Australian Cool Farm Initiative results and learnings from the Riverine Plains

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Key points

- Analysis of soil samples from 199 paddocks participating in the *Australian Cool Farm Initiative* project showed soil organic carbon (SOC) levels ranging from 0.74–4.77 per cent.
- Analysis of 199 surface (0–10cm) soil samples taken as part of the project showed that pH ranged from 4.3–7.3 ($CaCl_2$).
- There was a slight relationship between SOC and total rainfall for paddocks sampled in this project.

Aim

The *Australian Cool Farm Initiative* aims to increase the long-term sustainability and yield stability of the grain-producing regions of southern New South Wales and north-east Victoria, through the adoption of innovative agronomic strategies to increase soil health and related function.

Background

Mars Petcare (a subsidiary of Mars Incorporated) has committed to supporting the global wheat industry through the reduction of supply chain greenhouse gas emissions.

Mars Incorporated has acknowledged that greenhouse gas emissions impact the climate and the company recognises their responsibility to address the environmental and social impacts of the business. As a result, Mars Incorporated has adopted climate-change targets to reduce greenhouse gas emissions across their full value supply chain by 27 per cent by 2025 and 67 per cent by 2050, from 2015 levels.

Mars Petcare purchases a significant amount of grain from NSW. As a result, Mars Incorporated has initiated a local project, which aims to engage NSW growers by supporting innovative agronomic management with a focus on increasing soil carbon, novel crop integration and more efficient management of nutrients, especially nitrogen (N).

To achieve this, Mars Petcare has engaged The Sustainable Food Lab (SFL), an independent international organisation based in the United States of America, along with an Australian Coordinator, to administer the *Australian Cool Farm Initiative*. Riverine Plains Inc and Central West Farming Systems are delivering the project across southern and Central NSW in partnership with SFL.

A key part of the project involves the Cool Farm Tool (CFT) (https://coolfarmtool.org/), an online calculator and accounting tool, which enables growers to measure their greenhouse gas emissions and understand mitigation options for agricultural production. The Cool Farm Tool provides growers with the ability to enter their farm data and practices to understand the impact of their farming practices on greenhouse gas emissions and other outputs. The Cool Farm Tool also can provide real-time feedback on "what-if" farm management scenarios.

To ensure accuracy of reporting for Australian conditions, the greenhouse gas emission data produced as a result of this project continues to undergo review and is therefore not presented in this report. This report summarises the results of some of the soil data collected from Riverine Plains region growers participating in the *Australian Cool Farm Initiative* project during 2018–19.

Method

During 2018, 15 growers in the Riverine Plains region and 15 growers in the Central West Farming Systems region participated in the first year of the project, with a further 15 growers engaged in each region during 2019. Only results from the Riverine Plains region are described in this report.

All participating growers identified up to five wheat paddocks each season for inclusion in the project, with GPS-located soil tests (0–10cm) taken for each paddock. Figure 1 shows the locations of all samples taken from across the Riverine Plains during 2018 and 2019.

Each soil sample was air-dried and analysed for a range of soil properties, including soil pH ($CaCl_2$), soil organic carbon (SOC) percentage, cation exchange capacity (CEC) and nutrients. Soil samples were taken from specific locations in each paddock based on ease of access and the known location of representative soil types.

Anonymised soil test results, farm input data and yields were captured in a simple database and processed through the Cool Farm Tool, which generated predictions of greenhouse gas emissions for each paddock. Results were communicated to growers as they became available.

