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Integrating the L (learning) into PAR (participatory action research)

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Abstract. Declining soil organic matter, soil health and loss of natural fertility are major constraints to sustainability on Australian grain farms. Improved knowledge of soil health is required by those managing Australian soils - farmers. An extension program was delivered to Queensland grain growers in 2022/23 to develop participants' knowledge and their capacity to improve soil management. This program utilised Participatory Learning and Action Research, which combined a structured action learning approach that established on-farm participatory action research to start improving soil health. During the program over 70 properties self-assessed their soil health utilising their own soil data. Growers then identified their top priorities and new management practices they wanted to test in their paddocks. Deep placement of phosphorus was the highest rated priority and the management practice growers most wanted to test in their paddocks (49%). On-farm research sites were implemented to test and refine these practices on participants' properties.

Keywords: participatory action research, action learning, soil health.

Introduction

Soil health can be defined as 'the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans' (USDA nd). A healthy soil encompasses physical, chemical and biological properties and processes and their interactions. Key indicators of soil health are soil organic matter and natural fertility. Declining soil organic matter and soil fertility is seen in Australia where native vegetation has been removed, particularly under areas of long-term cultivation (Dalal & Mayer 1986). Hence it can be presumed that soil health too is declining, resulting in major constraints to the sustainability of Australian farms.

Soil health is complex as it is driven by interactions between soil properties, processes and practices across a range of soils and farming systems in Queensland. The extension effort on soil health has typically used traditional extension methodologies founded on a 'Transfer of Technology' paradigm, with generic recommendations of best practice and regional recipes. Furthermore, previous soils research has generally addressed single aspects of soil health. Because a healthy soil is maintained by the interaction of numerous biological, chemical and physical functions, a true understanding of soil health and the impacts of management on soil health is best considered in a holistic manner.

Soil sampling is one way of understanding soil properties. This is often conducted by an agronomist giving a recommendation to the grower that outlines the required fertiliser application. Without an understanding of the soil analysis and/or its connection to soil health, growers cannot make informed management decisions. To address this, a project was funded by the Department of Agriculture and Fisheries Queensland and through the Australian Government's National Landcare Program entitled '*Healthier soils through better soil testing'* in February 2022.

An underlying assumption for the project approach was that to create enduring change for improved soil health, land managers and their advisors must:

- recognise the need for change
- possess a knowledge of their current soil condition and the fundamental soil health processes that will determine the most appropriate management practices for their individual situation
- develop the skills to select and implement improved management practices.

In this paper we describe how participatory learning and action research (Hamilton 1995) was used to help growers increase their understanding of soil health, assess their own soil, and identify and test management changes in their own paddock to ultimately improve management of this vital natural resource. The process combined a structured action learning approach (Revans 1997) to help participants understand the foundations of soil health and use soil testing to assess the health of the soils on their own farms. Group dialogue and interpretation of their results helped them identify the biggest challenges to soil health on their farms and identify practices that could improve and maintain their soils. This supported participatory action research (Greenwood et al.

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1993) that was then used to establish on-farm research activities with interested land managers to test the most promising options for their own farms.

Methods

The project developed and delivered a theoretically informed extension program to facilitate learning and practice change designed to increase the frequency and comprehensiveness of soil testing and adoption of best practices to improve soil health. This program integrated action learning into a participatory action research methodology aimed at helping crop farmers' increase their understanding of their own soils integrated with subsequent support to test, refine and apply natural resource management best practices across their farms to improve their soil management. There were three key components to this program: soil testing, action learning workshops and participatory action (on-farm) research.

Activity 1 - Soil testing

Ninety cropping properties were identified by the project team. The project team soil sampled three paddocks from each of these properties (a total of 270 paddocks). Paddocks were identified based on grower curiosity coupled with the teams' experience. For example, growers may have been interested in assessing different management practices or paddock histories. The project team ensured rigorous soil coring and soil analysis was undertaken, to maximise quality of information for both the grower and the project. This also contributed to the Australian soils database. These results were compiled into reports for each individual grower (Figure 1).

