
# Cool Soils Initiative results and learnings from the Riverine Plains

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## Key points

- Analysis of soil samples from 165 Riverine Plains paddocks participating in the *Cool Soils Initiative* project during 2020 showed soil organic carbon (SOC) levels ranging from 0.70–4.75 per cent.
- Analysis of 165 surface (0–10cm) soil samples taken as part of the project showed that pH ranged from 4.2–7.3 ($CaCl_2$).
- During 2020, greenhouse gas (GHG) emissions from paddocks in the Riverine Plains region ranged from -1134 to 1165kg $CO_2$e/t and between -3062 to 2636 kg $CO_2$e/ha.
- Further validation of greenhouse gas emission data is required.

## Aim

The *Cool Soils 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

During 2018, Riverine Plains and Central West Farming Systems (CWFS) partnered with Mars Petcare to develop an industry program, the *Australian Cool Farm Initiative*, to quantify greenhouse gas emissions (GHG) from wheat production, as well as to identify avenues to support farmers in reducing emissions, with a focus on soil health. Technical support for this project was provided by the Sustainable Food Lab, an international agency with experience in supporting effective sustainability projects across supply chains.

The program was unique in Australia and has since evolved in response to local learnings and the desire to create more value for the farmers who have come on board.

During 2020, the project was recognised as an industry program of value, with Kellogg's, Manildra Group and Allied Pinnacle also joining the project, in partnership with Charles Sturt University (CSU) and the Food Agility Cooperative Research Centre (CRC). Farmer engagement also increased during 2020, with FarmLink joining Riverine Plains and Central West Farming Systems in delivering the project.

The program aims to create a platform for the food industry to support grain growers in reducing GHG emissions, leading to increased long-term sustainability and yield stability through the adoption of innovative agronomic strategies to increase soil health and related function.

Because soil health has been recognised as a key driver mitigating GHG emissions on farm, while supporting increased system resilience across variable seasonal conditions, the name of the program was also changed during 2020 to the *Cool Soils Initiative*.

Given the project partners' widespread use of wheat as a commodity, the emphasis of the program remains with wheat production, however the project will expand into the irrigated cropping sector during 2021, with a focus on corn production.

## Method

During 2019, 30 growers from both the Riverine Plains and CWFS region participated in the project. During 2020, the number of growers participating across the project increased to 85, which includes new participants from the area managed by FarmLink. There were 40 participant growers from the Riverine Plains region during 2020, with data from the Riverine Plains region described in this report.

All participating growers identified up to five wheat paddocks each season to include 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, 2019 and 2020.

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 (CFT), which generated predictions of GHG emissions for each paddock. Results were communicated to growers as they became available.

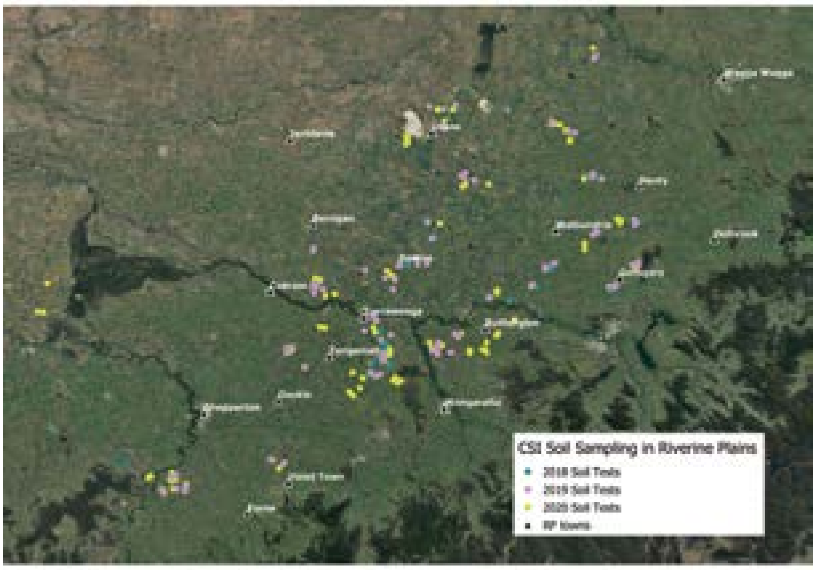



**FIGURE 1** Location of paddocks across the Riverine Plains area participating in the CSI project, incorporating the use of the Cool Farm Tool (CFT), from 2018–20

All participating 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 and new participants during 2021.

