Soil Carbon in the Coorong and Tatiara Districts

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Sampling in the South East of South Australia
Photo Credit: A.Schapel

Key Messages

- Know your current soil carbon levels and understand your soil type - this will give you an indication of the potential to increase soil carbon stocks on your soil
- Soil can vary greatly in its carbon content - target the areas / soils where the opportunities are greatest
- Soil carbon increases can only be used once on your farm carbon balance sheet

Project Activities

Nine monitoring sites were established and sampled within a 25 x 25m grid on consistent soil types and slopes; three existing sites where extensive soil carbon sampling had already occurred were measured for bulk density to enable organic carbon stocks to be calculated from existing soil chemistry data and one site was grid sampled on a 1ha grid basis to explore variability of soil carbon across a field

Key Project findings are captured below.

How does soil carbon vary in the topsoil across the region?

Existing data across the Upper South East is shown below in Table 1. This data was collected from 1990-2007 and gives an indication of what the potential is to increase soil organic carbon levels in this region (with the 75th percentile being the top end of what is thought to be able to be captured in these soils under current rainfall conditions).

			Ag District Benchmarks				
Texture	**Count**	**Mean**	**25%**	**40%**	**50%**	**60%**	**75%**
Sand	23	1.08	0.90	1.05	1.12	1.19	1.31
Loamy sand	933	1.21	0.85	1.01	1.10	1.24	1.51
Sandy loam	636	1.43	0.96	1.20	1.35	1.50	1.80
Loam	437	1.66	1.20	1.40	1.50	1.70	1.97
Clay loam	308	1.81	1.40	1.59	1.74	1.87	2.13
Clay	288	1.63	1.00	1.26	1.40	1.60	1.92
Weighted Mean (all texture)	2625	1.45	1.02	1.22	1.33	1.49	1.77

Table 1. Benchmark topsoil SOC (%) values for texture displaying the mean and percentile values for the Upper South East. *Source, A.Schapel, PIRSA 2023*

Of the sites measured as part of the project, only two exceeded the 75th percentile suggesting that they had limited capacity for soil carbon to increase in the topsoil (Figure 1). The loamy sands appear to have moderate to limited capacity to increase in soil organic carbon with the majority of sites already at or above the 50th percentile level. However, the sand and sandy loam soils appeared to have a larger capacity to increase soil organic carbon often below the 25th percentile benchmark. Further investigation is required to understand why soil OC values are below the 25th percentile and identify what management is required to improve soil carbon at these sites.

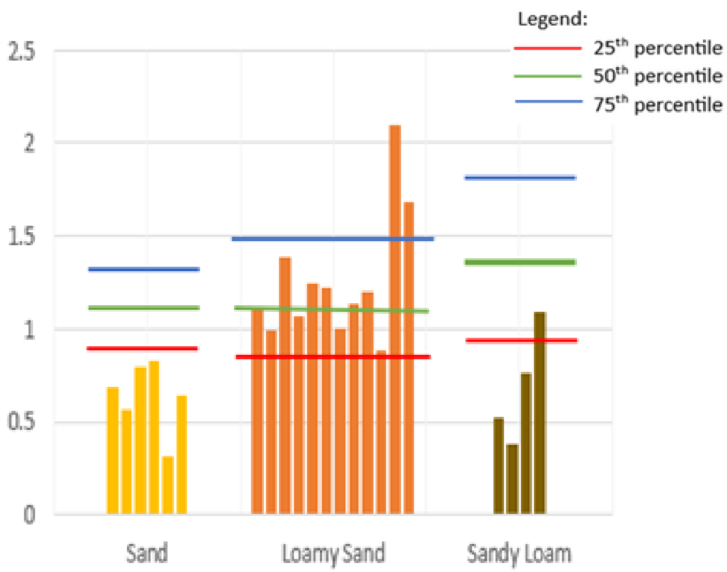


Figure 1. Project site OCwb (%) levels compared to the 25,50 and 75th percentiles for the region

Soil Carbon Terminology

Total Carbon (TC %) – Measures organic and inorganic carbon. Can be difficult to measure change in organic carbon in carbonate soils.