Figure 1. Example of soil data provided to each participant

Soil Nutrition

	Wheeltrack	Shallow Wheeltrack	Remnant Brigalow
Nitrate-N (mg/kg)			
0-10cm	2	2	1
10-30cm	2	3	0
30-60cm	3	5	0
60-90cm	1	2	0
90-120cm	7	11	0
Ammonium-N (mg/kg)			
0-10cm	2	2	3
10-30cm	2	2	3
30-60cm	2	2	1
60-90cm	2	1	0
90-120cm	1	2	1
Total Nitrogen (%)			
0-10cm	0.09	0.1	0.16
10-30cm	0.09	0.1	0.11
Total Organic Carbon (%)			
0-10cm	1.4	1.07	1.75
10-30cm	0.88	0.84	0.96

	Wheeltrack	Shallow Wheeltrack	Remnant Brigalow
Nitrate-N (kg/ha) (Assumed Bulk Density of 1.2g/cm3)			
0-10cm	2	2	1
10-30cm	5	7	0
30-60cm	11	18	0
60-90cm	4	7	0
90-120cm	25	40	0
Phosphorus Colwell (mg/kg)			
0-10cm	27	19	31
10-30cm	6	2	8
Phosphorus BSES (mg/kg)			
0-10cm	56	39	52
10-30cm	6	3	21
Phosphorus Buffering Index (PBI)			
0-10cm	70	92	85
10-30cm	85	91	81
Exchangeable Potassium (cmol/kg)			
0-10cm	0.38	0.29	0.55
10-30cm	0.19	0.17	0.22

Activity 2 – Action learning workshops

A workshop process was designed to build knowledge and facilitate learning, based on action learning (Revans 1997). This action learning (L) method incorporated propositional scientific knowledge (P) with farmer experience and their own soil test results to answer their questions (Q) about their soil health (L = P + Q). Through action learning, individuals can learn with and from each other by working on real problems and reflecting on their experiences.

The workshops explored physical, chemical and biological soil health indicators. Soil sample results provided real data at the workshops. This enabled farmers to assess their own data (not hypothetical examples) and make real decisions for change. These workshops were designed to:

1. Increase farmer knowledge and skills of soil testing and capacity to interpret results.
2. Help farmers identify and prioritise areas for improvement.
3. Enable the development of strategies and action plans to improve their soil health productively and profitably.

Ten workshops were run late 2022 to early 2023. Nine of these were face-to-face with the tenth run virtually. The workshops were structured around the growers assessing their soil health, utilising their own soil test results, against a variety of biological, physical and chemical functions and indicators, and discussing their assessments with other growers and researchers. The key functions of a healthy soil and their indicators were:

- the soil's ability to maintain soil organic matter (measured by soil organic carbon)
- the soil's ability to supply nutrients for plant growth (measured by available nitrogen, phosphorus and potassium)
- good soil structure (measured by dispersion and exchangeable sodium percentage)
- freedom of toxicities (measured by salinity and chlorides)
- freedom from pathogens (measured by Predicta B)
- levels of arbuscular mycorrhizal fungi (AMF) (measured Predicta B).

Activity 3 - Participatory action (on-farm) research

Many of the participating growers were keen to test their new ideas. After the workshops the project team worked one-on-one with these motivated growers to help implement action plans and test their strategies and options on their farms. This was based on participatory action research, a methodology that can deliver both new science knowledge and improved farming practices (Carberry 2001). Essentially, participatory action research with its interactive cycle of four steps (Zuber-Skerritt 2000) helps bring different people's knowledge and insights together to improve real-world problems.

It was envisaged that approximately 50% of participants would implement site testing of at least one identified management change to improve soil health. The project team, with soil science, extension and economic expertise, worked with these growers to also maximise scientific rigour and assist with interpretation and analysis of results.

Results and discussion

The 90 participating properties were spread across the Queensland grain belt from as far north as Kilcummin through to Goondiwindi (activity 1). This is where the learning began, with the team of experienced soil scientists, technical officers and extension officers in the growers' paddock discussing soil health, soil testing and determining which paddocks to sample.