## Results

### Rainfall

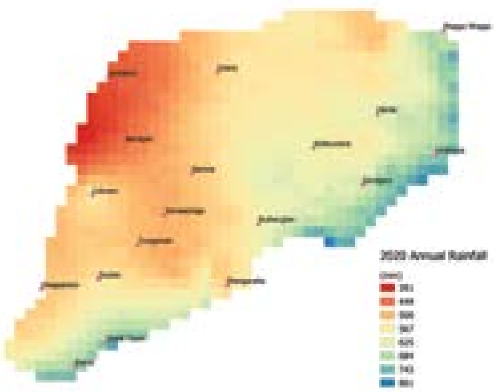
The 2020 growing season was generally excellent across the Riverine Plains region, with regular and timely rains contributing to high winter crop yields. During 2020, annual rainfall across the region ranged from 391mm to 801mm, while growing season rainfall (GSR) from April to October, ranged from 195–471 mm (Figure 2).

### Soil organic carbon

During 2018, 67 GPS-referenced soil samples were taken from participating wheat paddocks, while 132 samples were collected during 2019. During winter 2020, 165 wheat paddocks were sampled, with 24 per cent of these having been previously sampled.

Analysis of the 2020 winter sampling results show that SOC values ranged from 0.7–4.75 per cent across the paddocks tested (Figure 3). The highest value (4.75 per cent) was recorded in a paddock new to cropping with a history of low inputs and high stocking rates. The distribution of SOC results from the 2020 samples was similar to those sampled during previous years and the median value of 1.5 has remained consistent from 2018–20.

Of the paddocks with low SOC levels, two had just been purchased and had a history of low inputs and subsurface constraints, while another paddock that returned a



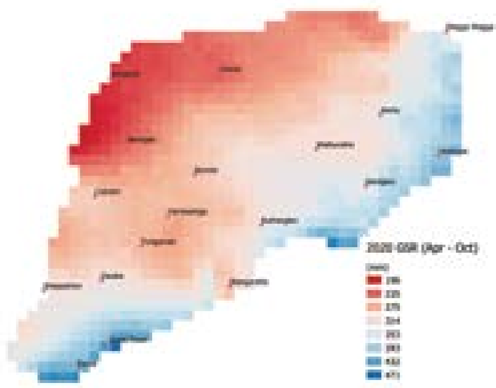




**FIGURE 2** Annual rainfall and growing season rainfall for the Riverine Plains region during 2020

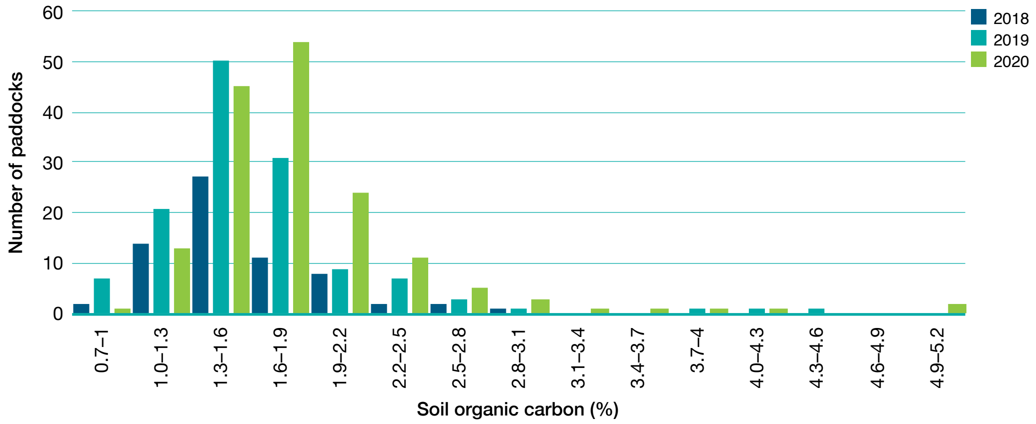



**FIGURE 3** Soil organic carbon distribution across paddocks sampled as part of the ACFI 2018–19 summer sampling program, ACFI 2019 and CSI 2020 winter sampling program for the Riverine Plains region

