

Action learning with grain growers to increase understanding of soil organic matter and develop management strategies

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Abstract. Soil organic matter is critical to sustainable farming. However, it is considered to be complex and is often misunderstood. An extension program was developed and delivered to engage grain farmers and agronomists, utilising a 'paired-site' approach that helped them explore their own soil organic carbon test results. A total of 258 participants attended the series of workshops from Hay (New South Wales) through to Clermont (Queensland). The focus of this project was to enable workshop participants to develop and document their own 'strategies to manage soil organic matter and carbon'; with 232 strategies documented at the end of the project. The highest-ranking strategy was using fertilisers to increase crop/soil nutrition to grow bigger crops with more dry matter. Evaluation surveys indicated that this extension program improved participants' understanding and knowledge of soil organic matter. This program has concurrently generated new data on management practices that increase soil organic carbon, contributed to data sets of its levels in these regions and facilitated new science in the analysis of soil organic carbon.

Keywords: action learning, engagement, soil organic matter, research outcomes.

Introduction

Soil organic matter (SOM) is critical for healthy soils and sustainable agricultural production. Grain growers understand that crops grown in healthy soils perform better and are easier to manage. However, sometimes the SOM story is made very complicated and confusing, leading to misunderstanding.

Levels of SOM are measured by soil testing for soil organic carbon (SOC), as SOM is composed of approximately 60% carbon. Levels of 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, Baldock & Murphy 2011). Higher SOC levels are considered better and will be encouraged by maximising productivity (Bell & Lawrence 2009). However, these SOC levels typically decrease as native vegetation is removed for agricultural production; most dramatically when land is used for cropping (Dalal & Mayer 1986).

The Australian agricultural industry has become increasingly interested in improving management of SOM for profitable and sustainable cropping. As a result, the Department of Agriculture and Fisheries and the Grains Research and Development Corporation (GRDC) invested in the '*Soil organic matter initiative*' in 2012 through to 2017. This initiative included an extension component to help grain growers throughout Queensland and northern New South Wales better understand the value of SOM and to enable the development of strategies to manage soil organic matter and carbon in their farming systems.

Soil organic matter management decisions are likely to be unique for each paddock and property because the achievable soil organic carbon levels depend on the potential of each soil to protect organic carbon and the productivity of the underlying farming system (Hoyle, Baldock & Murphy 2011). In this paper we describe how this project cut through the complexity, mystery and misinformation about SOM and SOC to enable grain growers to develop and document their own scientifically sound strategies to manage soil organic matter and carbon on their own farms whilst contributing to new research outcomes.

Methods

The project team identified that the basic principles of SOM and SOC were relatively quite simple if well-communicated using growers' own SOC data. As a result, they developed a process to engage farmers and agronomists within the grains industry to build knowledge and ability to manage soil organic matter. A workshop-based action learning (L) process (Revans 1997) was developed combining propositional scientific knowledge (P) and farmer experience with on-farm soil carbon testing to answer individual farmer's questions (Q) about the impacts of land-use on soil carbon levels (that is; L = P + Q). Action learning is a form of 'learning by doing' where the focus is on learning around individual's real problems to ultimately enable them to implement their solutions. Action learning was used by this project to assist participants to better understand the value of SOM in their farming systems and its impact on their profitability and sustainability by assessing the effects of landuse and practices on SOC in their own district and relating existing scientific knowledge to their own situation.

Initiation and engagement

Workshops were generally conducted with existing farmer groups, such as Landcare or groups of consultants that had registered their interest in SOM. Team members attended an initial meeting to provide a very basic understanding of SOC and discuss the paired-site soil testing approach. This allowed each participant to make a more informed choice when identifying which paddocks to sample on their own farms; the paddocks of most interest to them personally, and so the ones from which they could learn the most.

The paired-site soil testing approach

Each participant nominated two paddocks with the same soil type but different management history. This was done in consultation with members from the project team to maintain scientific rigor in the sampling process. Each pair was taken from the same soil type ensuring the comparison would highlight the impact of their past land use and farming practices and ultimately contribute valuable new soil carbon data to existing databases. The development history and paddock management were recorded for each site. Paddocks were sampled and analysed for carbon using various analysis methods.

Conducting action learning workshops

Each group were then brought together for a workshop entitled "Soil organic matter and carbon; improving levels through farm management". The workshop process was designed to facilitate learning by integrating existing scientific understanding and farmer experience (L = P + Q). Paired-soil tests from each participant's farm were designed to 'get farmers interested', to engage them with their own data (not hypothetical examples), and to use the results to make real decisions on their future practices.