Over 70 enterprises attended workshops (activity 2; 97 growers and advisors in total), who managed a total of over 300,000 hectares. A baseline survey was conducted at the beginning of the workshops. Of the attendees, 76% stated that they were unsure that they understood their soils and knew how to manage them productively (Figure 2) with 73% indicating that they were unsure how to manage their soils sustainably (Figure 3).

Figure 2. Results from baseline survey: Which statement best describes your existing knowledge of your soil and your ability to manage it productively

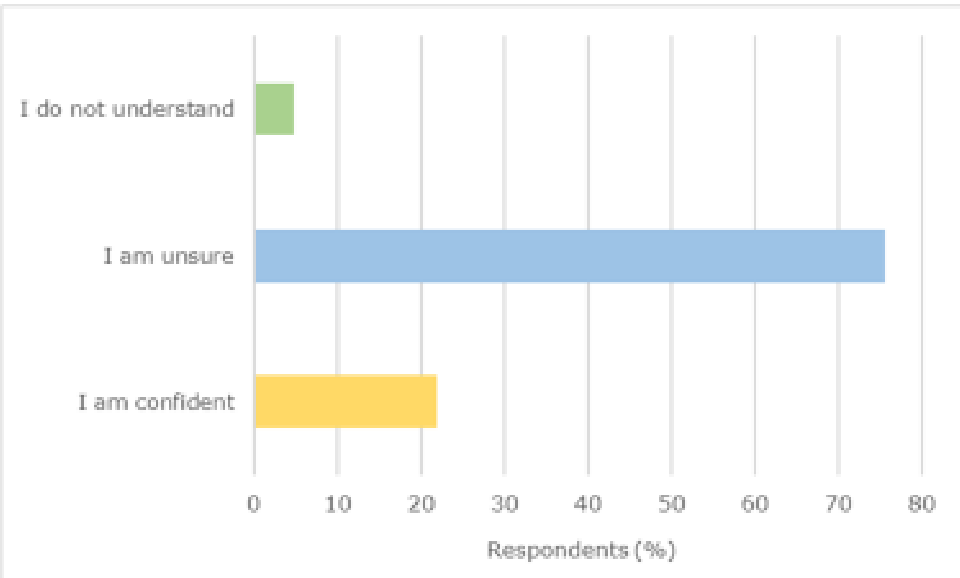
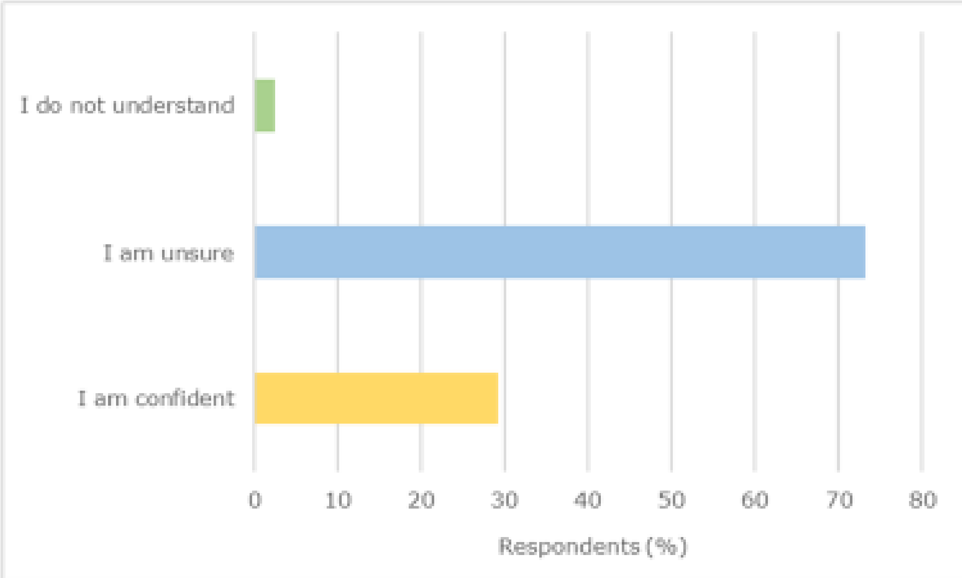
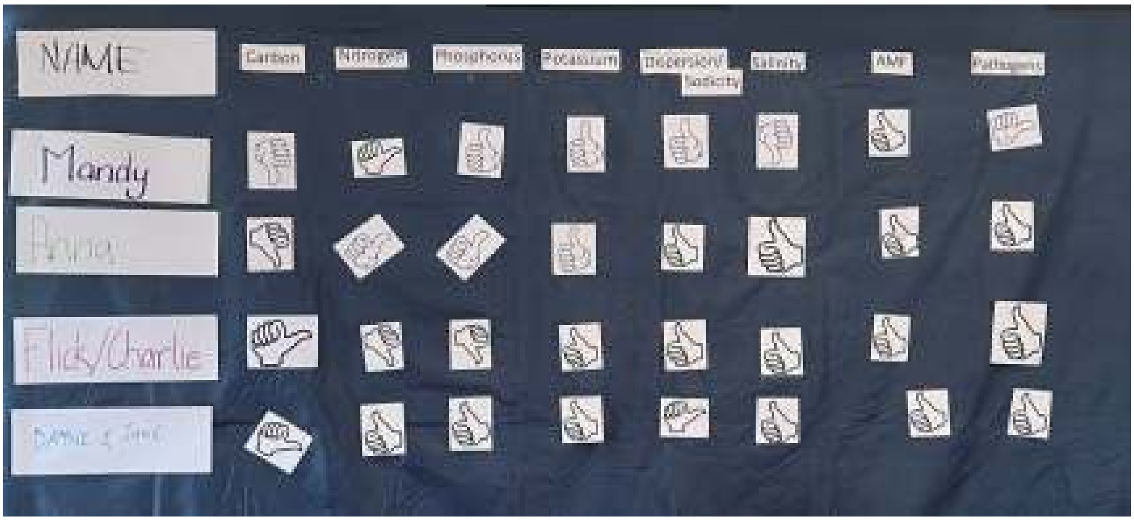