0.8 per cent SOC has a history of average SOC values. From other studies, including the *Quantifying-in paddock variation* project (page 18), we know SOC can be highly variable across the paddock and the low value returned in this instance may not be representative of the paddock as a whole. Spatial variability within a paddock and identifying the most representative location in a paddock to sample is an area requiring further project research.

Across all project years (2018–20) there was no clear relationship between SOC levels and grain yield for the paddocks sampled in the Riverine Plains (Figure 4). During 2020, water was not a limiting factor in grain production and all crops were taken through to grain harvest. Several paddocks yielded less than 2t/ha due to the ongoing effects of transient flooding at the start of the season.

### Soil pH ($CaCl_2$)

The Riverine Plains region has a diverse range of soil types. This is reflected in the pH values seen across the area, with soils ranging from naturally acid to alkaline. Soil pH values higher 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 2020 ranged from pH 4.2–7.3 (Figure 5). While the three years of results (2018–20) show a similar distribution of soil pH, detailed 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.

### Aluminium toxicity

Figure 6 shows the relationship between aluminium and pH for the sampling conducted during 2020. Similar to the 2019 data, 2020 data shows that as soil pH values decrease, aluminium solubility increased for the soil samples collected, with an increasing contribution of aluminium into the CEC. This response is highly predictable within each soil type, with the exact relationship depending 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, although different plant species have differing tolerance to aluminium. Aluminium saturation was above six per cent in 12 per cent of paddocks sampled as part of this project.

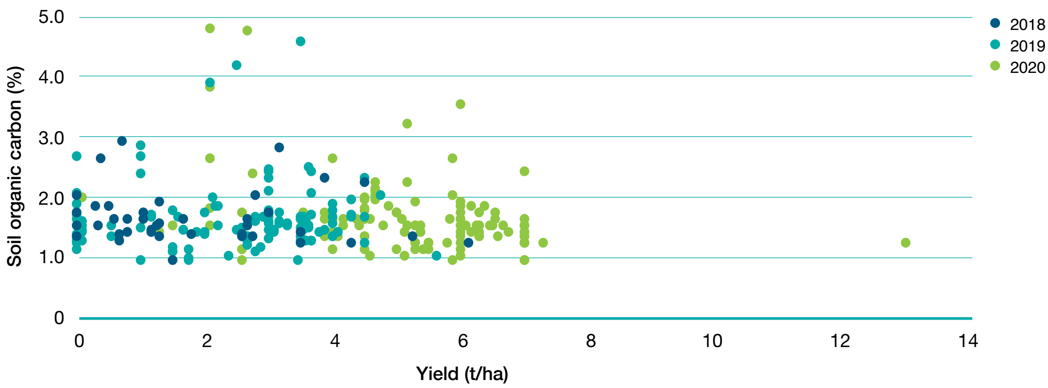



**FIGURE 4** Relationship between soil organic carbon percentage and yield across paddocks sampled as part of the as part of the ACFI project 2018– 19 and 2020 CSI project