The half-day workshops were structured around the following sessions:

1. An introduction and discussion of soil organic matter and soil carbon principles and processes.
2. A paddock visit (if possible) to understand the results of a group member's paired-sites, usually native vegetation versus continuous cultivation.
3. A facilitated session discussing collated results using a series of charts (10-20 scenarios) of major land use contrasts, such as: timber cleared for native pasture; age of cultivation comparisons; continuous cultivation versus old crop land returned to pastures. For each chart the initial contrasts were explained and the group were asked to "vote" on what differences they expected, before looking at the actual results (using "Turning Point" technology which is an audience response system). The group then discussed their rationale about why they voted the way they did and ultimately the implications on SOM levels.
4. A session that ensured each participant understood their own soil carbon results and clarified any anomalous results.
5. An evaluation survey, followed by a group discussion of participants' major learnings.
6. The documentation of individually targeted strategies to manage soil organic matter and carbon on their own farms, with each participant taking home an action plan identifying practical changes to their farming systems to achieve these identified strategies.

The workshop process was designed to ultimately help each individual participant to develop and document practical on-farm strategies to manage SOM and soil carbon and the ability to identify the most appropriate practices to implement these strategies on their own farms.

Results and discussion

A total of 258 growers and agronomists attended these action learning workshops resulting in 232 documented strategies to manage SOM on their own farms. Respondents from the groups manage approximately 700,000 ha of cropping and 250,000 ha of sown pastures. The cropping area data were lower than expected as most consultants did not provide data on their hectares under management. The evaluation surveys provided good insights into the project's impact on farmers' knowledge, skills and intentions to improve their management practices into the future. These 232 scientifically sound strategies coupled with evaluation results confirmed that using Revan's (1997) action learning process of introductory theory on accepted scientific knowledge (P) and examples of interest to answer participant questions (Q) enabled most farmers to Learn (L): that is, to understand their own soil test results and develop strategies to manage their own SOC into the future.

This was achieved firstly by using participants' own soil test results rather than hypothetical examples, which got participants' attention. Secondly, the structured learning processes helped them translate this information into personal knowledge for management on their own farms. The facilitated discussion after "voting" for the various scenarios (using their own soil test results) was critical as it enabled participants to discuss their logic as to why they thought SOM levels would be higher or lower for a particular practice and the drivers behind the change. Repeating the process across various scenarios (10-20) effectively improved participants' knowledge, skills and intentions to improve their management practices into the future. The project has demonstrated that theoretically informed learning processes can avoid the confusion that often accompanies a topic like soil carbon, simplify it, and help make it real for managers. The key insights from the evaluation are summarised below.

The highest rated impacts on participants' knowledge (top five in order) were:

- understanding how organic matter/carbon helps the soil and crops
- understand soil organic carbon levels under different farming practices
- understand how soil organic matter/carbon work
- understanding the value of soil organic matter/carbon
- understand the difference between 'organic matter' and 'carbon'.

The highest rated impacts on participants' skills (top four in order) were:

- skills to identify the best ways to boost my soil carbon levels
- skills to assess my soil organic matter/carbon levels
- skills to manage soil organic carbon on my own farm
- skills to increase the sustainability of my practices.

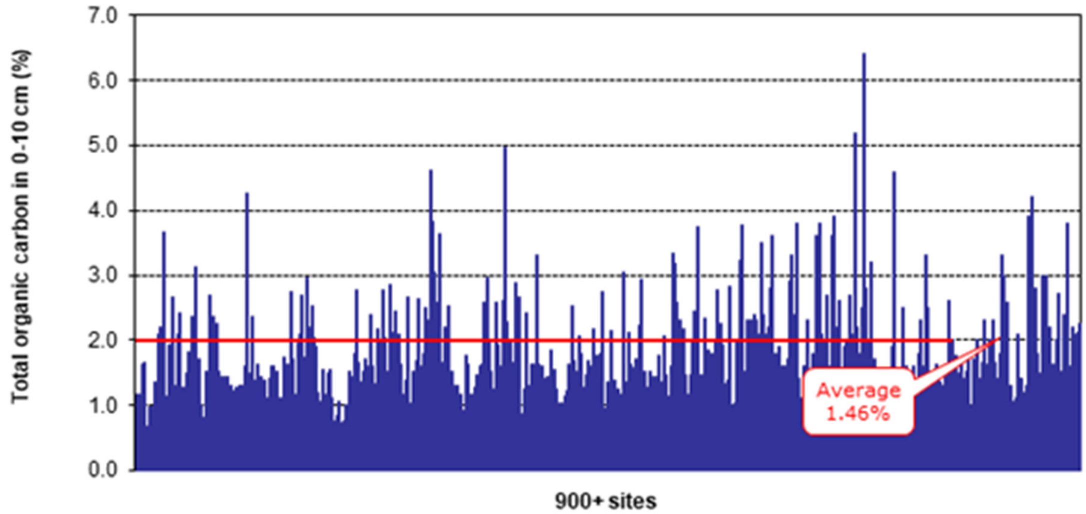
These results indicate that participants improved both their knowledge of SOM as well as their skills in assessing and managing SOM on their farm. The higher-level impacts from these workshops was the development of strategies by the participants to manage SOM on their farm with 70% of survey respondents indicating that they would do something differently as a result of the workshop (i.e. change practice). Of the 232 future strategies to manage organic matter/carbon developed by the participants, the key elements were (% of respondents):