Total Organic Carbon (TOC% - test removes inorganic carbon and then measures the ramaining organic carbon component (Test used in Carbon accounting methods)

Organic Carbon (OC %) – Measures organic carbon (Walkley Black method) - the standard analysis for soil organic carbon in South Australian soils (more accurate on carbonate soils)

Bulk Density (g/cm3) - the weight of soil in a given volume

Soil Carbon stock (Soil C t/ha) – a calculated figure where organic carbon values (as a %/concentration) are converted to an amount per hectare. Soil carbon is often calculated to a standard or equivalent soil mass which takes into account differences in both bulk density of the soil (soil mass) due to location or time.

Soil Mass (t soil/ha) - an easier way to talk about bulk density where the mass of the soil on a per hectare basis is discussed. For example a bulk density of 1.4g/cm3 is the same as 1400 t of soil/ha each 10 cm depth.

What is our potential to increase soil carbon on these sites?

The sandy soils measured had an average OC (0-10cm) of 0.65%, and the sandy loam soils had an average OC of 0.7%. Increasing soil carbon stocks to the 75th percentile across both these soils will result in an increase of approximately 9.2tC/ha on sandy soils and 14.8tC/ha on sandy loam soils (assuming bulk density stays the same over that time).

Increasing soil carbon to the 75th percentiles through the whole profile (0-30cms) would result in a much greater increase; with an estimated increase of 29tC/ha on the sandy soils and 49tC/ha on the sandy loam soils (Figure 2).

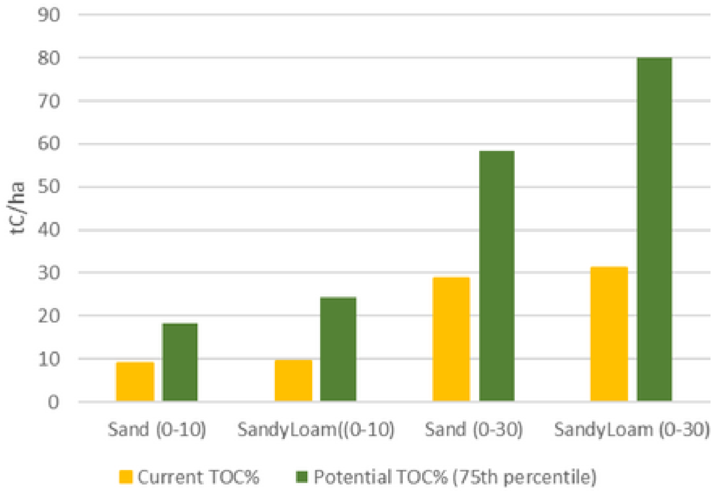


Fig.2 Potential to increase soil carbon stocks

For those soils that are starting with a higher starting organic carbon, the opportunity to sequester carbon is reduced. The loamy sand soils measured were starting with an average soil carbon level of 1.26% - the 75th percentile for these soils is 1.5% with the realistic potential to only capture approximately 3.3t/ha in the topsoil.

This highlights the importance of knowing what your current organic carbon levels and soil types are so that the opportunities for carbon sequestration can be identified and changes can be captured.

Figure 3 demonstrates the ability of different soils capacity to store soil carbon. They are sites from two different paddocks at Coomandook operate under the same management regime (a continuous cropping system) across two different soil types. The sandy loam soil (Farm 2 - Fig 3b) has an increase in carbon stocks of 7.24tC/ha or 26.57 tCO2e/ha when compared to the loamy sand soil Fig 3a).

