keep up the good work. • Can they continue especially with respect to biological life in soil and how to increase it? • The group discussions are very important as well as expert speakers. • it was a worthwhile program • Very well delivered, good timing to look at problems and discuss ways of fixing.
7 workshops	130 producers	

An audit of the first discussion group after three sessions was completed by only five producers but shows that most producers recorded a modest amount of skill change (table 40).

Table 40 Tamar NRM group evaluation of knowledge change after the first three sessions

Assessment questions	Before	After	Change
How would you rate your prior knowledge on the three field day topics and how would you rate your knowledge now? (1= low, 5= high)	2.3	3.5	88% recorded a skill increase by average of 13%

Post audit survey questions of the second discussion group shown in table 41 reveal several outcomes including:

- intention to adopt. Eight out of ten respondents indicated they intend to make sensible change practices (excluding reducing fertiliser to increase soil biology or no change).
- there was better recognition of soil issues and that through the discussion, producers also received additional information that will help with animal management.
- All respondents are wanting to understand soil limitations better. Most identified more soil testing is happening or planned.
- Producers are gaining better recognition of the variability of soil conditions and types on their farms.
- Still work needed to improve producer's skills on reading soil tests.

Table 41. Tamar NRM group before and after questions from workshops 4 to 6.

Before	After
Pre - What farm management strategies to maintain soil condition or improve it do you use? <ul style="list-style-type: none"> • Combination of strategies, organic matter increase, fertilisers and organic matter, diversity of species, observation, test, and practice • Drainage • Strip sowing • Multi-species planting/diversity 	Post- What farm management strategies to maintain soil condition or improve it have you changed since you attended the Healthy soils discussion group sessions? <p>Assessment</p> <ul style="list-style-type: none"> • Soil test, clearing scrub wattle, engaged agronomist for advice on managing cleared 20 ha. • Enhanced soil testing plan. <p>Fertiliser and lime</p> <ul style="list-style-type: none"> • Fertiliser, planted fodder crop, 18 month plan to follow to establish perennial pasture. • Fertiliser reassessment. • Lime, fertiliser, sowing mixed spp pastures and lengthening rotation.

<ul style="list-style-type: none"> • Measuring and monitoring • Irrigation • No till 	<p>Groundcover</p> <ul style="list-style-type: none"> • To increase soil conditions through keeping a mulch layer, use of worms and dung beetles to recycle matter and to keep height on grass. • Groundcover maintenance. • Better coverage. <p>Soil biology</p> <ul style="list-style-type: none"> • Methods of improving soil carbon and microbiological activity. • Use of fertilizers reduced, focus on soil biology. <p>No change yet.</p>
<p>Pre: What are your key soil limitations for feed production in your business?</p> <ul style="list-style-type: none"> • Drainage • Lack of input from microbes and bacteria • Wildlife control – fencing 	<p>Post: Through attending Healthy Soil Workshops, have you learnt anything new on your key soil limitations for feed production in your business?</p> <p>Drainage</p> <ul style="list-style-type: none"> • A lot of information about the importance of good drainage, better understanding of soil types & how to ID on property. • Importance of good drainage. <p>Fertiliser</p> <ul style="list-style-type: none"> • Yes - I now realise how much nutrient needed to enhance productivity • I have learnt about the importance of setting the pasture and soil up in autumn <p>Monitoring and assessment</p> <ul style="list-style-type: none"> • Need for greater monitoring of soil health and condition • Soil test. Soil test. Soil test <p>Improved recognition of constraints</p> <ul style="list-style-type: none"> • My limitations are acid soil that is wet clay in winter and dry hard in summer (Recognition of). • Not producing feed (being limited by soil constraints) • Understanding better how the soil needs to be treated <p>Other - in a discussion group environment they pick up other messages</p> <ul style="list-style-type: none"> • Necessity to invest is fencing to reduce native animal burden on pasture more than offset by the improved feed production. • Animal management
<p>How did you identify your key soil limitations? And if you have addressed them, how did you do this?</p> <p>Attendee producers were not universally testing soils as part of their management.</p>	<p>How did you identify your key soil limitations? And if you have addressed them, how did you do this?</p> <ul style="list-style-type: none"> • Digging sample holes and observing aggregates, roots, worms etc • Observe animal health closely (eg. Impacts of low Mg, Se etc). • Examining soil - digging a clump and identifying earthworm numbers, fungi, smell, particle types etc, soil testing and applying dolomite, lime, fertiliser, and some trace elements. • More soil testing and pasture composition monitoring.