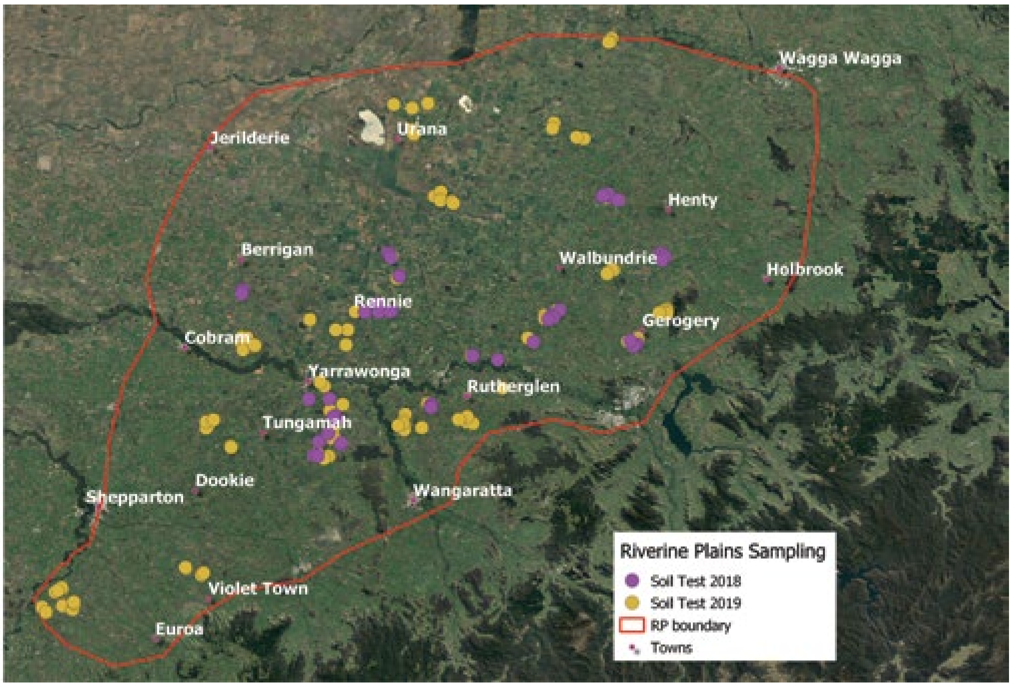


FIGURE 1 Location of paddocks across the Riverine Plains area participating in the ACFI project, incorporating the use of the Cool Farm Tool (CFT), during 2018–19

All contributing growers were encouraged to test an innovative farming practice, with additional soil sampling available to follow specific paddocks through the rotation. Additional technical support was also available to support innovative practices, such as novel intercropping strategies in grazed winter wheat, growing new pulse crops, brown manuring and summer cover cropping.

The project will continue with existing participants during 2020, with a further expansion of participant numbers.

Results

Rainfall

The 2018 and 2019 growing seasons varied greatly across the Riverine Plains region. During 2018, annual rainfall across the region ranged from 245–487mm, while growing season rainfall (GSR) from April to October, ranged from 122–239mm. During 2019, annual rainfall ranged from 214–409mm, while GSR ranged from 156–266mm (Figure 2).

Soil organic carbon

From November 2018 – February 2019, 67 GPS-referenced soil samples were taken from participating wheat paddocks. During 2019, an additional 132 soil samples were taken from July – September, including 16 samples taken from paddocks already sampled during the 2018–19 summer.

Analysis of the 2018–19 summer soil-sampling results show SOC values ranged from 0.9–2.9 per cent in the paddocks tested (Figure 3). The highest value (2.9 per cent) was recorded in a paddock that for many years had been managed using best management practice to maintain or increase soil carbon through disc seeding, stubble retention, lime application and the use of pasture rotations in the system.

Analysis of the 2019 winter sampling results showed a greater range of values, with SOC values ranging from 0.74–4.77 per cent (Figure 3). The lowest value (0.74 per cent) was recorded in a recently purchased paddock with a history of low inputs and high stocking rates.

Figure 4 shows no clear relationship between SOC levels and grain yield for those paddocks sampled, with yields below 1t/ha indicating crops that were cut for hay. During 2019, poor winter rainfall meant many wheat crops didn't have enough stored water to finish, which resulted in many of these crops being cut for hay. As a result, yields across the Riverine Plains region during 2019 were mainly limited by GSR and not influenced by SOC levels.

Previous research across Victoria and NSW has demonstrated a strong relationship between rainfall and SOC (Soil Carbon Research Program). This work showed rainfall to be the single largest factor governing soil carbon accrual when comparing between regions and soil types. However within regions, soil management strategies became more important.