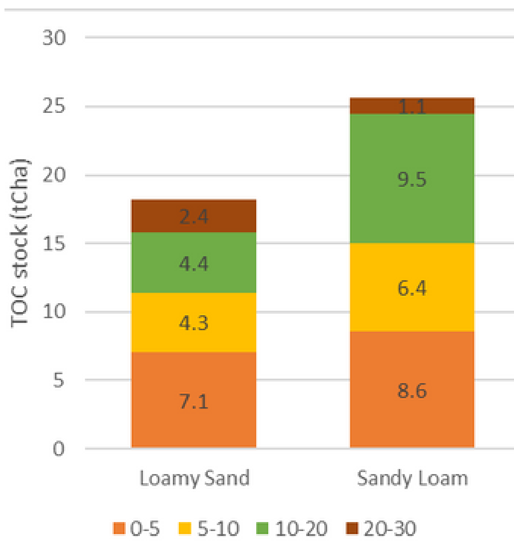


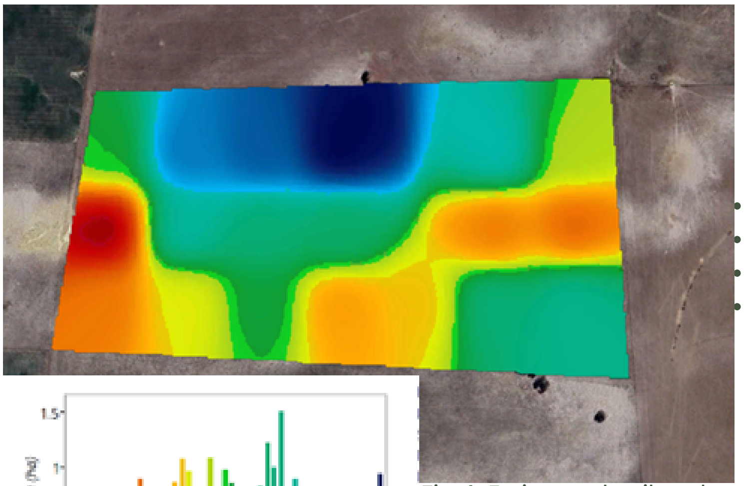
Fig.3 0-30cm equivalent soil mass (4000t soil/ha) distribution of TOC stock down the profile


Fig. 3a


Fig 3b.

Understanding variability in soil carbon stocks

Soil carbon varies greatly both within a small sampling zone, within a field and across a farm. This is shown below in Figure 4 where the organic carbon levels have been grid sampled and turned into a spatial map to show the variability across the farm with estimated soil carbon stocks ranging from 17–65 tC/ha. The field was sampled on a 1ha grid basis with soil carbon measured at 0-10 and 10-30cm. The bulk densities have been estimated based on other sampling that has been conducted across the farm. Figure 4a and 4b show the variability at the two different levels showing the importance of sampling deeper where there may be soil textural differences.



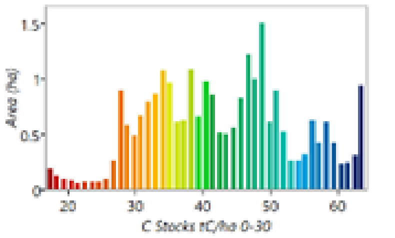


Fig.4 Estimated soil carbon stocks (tC/ha) JWE10

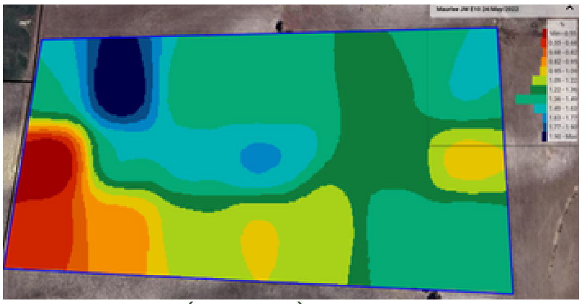


Fig.4a Soil OC (0-10cms)

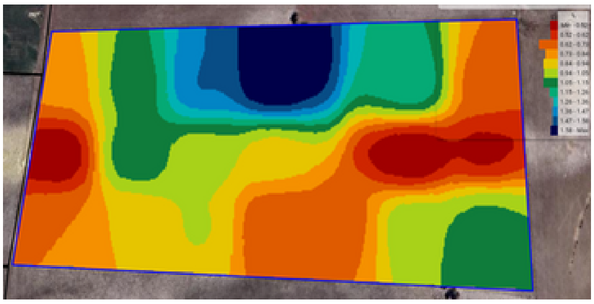


Fig.4b Soil OC (10-30cms)

Impacts of different management practices

As part of this project, a number of paired sites were monitored to assess the potential impact of varying management practices;

- ***Effect of irrigation on soil carbon stocks***

At the sampled site, Irrigation increased the TOC stock compared to the dryland site (Figure 5). Interestingly irrigation only increases stock in the 0-30cm and has limited effect in the 30-50cm where the dryland and irrigated stocks are very similar.