Figure 3. Results from baseline survey: Which statement best describes your existing knowledge of your soil and your ability to manage it sustainably



The growers used their own soil analysis data and new knowledge gained during the workshop to assess their soils against several soil health indicators. As this could be a possibly confronting situation, the team utilised a "thumbs" rating (Figure 4) and ensured participates understood it was their <u>own</u> assessment. There is concern within the agricultural industry about the future possibility of legislation on issues such as soil health, which is causing concern amongst growers. Hence the thumbs rating was used to keep the mood light and the growers focused on learning. After the event this rating was translated into quantitative data with a "thumbs down" equivalent to 1 = lowest rating (i.e. most problematic), thumbs sideways equivalent to 3 = moderately problematic, through to a thumbs up equivalent to 5 = highest (i.e. least problematic) (Figure 5).

Figure 4. "Thumbs rating" for assessing soil health functions



After utilising the board with their "thumbs rating", time was provided for participants to reflect on their assessment and identify their soil health priorities. An evaluation at the conclusion of the workshop asked participants to describe their three key learnings and to identify management strategies that they wanted to try to improve to address these priority aspects of their soil health. Their top three learnings were "management practices to improve soil health" (31%) followed by "understanding how my soil works" (26%) and "understanding soil test and interpretation" (22%) (Figure 6).