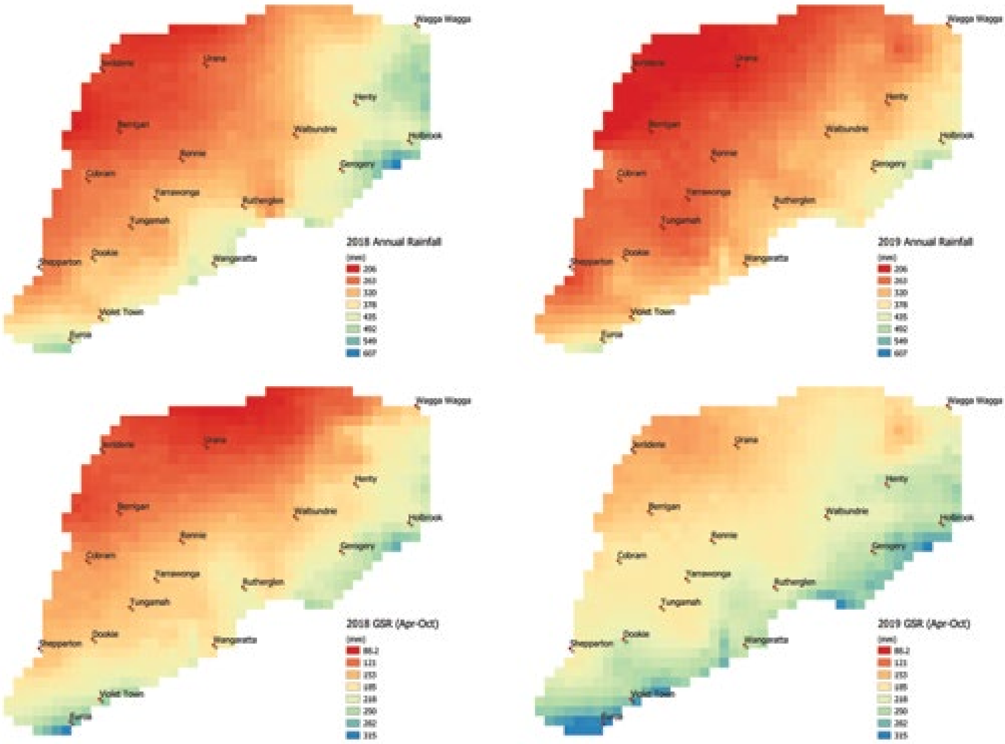


FIGURE 2 Annual rainfall and growing season rainfall 2018–19 for the Riverine Plains

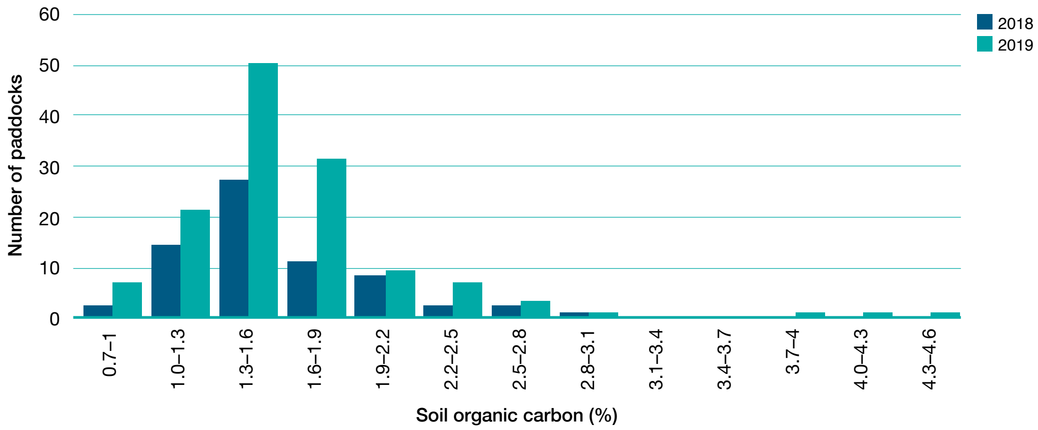


FIGURE 3 Soil organic carbon distribution across paddocks sampled as part of the ACFI 2018–19 summer sampling program and the 2019 winter–spring sampling program for the Riverine Plains region

While the 2018 and 2019 data show a slight trend for increased SOC when total rainfall increased (Figure 5) there was no such trend for GSR (Figure 6). Further comparisons will be carried out in the future to see if more 'normal' rainfall years show a different result.

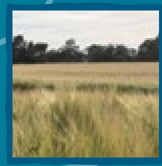
Figures 5 and 6 also show there was higher total rainfall received across the project paddocks during 2018 compared with 2019, but there was less GSR received during 2018 compared with 2019.

pH ($CaCl_2$)

The Riverine Plains region has a vast range of soil types, which is reflected in the pH values seen across the area, with soils ranging from naturally acid to alkaline. Soil pH values of greater than pH 5.2 are ideal to ensure nutrient availability is not limited, while being high enough to ensure aluminium (Al) toxicity is not an issue.

The soil pH in the surface (0–10cm) soil samples taken during the 2018–19 summer ranged from pH 4.5–7.4, while the 2019 winter pH sampling results ranged from 4.3–7.3 (Figure 7). While both sets of results show a similar distribution of soil pH, analysis of paddock history and management data collected as part of the project (data not presented) suggests the range of pH values also reflects the use of amendment practices, such as applying lime, which can take a long time to show a response in the soil profile.