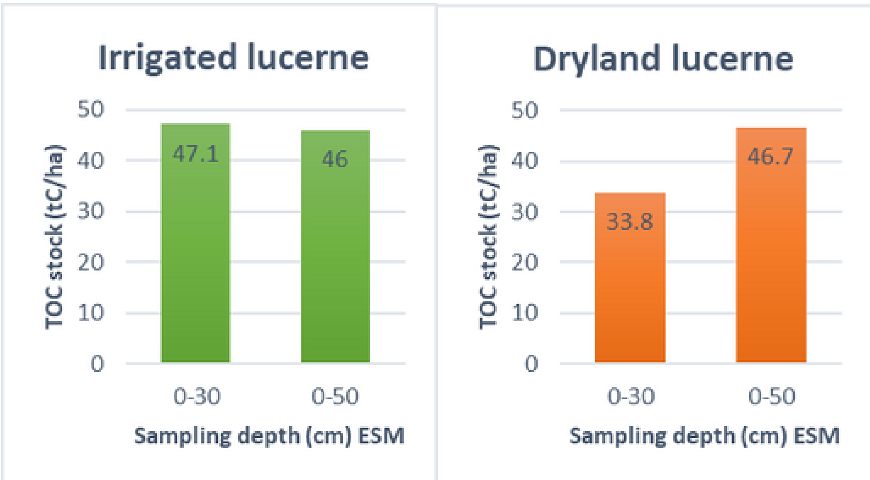


Fig. 5 - TOC stocks in irrigated and dryland lucerne

- *Effect of deep ripping on soil carbon stocks*

A site sampled in the project area in 2021 compared a control area to an area that had been deep ripped with inclusion plates in 2019 to try and improve pasture production on the site. The Yeomans plough with inclusion plates was found to increase organic carbon stock for all methods measured and at all depths. The key finding from this was that not only have soil carbon stocks increased (Figure 6) but there has been an increase in the storing of soil carbon at depth increasing the security of soil carbon stocks.

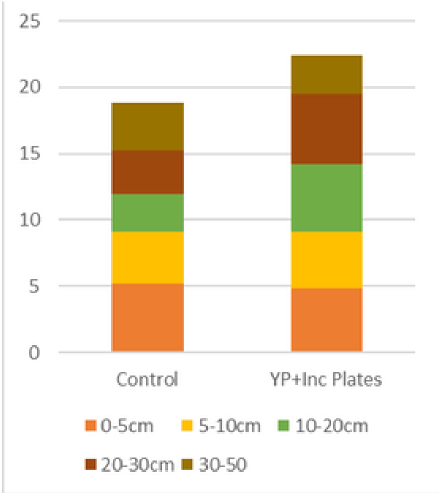


Fig.6 Impact of soil amelioration on Soil C stocks (TOC t/ha)

Vulnerability of soil carbon stocks - opportunities to 'secure' it

Soil carbon exists in different fractions. The particulate, humus and resistant fractions. The particulate fraction varies and fluctuates over time – it is impacted by soil type, rainfall, temperature and management practices. The soil has a limited capacity to protect organic carbon from mineralisation; particularly at the soil surface where it is more exposed to the elements. The deeper we can store carbon in the soil, the more 'protected' it can be come. This is an area that needs to be explored further to see if we can capture carbon deeper in the profile increasing its security.

How does soil carbon fit into my on-farm accounting?

An increase in 1t/ha soil carbon stocks is equivalent to 3.67t CO_2e/ha.

The potential is there to increase soil carbon stocks across the Coorong and Tatiara District regions but once the carbon is captured, it can only be used once in carbon accounting and levels must be maintained or it can have a negative impact on your balance sheet.

Greenhouse gases have different levels of effect (global warming potential) in the atmosphere and to make sure we compare the GHG gases fairly (or apples to apples) we convert the gas to a standard equivalent tonnes of carbon dioxide (CO_2) known as CO_2 equivalent or CO_2e.

To convert soil carbon stock to CO_2e we multiply by 3.67 which is the atomic mass of CO_2 divided by the atomic mass of C (44/12).

Atomic weight of a carbon atom is 12 and the atomic weight of an oxygen atom is 16 so the atomic weight of CO_2 is 44 (12 + 16 + 16).

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