Figure 5. Participant self-assessment of aspects of their soil health indicators

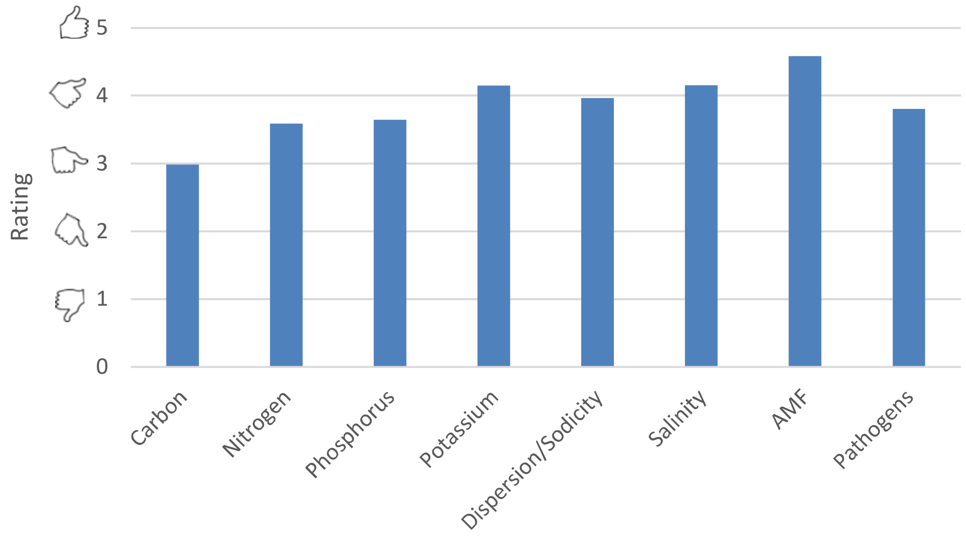
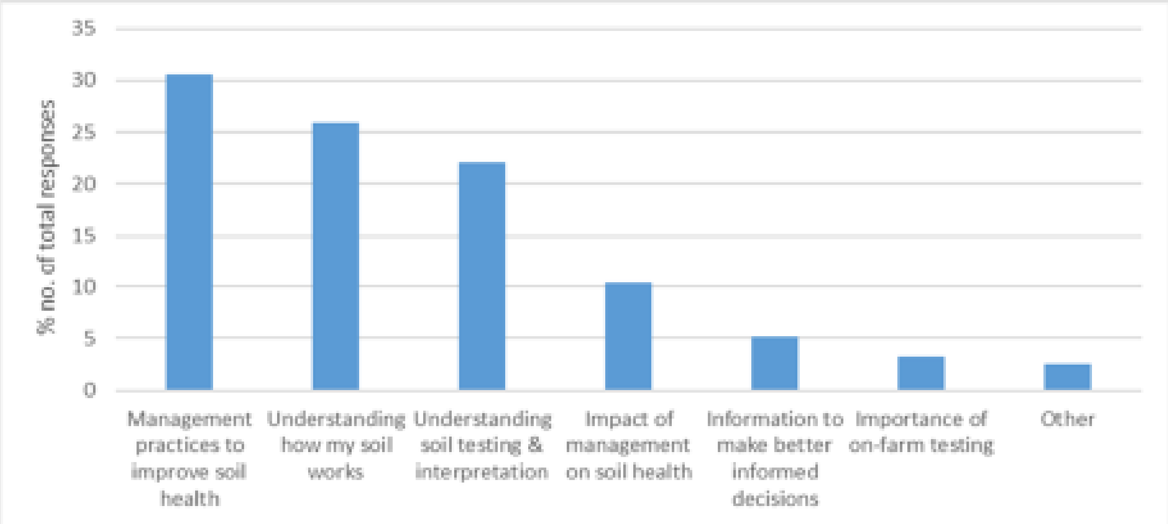