- (44%) use fertilisers to increase crop/soil nutrition (grow bigger crops with more dry matter)
- (34%) improve the productivity of my pastures (N fertiliser; P fertiliser; pasture legumes)
- (32%) change enterprise mix to use more pastures and forages
- (29%) maintain cover and stubble (i.e. avoiding tillage, burning and baling)
- (24%) increase cropping intensity (less fallows)
- (22%) use more crops that will produce more dry matter (e.g. summer vs winter)
- (21%) use more legumes (i.e. pulses)
- (16%) assess soil carbon and consider soil organic matter in my decisions
- (15%) use better agronomy to grow better crops (max production in my current system)
- (12%) use manures (mostly along with synthetic fertilisers)
- (2%) continue as I am (no change).

These results highlight growers' increased ability to identify strategies to manage SOM/SOC on their farms. The project team were very pleased to see that these strategies aligned with scientifically sound management practices. The workshop process identified participants' recognition of the contribution that productive pastures and good crop nutrition that maximised production, can make to maintaining and managing soil organic matter. This recognition has been a critical contribution to the direction of future research particularly in pasture management and farming systems.

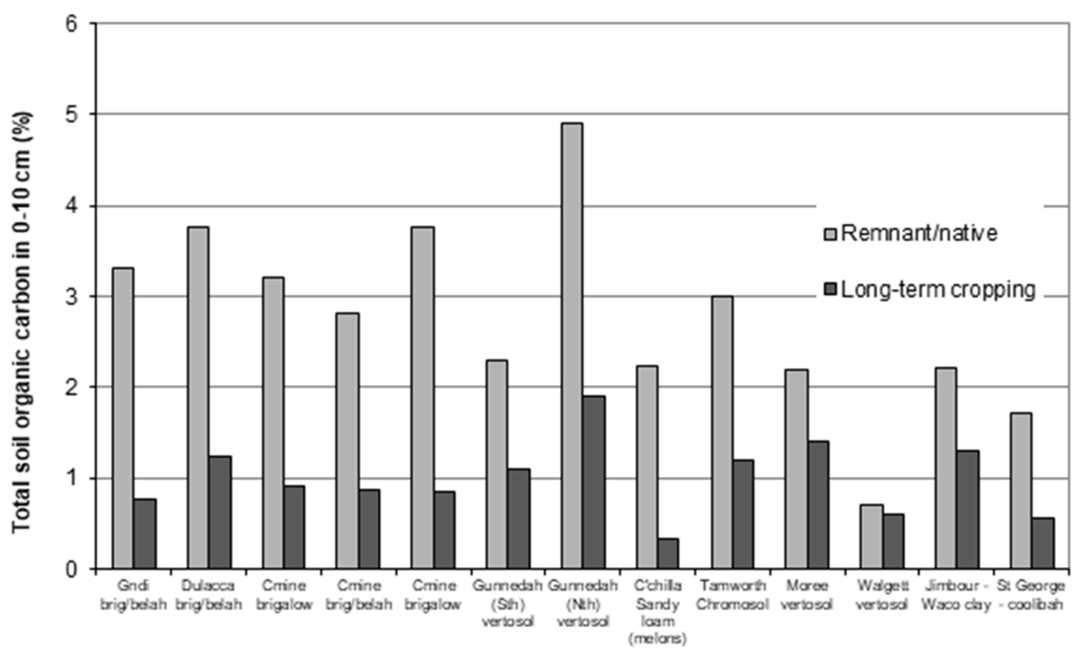
The paired soil test results were added to an already existing database, to make a collective total of over 900 samples, indicating the average total organic carbon (0 - 10 cm) level was 1.4%, although this varied from 0.5% to 3.8% (Figure 1). This data was a significant contribution to the current data of soil organic carbon status in this region.