	<ul style="list-style-type: none"> • Ground mulch is missing from my soil and pasture system. I have increased mulch by harrowing manures and slashing high grasses early Spring, which started decomposition before seed heads grew on grasses. • Seasonal limitations to usage of some paddocks. Better rotational use of paddocks, weed control and moisture preservation. • Using weeds to identify missing elements. • Physical examination. • We soil test every paddock, which is reviewed by our agronomist and a 5yr plan is developed from the results. Then we plan to test again. • More soil tests, giving areas time to recover. • Will do further soil testing at the most suitable time for accurate results and follow up with prescription applications in autumn.
<p>Do you think your soil type varies much over your farm? A little bit; A fair bit; A lot Participant producers agreed it varied a lot.</p>	<p>60% believed they have more soil type variation and 40% less.</p>
<p>What is your understanding of reading soil reports? A little bit; A fair bit; A lot Feedback was participants were unable to read a soil test.</p>	<p>60% a little bit and 40% a fair bit.</p>

The greatest impact to practice change recorded by participant feedback was an increase in soil testing and interpretation to assist management. Managing soil profile variability is better understood, drainage and drainage plans appreciated more, fertiliser budgeting, pasture management, soil biology, wildlife grazing pressure also featured strongly. Most identified in survey monkey audit that more soil testing is happening or planned.

Adoption of practices would need to be assessed in a year or two to have greater monitoring and evaluation value, but the facilitator said drainage was viewed as a singularly important issue to address. They knew producers contacted experts to get drainage plans and others started taking soil samples to assess nutrient deficiency and fertiliser adjustment, while others started a biological monitoring program.

4.3.3 Community of practice

The regional event was highly successful and attended by 59 participants with all producer groups represented. Another five had registered but couldn't attend on the day and were subsequently sent the webinars link.

The webinars were made publicly available on August 16th, 2021. Alternative fertilisers – had 77 views, soil acidity 69 views and soil organic carbon 43 views after one week. Up until the end of March, the fertiliser webinar has now had 194 views, soil acidity 156 and soil organic carbon 183 views.

The webinar was quite interactive which was evident through 11 chat box questions plus additional verbal questions and 26 chat box comments. The quality of the speakers and satisfaction of the event can be gauged through some of the feedback given in the chat box from three producers.

- “Thanks to organisers and the group. It’s a great program!”
- “Thanks, three great sessions.”
- “Thank you all for some great information.”

The webinar was a success due to the quality of speakers involved and the participants willing to engage and ask questions.

The scenarios used for promotion and presentations, encapsulated producer’s questions and this got them to attend.

The outcomes of the webinar were:

- A legacy of three informative science backed webinars available through SFS YouTube channel. Success was summed up by this public online comment regarding the Fertilisers webinar: “Excellent presentation. Rigorous, open, defendable, unbiased science. This is important – SFS please circulate widely. Also email feedback included “Acidity and Carbon presentations were great – clear, well structured.”
- Provided direction in what participants are interested in and highlighted potential knowledge gaps. The next Premium Pasture event topic has been chosen based on the discussion around understanding soil nitrogen content within pastures and the role it plays in building soil organic carbon. This is based on audience comments regarding Mark Farrell’s discussion of soil nitrogen. *“Has there been the same work within the livestock system to see if there is a deficit of N?” and “Great discussion. Any studies that show how well N is being used in modern grazing systems - e.g. leaching extent, role of pasture is mopping up N. How N efficient can we be in grazing?”*

The webinars were also promoted through Agriculture Victoria’s, Soils community of practice Newsletter in July-August 2021.

Resource sharing

A Healthy Soils project page was established on the SFS web site and is available from the following link [HEALTHY SOILS – Southern Farming Systems \(sfs.org.au\)](https://www.sfs.org.au/healthy-soils). The page has had 115 views since going live in January 2022.

This page has been promoted to the soils group and allows products and resources created through this project to be shared. Below is a list of resources on the webpage. Useful resources have been shared by five soils groups and all the group’s case studies will be made available on the site following publishing by MLA.

Research Information & Objectives

What resources are available?