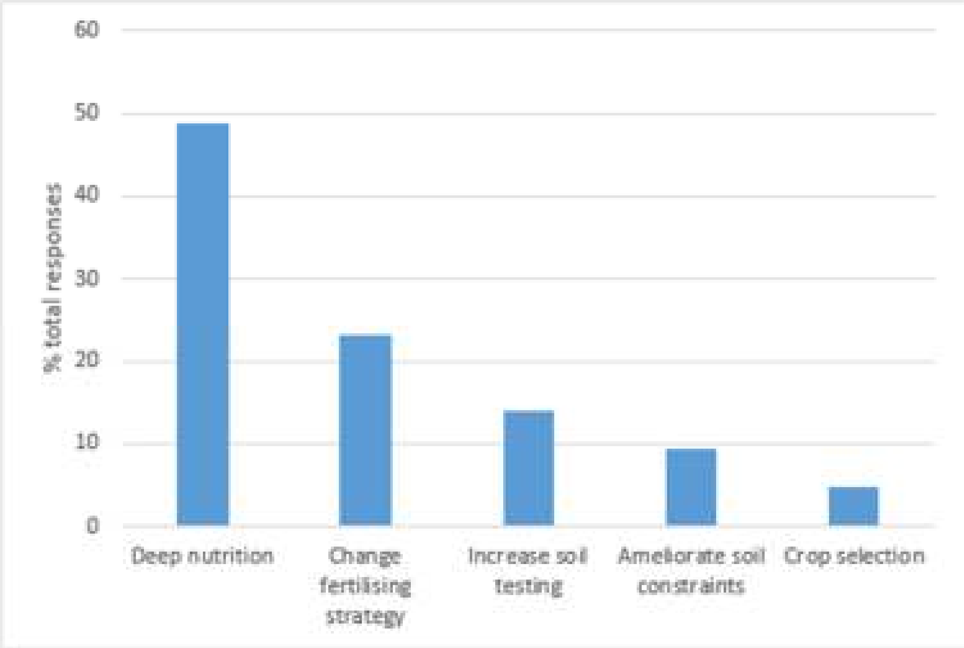
Figure 6. Top three learnings



Forty-three of the properties attending identified a specific management practice that they wanted to test. The application of deep banding nutrients was the highest rated (49%) followed by change in fertiliser strategy (23%) (Figure 7). This response was not surprising as the application of deep banded nutrient is logistically challenging for most growers and requires a significant upfront cost which pays off over many years (up to a decade). Hence, the growers identified this as a key strategy which they wanted the project team's help to assess. This process was the conduit to facilitate activity 3, participatory action research.

It was interesting to note that soil organic matter was not the highest priority even though it was rated the lowest in their self-assessment. This is most likely because very little can be done directly, in terms of management practices, to improve soil organic matter in the short-term. Levels of soil organic matter (measured as soil organic carbon (SOC)) are the result of the balance between inputs (e.g. plant residues and other organic inputs) and losses (e.g. erosion, decomposition) in each soil and farming system (Hoyle et al. 2011) and take a long time for impacts to be seen. Past research has shown that higher SOC levels will be encouraged by maximising productivity (Bell & Lawrence 2009). Hence growers identified management changes focused on improving crop and pasture nutrition, to increase biomass production, which improves both productivity and soil health by supporting higher levels of soil organic matter.

Figure 7. Management strategy participants wanted to try



After the workshop the project team has been working with interested growers to implement the management strategies they were interested in trialling. As a result, we are now working with these 43 growers implementing participatory action research to help them test their identified management strategy to improve their soil health and productivity. The broad topics being investigated include:

- deep drilling phosphorus and potassium to deficient subsoils (14 sites)
- increasing rates of nutrients applied to pastures (11 sites)
- conducting additional soil testing to understand chemical/nutritional/biological constraints across a paddock (11 sites)
- increasing rates of nutrients applied to crops (7 sites)
- deep ripping (1 site)
- redesigning paddocks (1 site).

Farmers are being supported by project personnel to develop trial plans, conduct pre- and post-treatment soil testing, biomass and grain yield measurements and plant tissue and grain testing. The team's soil, extension and economic scientists have been working with these growers to maximise scientific rigour and assisting to interpret and analyse results. This research is currently underway and is expected to be finalised early 2024. After which further evaluative impact data will be collected.

Some of these on-farm trials have been rolled into a new project aimed at improving growing decision-making utilising participatory action research. As a result, these growers have been able to explore these issues more deeply and document what we know, don't know, or are unsure of, incorporating growers', agronomists' and researchers' knowledge. Data from these growers' trials will be brought together to build joint interpretation of the results and their implications by presenting findings and discuss growers' experiences during the research. For example, what have we learned, what will we do differently, what difference will it make, have we answered the research question? As a result, these trials will become legacy pieces for ongoing grower learning.

Conclusion

This extension process has helped nearly 100 growers and advisors develop knowledge and increase their capacity to improve soil management. This approach combined a structured action learning approach that established on-going participatory action research to start improving soil health on participants' farms. This impact is supported by evaluative data indicating that the growers were able to assess key aspects of their own soil, prioritise these, identify actions and ultimately test these actions in their own paddock. This program further supports the effectiveness of participatory learning and action research, and the value of using growers own real data to inform their decision making; integrating the 'L' into 'PAR'.

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