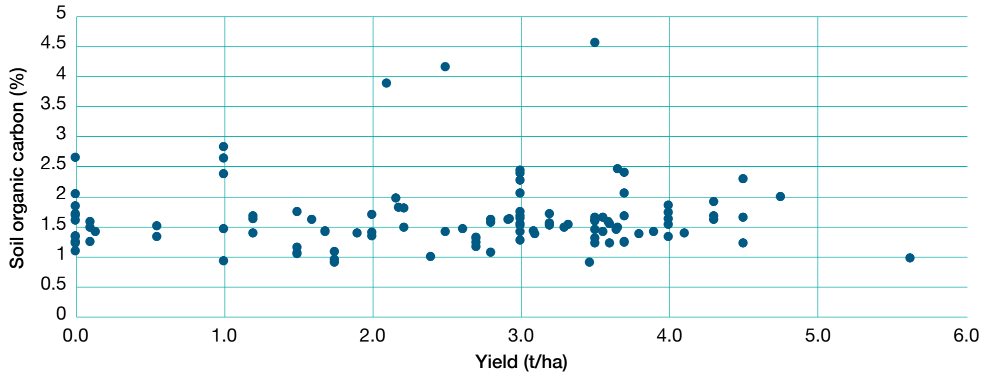


FIGURE 4 Relationship between soil organic carbon percentage and yield across paddocks sampled as part of the ACFI project during 2019

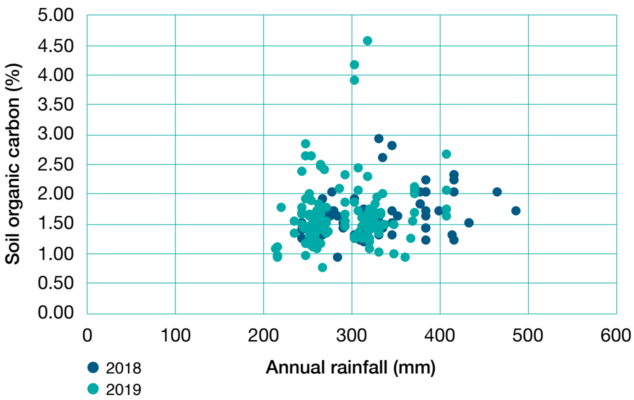


FIGURE 5 Relationship between soil organic carbon percentage and annual rainfall during 2018 and 2019

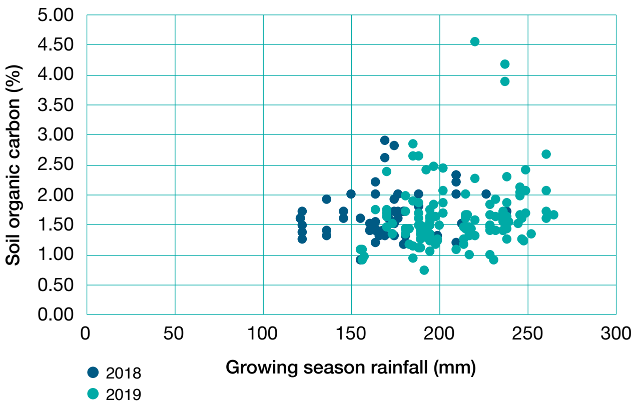


FIGURE 6 Relationship between soil organic carbon percentage and growing season rainfall (April – October) during 2018 and 2019

Aluminium toxicity

Figure 8 shows that as soil pH values decrease, aluminium solubility increased for the soil samples collected as part of the project, with an increasing contribution of aluminium into the CEC. This response is highly predictable within each soil type, with the exact relationship being dependent on clay mineralogy. Plant toxicity effects due to increased aluminium solubility are generally seen when the aluminium saturation of cation exchange sites exceeds six per cent,

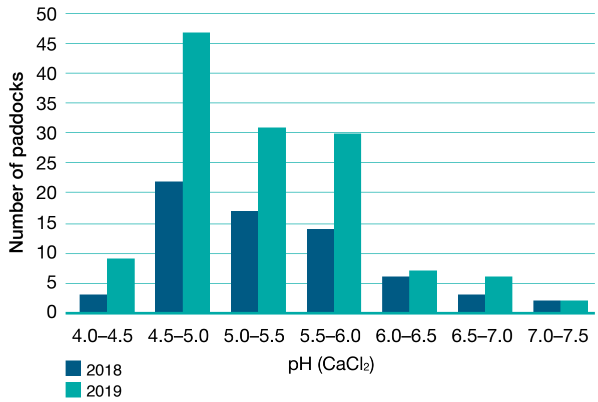


FIGURE 7 pH ($CaCl_2$) distribution across paddocks sampled as part of the ACFI project 2018–19 summer and 2019 winter-spring sampling programs

although different plant species have differing tolerance to aluminium. Only a relatively small proportion of paddocks sampled as part of this project showed aluminium saturation above six per cent.