Visual indicators of soil condition

[Visual indicators of soil condition Online Booklet](#)

[Poster](#)

Video 1. [Visual indicators of soil condition Part I: In the paddock](#)

Video 2. [Visual indicators of soil condition Part II: Plants and pasture](#)

Video 3. [Visual indicators of soil condition Part III: Soil surface and clover roots](#)

Nutrients/Fertiliser

[Healthy Soils Webinar Video – Session 1 Fertilisers](#)

[Healthy Soils Webinar Presentation Slides – Session 1: Nutrients/Alternative Fertilisers](#)

[Understanding Biological Farming Inputs Technical Report](#)

[Chicken Litter: Alternative fertiliser for pastures and ways to increase soil organic carbon Report](#)

[Fertiliser test strips](#)

[Test Strips help make better fertiliser decisions](#)

[Nutrients/Fertilisers – Producer Case Studies](#)

[FAQ Nutrients/Fertilisers/Biological amendments](#)

Soil Acidity

[Sharing Information Webinar – Session 2: Soil Acidity](#)

[Holbrook Landcare Network Healthy Soil Group Soil Acidity](#)

[Holbrook Landcare Network Healthy Soil Group- Accurate soil sampling to 20 cm in 5 cm intervals video](#)

[Tackling Acid Soils - findings to date video](#)

[Soil Acidity – Producer Case Studies](#)

[FAQ Soil Acidity](#)

Soil Organic Carbon

[Building Soil Organic Carbon – the role of your management Webinar with Susan Orgill](#)

[Soil Carbon Webinar with Cam Nicholson](#)

[Soil Organic Carbon Workshop with Lisa Miller](#)

[FAQ Soil Carbon](#)

Soil Biology

[Soil Biology & Testing webinar with Dr Helen Hayden](#)

Waterlogging

[Waterlogging Webinar 2020](#)

Soil Structure and Soil Protection

[Groundcover factsheet - Tablelands Farming Systems and Coolac Farming Group](#)

[Soil Structure and Soil Protection – Producer Case Studies](#)

Sodicity

[Sodic Soils Webinar with Cam Nicholson](#)

[Sodic Soils Webinar Presentation Slides](#)

4.3.4 Case studies

Twenty producer stories were developed and sourced from the discussion groups. Only seven have been published to date. Initially the first 10 were to be completed by the end of 2020 but the producers had not had much chance to implement works associated with the project and so this was delayed.

The case studies offer producer's insights from the Healthy soils group members into most soil management topics. The dominant topics covered, was liming, and managing soil acidity and soil testing which were focus areas for most producer groups. Other topics covered include waterlogging management and soil organic carbon.

Of the seven published stories, there has been a high number of views indicating the popularity of the stories. One of the case studies (Lime lifts clover at Overdale) has been added to the soil hubs.

Table 42. Case studies written from different soil discussion groups.

Group name	First story	Second story
Mid Goulburn GSSA	Tests strips help make better fertiliser decisions. Published 25/6/2021 in Friday Feedback with 1,677 views.	Know your soil profile. Submitted June 2022
PPS	Lime lifts clover at Overdale. Published 6/8/2021 with 1,385 views.	A perfect recipe for a productive phalaris pasture. Submitted June 2022.
Tamar NRM	Soils for the Future. Published in Feedback magazine Jan 2020.	Soil group stirs a passion. Published 13/8/2021 in Friday Feedback with 1,885 views.

Holbrook LN	Lifting expectations and production with lime. Published 18/6/2021 in Friday Feedback with 1,199 views	Soil testing drives farm production. Submitted April 2022.
Kangaroo Island PG	Soil testing highlights potential for lime KI. Published 23/3/2021 in Stock Journal, SA	Independent advice supports sound decisions. Submitted April 2022.
Tablelands Farming Systems	Soil information is gold. Published 20/8/2021 in Friday Feedback with 2,661 views.	Increasing ground cover pays dividends. Submitted May 2022.
Flinders Island PG	Liming breathes new life into perennial pasture. Submitted August 2021.	Navigating root bound soils gets soil thriving on Flinders Island. Submitted June 2022.
Meningie field livestock and pasture	Soil management key to lift farm production. Submitted August 2021.	Lucerne pastures and rotational grazing lift soil carbon levels. Published 29/4/2022 in Friday Feedback.
Coolac Farmers	Soil strategies for the best returns. Published 18 May 2022.	Reinforcing the key elements of soil management. Submitted May 2022.
Hamilton SFS/BWBL/GSSA group	Changing soil organic carbon levels through management, is it working? Submitted May 2022.	Managing wet soils for productivity and environmental gains. Submitted May 2022.