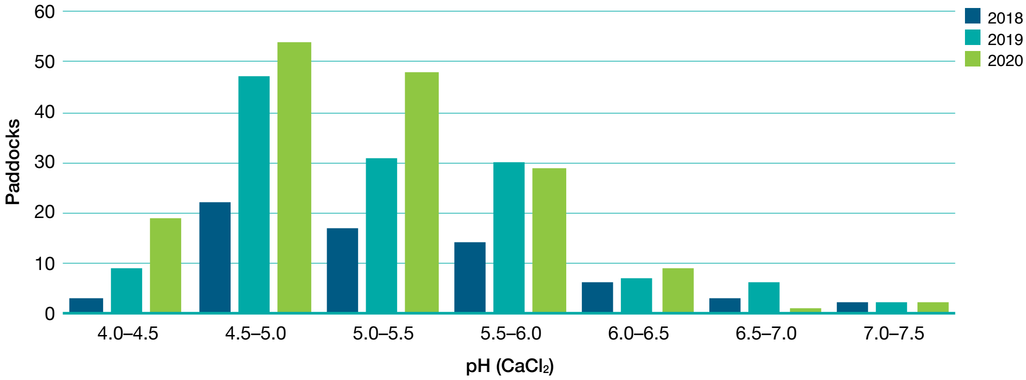



**FIGURE 5** pH ($CaCl_2$) distribution across Riverine Plains region paddocks sampled as part of the ACFI project 2018–19 and 2020 CSI project

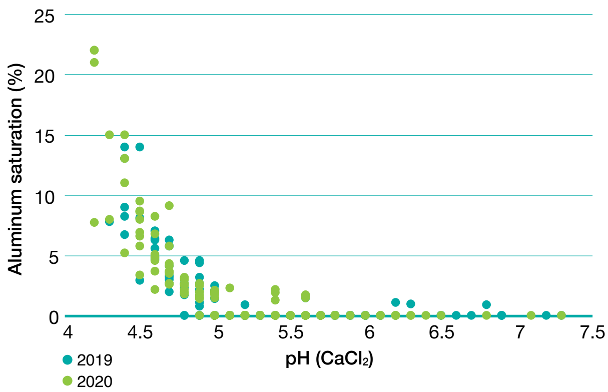



**FIGURE 6** Relationship between aluminium saturation and soil pH ($CaCl_2$) for samples taken from the Riverine Plains as part of the ACFI project 2019 and 2020 CSI project

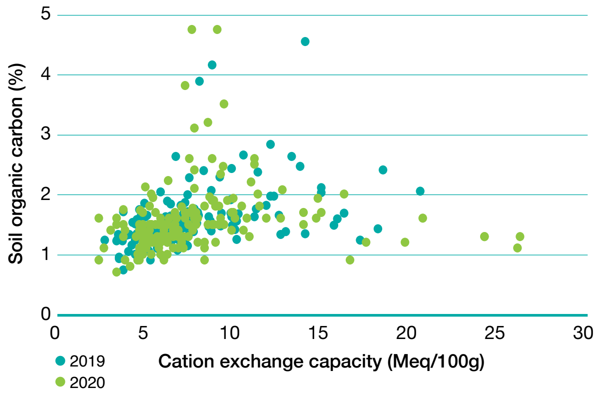



**FIGURE 7** The relationship between soil organic carbon percentage and the cation exchange capacity for Riverine Plains paddocks sampled as part of the ACFI project (2019) and CSI project (2020)

### Cation exchange capacity

The CEC of a soil is an 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 within a soil. Figure 7 shows the relationship between SOC percentage and CEC for the soil samples analysed during 2019–20 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 GHG emissions per hectare (kg $CO_2$e/ha) as well as greenhouse emissions per tonne of grain produced (kg $CO_2$e/tonne wheat).

Figures 8 and 9 show that paddocks one and two both have negative GHG emissions. These paddocks both returned unusually high SOC values for a cropping paddock, possibly because the paddocks are both new to cropping and have residually high SOC levels from the previous pasture phase.

The paddocks shown in Figure 8 are ranked according to increasing emissions per tonne of wheat produced, with emissions ranging from -1134 to 1165kg $CO_2$e/t. Figure 9 shows emissions per hectare, ranked in the same order as Figure 8 (i.e. by emissions/tonne), with a much greater range in emissions of between -3062 to 2636 kg $CO_2$e/ha.

Results from this and previous analyses has highlighted that further work is required to validate the emission calculations made by the tool for Australian conditions. Further validation of the CFT will be conducted during 2021 through the broader *Cool Soils Initiative* project.