Figure 1. Soil organic carbon levels in New South Wales and Queensland



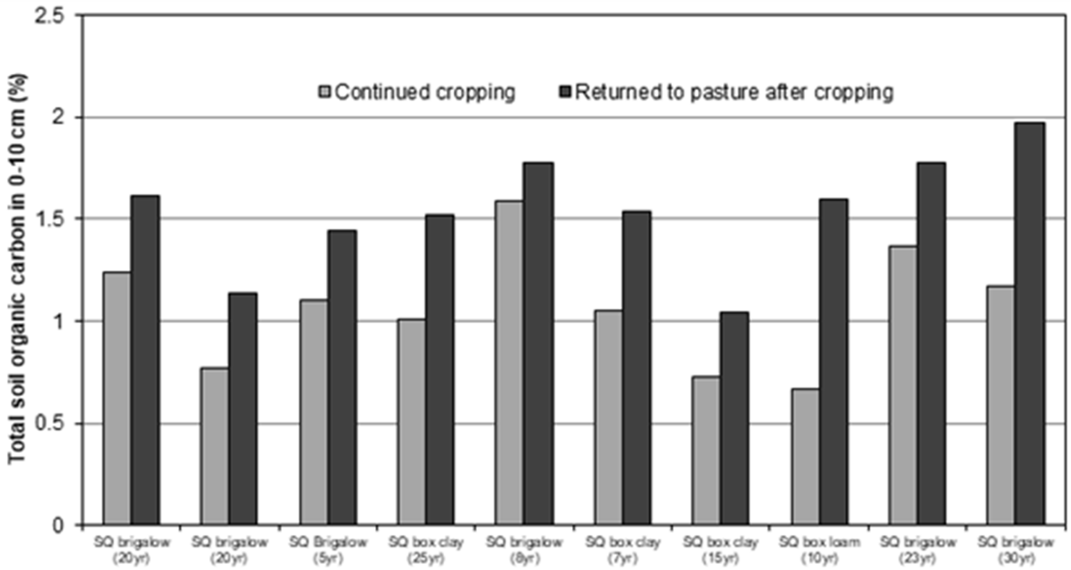
The dramatic decline in organic carbon levels (and its associated nutrients) with continuous cropping was clearly illustrated to participants from a compilation of their own soil pairs comparing native vegetation (typically remanent Brigalow) and long-term cultivation (for example, Figure 2) in the local area and regionally. The reasons for this decline and the implications for regional farming systems were discussed at length.

Figure 2. Impact of long-term cropping on SOC levels



For alternative land uses after development, sown pasture sites had slightly higher organic carbon levels than native pastures at most sites, including those that had previously been under cropping. This is in line with expectations that sown pastures will have higher long term dry matter production than the native species that they have replaced. Farmers were particularly interested in the ability of sown pastures to increase soil organic carbon levels after a cropping phase, and the results showed a significant increase in most cases (Figure 3).

Figure 3. Soil organic carbon crop versus returned to pasture after cropping



The professionally sampled soils across a broad range of soil types and geographical locations were critical in calibrating more detailed fractionation analyses in research laboratories for the national SOM research project. These cutting-edge results were discussed with participants to contribute to their understanding of SOC.

Conclusion

This extension program has helped 232 growers and agronomists from Hay (New South Wales) through to Clermont (Queensland) better understand soil organic matter and organic carbon, develop skills and identify strategies to manage SOM on their own farms. These strategies were aligned with scientifically sound practices. The identification of these strategies has also focused future research particularly in the areas of pasture management and farming systems. The program has also provided a useful local data set and general benchmarks to compare land use impacts on soil carbon. Professionally sampled soils from a range of scenarios have subsequently been used to help calibrate more detailed fractionation analyses in research laboratories for the national research effort.

The interest generated by this project has continually surprised and pleased the project team. The impact of the activities on participants learning clearly shows the value of professional extension processes that use action learning principles based on real (not hypothetical) on-farm data to engage participants and support them to develop informed on-farm strategies for their own farms. This interest level continues, as is demonstrated by consistent requests to present nationwide and to access our data sets. Understanding soil organic matter and how to manage its decline continues to be an important issue within Australian farming systems.

Acknowledgements

The research presented within this paper would not have been possible without the support of growers and agronomists and investment from the Grains Research and Development Corporation and the Department of Agriculture and Fisheries.

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