4.3.5 Where to next for the groups

All 10 groups had discussions about where to next, so they can continue to learn about soil constraints and management. Further opportunities promoted were MLA PDS or PGS courses, including PayDirt and training packages related to Pasture Paramedic (resowing and manipulation). Five of the groups are already involved or are developing applications to undertake a PDS. Only three producers expressed interest in undertaking the PayDirt PGS training package and all from the Flinders Island group. For delivery of PGS training, new trainers would be required to deliver to Tasmania and NSW. A summary of groups plans, and unanswered questions is provided.

Holbrook landcare network

The group developed an Acid Soils Strategy, including “next steps.” There is ongoing support from several members of the group to further investigate the most effective top-dressed liming strategy in perennial pasture systems. The group have recently applied for an MLA PDS, Project Title: Managing soil acidity in permanent pastures. The questions the group aims to answer are:

- What rate and frequency of top-dressed lime is required on established pastures to increase 0-10 cm pH_{Ca} above 5.5? (i.e., how do we achieve amelioration of subsurface acidity when lime is top-dressed?)
- What is the benefit of updated approaches to acid soil management on productivity and composition of perennial pastures?

These knowledge gaps were identified in the final workshop.

Coolac farmers group

Coolac Farmers group is an established body - the Healthy Soils Group was a subset of this a much larger group. The wider group will continue engaging in various projects as opportunities become

available. The future may depend on where the group maintains its own identity or becomes part of a larger farming systems group.

Tablelands Farming Systems group

Tablelands Farming Systems (TFS) is a well-established group who have a range of projects and activities for members. One of these has been the Soils Club of which many of the members of the Healthy Soils Group have also participated. TFS has a number of on-going projects including the Farm Forecaster, annual soil testing, and worm testing. It is likely that there will be future soils projects that members of the group can participate in – some applications had been made.

Mid Goulburn GSSA

The group members offered the following ideas on what they wanted to do next:

- They wanted to revise/discuss topics periodically to maintain knowledge and skill levels. They suggested the facilitator run an occasional workshop, after they get soil test results back in spring, to remind them about critical values and fertiliser/lime rates, and update calculations for cost \$/kg nutrient for different product options. This would assist them to prepare for their autumn fertiliser program.
- MLA needs to continue to make information about soil management and the Healthy Soil groups available on their website.
- Some producers felt the soil information on the MLA website was too basic and they were often looking for more detail about the topic.

PPS

PPS will continue their soil test digitalisation project which involves collecting member soil tests and presenting the data in graphic form. PPS believes that this will provide better interpretation of soil tests and encourage an increase in testing. Other PPS projects and extension will continue to inform members on pasture and soil management and promote continuous improvements on member farms. The PPS group have had regular PDS applications. Members did not express interest in undertaking PGS training courses.

Flinders Island Group

The Flinders Island Group is a self-managed group that will take up further opportunities to build on what they know and have learned. Most members will have better questions of their agronomists and advisers and experiment with what they have taken away from this project for their businesses. They had three producers that expressed interest in PayDirt but ideally need a local advisor trained to provide this service and more information was sent to the facilitator on becoming trained up to potentially deliver this training package.

Meningie field livestock and pasture group

The group advisor has been trained in delivery of PayDirt and has offered the training to group members. The group has recently started a PDS called, 'Improved Grazing Production on Non-Wetting Sandy Soils.' The group showed high interest in soil carbon and the impact that carbon and climate change policy is likely to have on farm businesses and as a result plan to deliver a suite of projects to improve understanding of baseline soil carbon and the potential to increase soil carbon, and methods to reduce methane emissions. They also plan to implement a small Smart Farms Project to maximise production on non-wetting sands using perennial veldt grass based grazing systems.

Tamar NRM

Producers will continue to build skills through other projects and programs including "Carbon Neutral Farming." They have expressed interest in undertaking a PDS and were planning to workshop possible ideas for demonstrating at their management committee.

Kangaroo Island Productivity group

The facilitator expressed interest in learning more about Paydirt and possibly becoming a coach for one or more of the PGS courses. This would allow PayDirt to be offered locally.