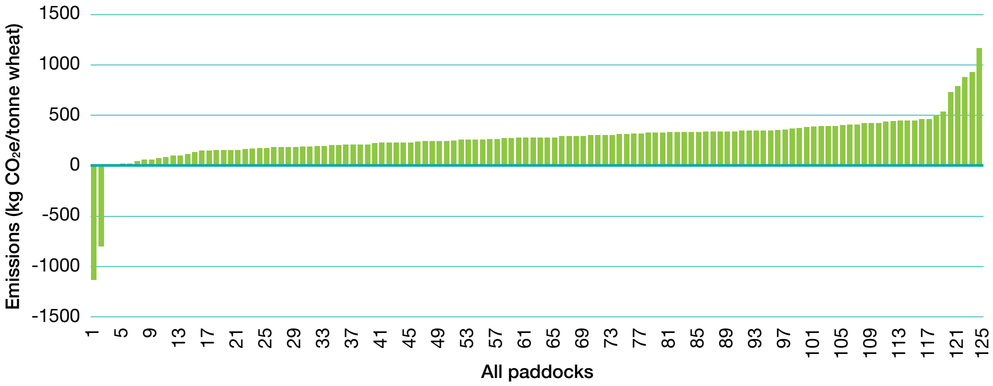



**FIGURE 8** Greenhouse gas emissions per tonne of grain produced from Riverine Plains 2020 sample paddocks (ranked from lowest to highest)

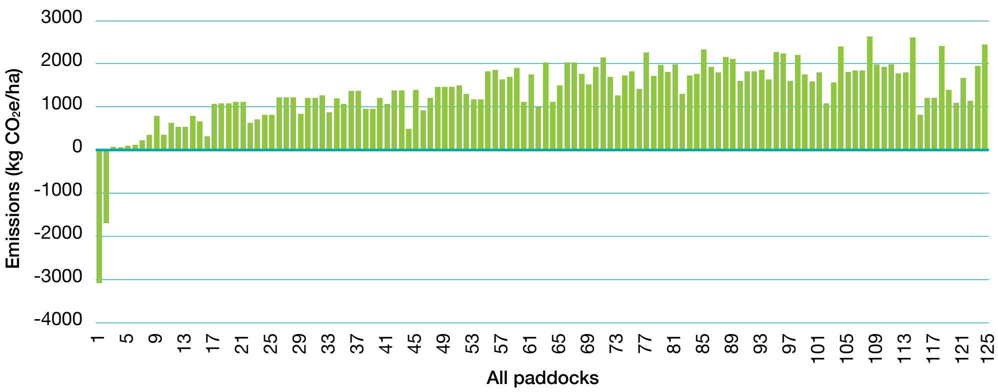



**FIGURE 9** Greenhouse gas emissions per hectare from Riverine Plains 2020 sample paddocks (ranked from lowest to highest paddock emissions/tonne wheat and in the same order as Figure 8)

## Observations and comments

During 2020, the *Cool Soils Initiative* project in the Riverine Plains area involved 40 participants, who collectively managed an area of more than 120,000 hectares.

Analysis of 165 surface (0–10cm) soil samples, taken as part of the project, showed that pH ranged from 4.2–7.3 ($CaCl_2$), while SOC levels ranged from 0.70–4.75 per cent. This suggests SOC values within the region are staying constant and the methodology to capture in-paddock spatial variability needs to be further developed. Subsoil acidity is becoming a more pronounced limitation in the region, with 5cm incremental sampling to 20cm now recommended as standard practice. While liming is generally practiced across the region, incorporation and the use of higher liming rates to target problem areas needs to receive a greater focus.

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

The *Cool Soils Initiative* continues to evolve, with associated research projects working through specific issues to support the larger program. These include better access and interpretation of paddock-scale spatial data, review of the GHG emission calculators, and understanding the economic value of practice changes to increase soil health. Results from a sub-project *Quantifying in-paddock variation of soil organic carbon and pH in north-east Victoria*, are reported on page 18 of this publication.

## Acknowledgements

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