Cation exchange capacity

Cation exchange capacity (CEC) is the estimate of the soil's ability to attract, retain and exchange cation elements, with a higher CEC tending to be indicative of higher clay content

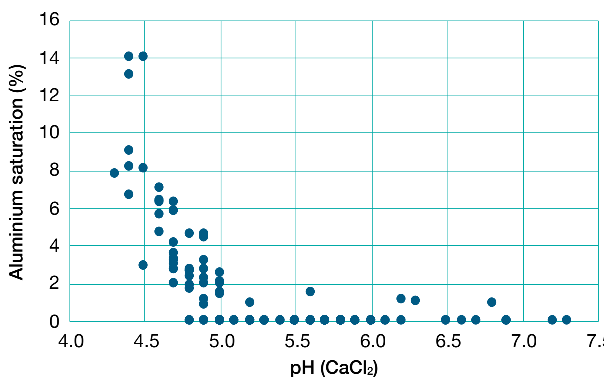


FIGURE 8 Relationship between aluminium saturation and soil pH ($CaCl_2$) for samples taken as part of the ACFI program in the Riverine Plains region during 2019

within a soil. Figure 9 shows the relationship between SOC percentage and CEC for the soil samples analysed as part of the project, with a non-significant trend for carbon values to increase with CEC. This is due to the fact that SOC (through organic matter) binds to clay particles because clay has a greater ability to attract cations than sandy soils (due to their high negative charge). Clay soils therefore tend to have higher CEC values than sandy soils and have a higher capacity to retain SOC. This explains why it is easier to build carbon levels on clay soils than sandy soils.

Greenhouse gas emissions

Data from each paddock was also analysed to determine the greenhouse gas emissions per hectare as well as greenhouse emissions per tonne of grain produced. Results from this analysis has highlighted that further work is required to validate the emission calculations made by the tool for Australian conditions, and as such, emission results are not presented in this report. It is expected that emissions results will be reported in future editions of the trial book.

Observations and comments

During 2019, the *Australian Cool Farm Initiative* project in the Riverine Plains area involved 30 participants, who collectively managed an area of 93,000 hectares.

Increasing SOC has been globally recognised as is a key driver in reducing emissions, through sequestration of atmospheric carbon dioxide (CO_2) while increasing system resilience through increased water storage and nutrient cycling, potentially contributing to increased sustainability and yield stability. Therefore, this project focuses on the adoption of on-farm practices that may increase soil carbon while maintaining production and profitability.

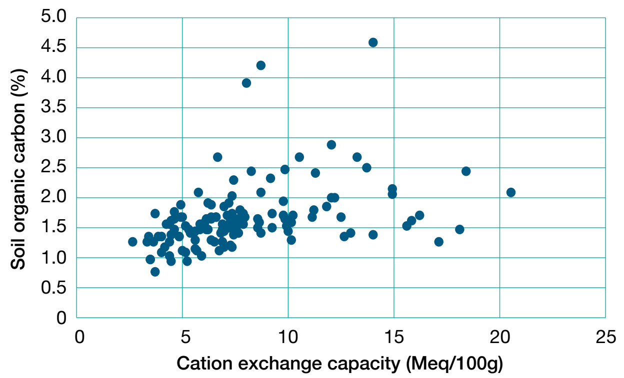


FIGURE 9 The relationship between soil organic carbon percentage and the cation exchange capacity for the paddocks sampled as part of the ACFI project in the Riverine Plains during 2019

The ACFI is an evolving project, with some value-add projects currently underway. One such project is looking at the effects of a pasture phase on SOC values over time within a mixed farming system. A selection of paddocks going from pasture into crop have been intensively sampled for soil carbon stocks in 10cm depth increments down to 30cm depth, as per the Australian Government Carbon Farming Initiative (CFI) methodology 2018. Results from this work will be presented once completed, in 2021.

Acknowledgements

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