Hamilton

Most of the producers were members of one or two of the three amalgamated producer groups. Each group will pursue separate interests.

There were some further unanswered questions identified by producers regarding waterlogging management that provide opportunities for more work such as:

- Plants using water to lessen waterlogging affects.
- Quantifying levels of severity of waterlogging.
- Understanding water infiltration rates of different soil types.
- Understanding when drainage/manipulation is the best option.

Soil organic carbon remains a topic of interest. Particularly looking at short-term versus long-term practices, clover-improving carbon at depth and compost as an input to increase initial carbon stores in soils with below potential carbon.

4.3.6 Soil discussion group overview

There is huge interest in healthy soils and soil management and particularly around opportunities with soil organic carbon. However, there is a lot of misinformation about soil health with various tests and soil amendments, or practices promoted by some consultants that have not been evaluated in replicated experiments with proper control treatments.

Currently there are widely promoted, and persuasive messages associated with regenerative agriculture practices that are factually incorrect. This messaging being conventional farming is harmful and improved soil health is achieved by reducing conventional fertiliser inputs. This leads to an increase in crop yields or herbage mass because soil will become healthy, and soil organic carbon or soil biology will improve. Also, soils become supposedly healthier by implementation of multi plant species, rotational grazing methods or through application of only natural fertilisers or products. These approaches are in turn supported by soil biology testing and interpretation of product requirements that are unproven to increase pasture growth. Therefore, provision of evidence-based information is critical.

There were a small number of producers who joined groups that held these types of views and producers who felt pressure to adopt regenerative practices for fear of missing out on creating soil health or degenerating their soil condition. Despite being in the same workshop, many producers were planning to increase soil testing and fertiliser use, but for those with alternative views, they were unconvinced and planned to decrease fertiliser and increase soil biology. Therefore, skill development in conventional areas will not be possible for these producers. It is also important that conventional science-based soil management practices be promoted that they do create healthy soils to avoid other producers adopting persuasive regeneration type beliefs.

Some groups targeted commercial producers to form the group, and this worked well. This was done to ensure a business/economics focus was overlaid on any soil health activities and discussions. This

also meant that any practice change would impact on more hectares. Where a non-targeted approach was made, there tended to be more small-scale farms involved that didn't necessarily have profitability as a focus.

Linking the groups with larger organisations worked well as the information and promotion of open events could be communicated to this wider network. This also provided an opportunity for existing members to value their membership by seeing that the groups were actively doing interesting things, and hopefully encourage new members to join the farmer organisations (e.g GSSA, PPS, SFS, HLN).

This project focused on developing skills. Results showed skills could be increased through soil discussion groups, however it is questioned if soil discussion groups are the most appropriate method for development of skills and therefore appropriate for future investment. Soil discussion groups easily showed they increased knowledge, but skill development may require a more fixed training approach compared to the more relaxed discussion group style where producers learn by discussion of ideas and results.

Discussion groups are not traditionally associated with skill development, unlike training courses. However, they did show skill development could occur and that ingredients to its success was by providing ways to practice skills. Group success was dependent on the facilitator's approach, but it is acknowledged that the groups could have all been successful at building skills, but the capture of that information was sometimes unconvincing.

Running sessions that built on knowledge and skills learnt in previous session was a key ingredient in producer skill development rather than just having different guest speakers on standalone topics each session. Sessions designed to be as hands-on as possible to build the skills in assessing different soil profiles and using appropriate tests (soil lab and field tests, plant tissue tests, check plant roots/nodules, assess ground cover, test strips) helped to build the skills of being able to diagnose any soil constraints.

Skill development was dependent on the complexity of the skill. The development of soil test interpretation is complex and unlikely skills are cemented in one session. However, using weed indicator species to inform on likely soil conditions was easier for producers to develop skills in, especially if they were already familiar with weed identification.

How the focus and the activities for the group were planned was very important. It was essential that the group could identify any soil factors that were not an issue, so they know whether to worry about them or not and not just assume they affect them. Groups also needed to focus on soil issues that they can do something about and be able to measure, monitor, evaluate the cost/benefit of improving management.

While PGS courses fill the skill development requirement, they have not been in high demand from the Healthy soils group producers. This could be that producers want a break from commitment to additional training especially while covid is still present or they may not want to engage in formal training. Therefore, there may be a need for an alternate training medium such as short training events that adopt some of the successful components of both learning environments. It was the experience of the soil discussion groups that to focus on six sessions on the one topic was difficult to maintain producer engagement, but one session was too short to develop reinforcement and practice opportunities for skill building.

A suggested approach is two to three sessions of half day workshops related to soil assessment and management. They could concentrate on developing knowledge and less complex skills and be directed into the PGS pathway for more advanced skill development. Producers could choose modules, consisting of a two-hour training inside session, 1 hour field activity session to practice skills, half hour of dedicated discussion and half hour chat time (social interaction) which was deemed important for producers to share ideas and thoughts and strengthen the appeal of attendance. The modules created could add further value by being converted into online learning modules. Popular modules could be soil organic carbon, liming, waterlogging, nutrients, and soil biology all linking back to assessment of soil condition and improving pasture production.

5 Conclusion

5.1 Key findings

- Healthy soils and soil management is of high interest to producers.
- The process of using indicators as visual assessment of soil condition works well and is supported using good photos which provide a valuable resource.
- Posters of soil indicator can be used to raise awareness, but online support material increases reach and ease of accessibility to information.
- A phone app for use of soil condition indicators was currently deemed not feasible because of the vast array of indicators used to inform soil condition and there is currently low demand for agricultural apps.
- The five easy steps to P could be simplified in the short term or redesigned to account for decisions on other nutrients and treatment of acidity or sodicity in the future.
- Pilot soil discussion groups showed success in building the skills and confidence of producers.
- Producer groups and facilitators generally struggled with the concept of skill development, both what was a skill and how to measure it but were very good at increasing producer knowledge and measuring knowledge change.
- Skill audits unless done before and after the event to get fair comparison were generally inadequate to make objective assessment of skill development.
- Community of practice was of value to share resources amongst groups and hear about what other groups were doing.
- Completed case studies were informative and provide an information source of producer individual skills developed in the project.
- Most groups were interested or are involved in PDS to continue further training, however there was currently little interest in PGS training packages.

5.2 Benefits to industry

The collection of indicators of soil condition provides a great resource that has allowed the production of posters and online mobile booklet and has also been further utilised to create other products such as such online training modules and hard copy booklets. This legacy resource allows producers to connect what they are seeing to their soil condition. This joining of dots will lead to better recognition of soil constraints and possibly more soil testing to ensure correct diagnosis and

improved soil management. The indicators of soil borne root diseases and nodulation have been utilised to further extend the investment of research work in the MLA FIP. The exposure of 149 core producers through the program and another 204 through open days plus many others through web-based resources and case studies was important in raising awareness of science-based soil research and building of producer skills.

6 Future research and recommendations

Two key focus areas for many groups was soil acidity and soil organic carbon and Holbrook landcare healthy soils group raised some good unanswered questions on the economics of liming pastures. While there is some thought that research regarding soil acidity has all but been completed, the last big extension project was through Acid Soil Action in 1990s and key messages around liming rates, acidification rates and soil acidity monitoring have since changed. An update or development of practical producer resources could be warranted. With misinformation around soil organic carbon, more resources aimed at producer's questions on soil organic carbon could be created. The information collected from producers in the soil discussion groups creates a wealth of knowledge on what they want to find out and could be used in future product development.

Due to the high interest in healthy soils, it is a recommendation that MLA need to take an active role in promoting science backed soil management information and that conventional agriculture can create healthy soil systems that leads to highly productive pastures. While it is not easy to change producer's beliefs, presentation of science-based facts in easy-to-understand ways, may help avoid a waste of producer's resources and eventual loss of production.

Discussion groups may not be the best delivery method for producer skill development while increasing skills remains a focus of MLA training delivery. Smaller well designed short course modules are suggested as a feeder course into PGS training packages but need to also provide a stand-alone training method where skill delivery occurs. Group facilitators need additional guidance in terms of skill change capture.

That the five easy steps to P recommendations highlighted in Appendix 8 be adopted or the ideas that had previously been captured FIP extraction for P extension presented in section 4.2.

7 References

MLA project B.FDP.0021 Coordination of Participatory R&D for the Feedbase Investment Plan in Victoria, Lisa Miller, 2017.

Nicholson and Long, (2015) Using temperament typing to improve your approach with clients In *Rural Extension and Innovation Journal* 11(1). 144-150