

Soil Carbon Benchmarking 2020-21

Background

There is strong interest in assessing and understanding the soil carbon (C) levels in our agricultural soils. However, there are few sites that are suitable for monitoring soil C change to depth and over time. Selecting the most appropriate soil carbon test and understanding what it means can also be confusing.

Ten paired monitoring sites were selected to measure soil carbon to 50 cm at strategic locations across the Island with consideration of rainfall, soil type and land use (perennial pasture and continuous no-till stubble retention cropping) compared to annual pasture. Common soil carbon tests were analysed to establish guides for the soils in the region.

What was done

Sampling methodology was based on the national soil carbon research program and existing SA long-term soil C monitoring site protocols. Ten 'paired' paddocks (Figure 1) were selected to compare the impact of management practice on soil carbon (Table 1).

Table 1. Site list showing soil type, rainfall, farming system comparison and years under management.

Farmer	Site	Soil type	Rainfall	Site	Yrs	Comparison Site
Heinrich	1, 2	Ironstone	6-700mm	Pasture - Kikuyu	10	Annual Pasture
Green	3, 4	Sand over clay	<500mm	Pasture - Kikuyu	11	Annual Pasture
Paxton	5, 6	Ironstone	6-700 mm	Pasture - Kikuyu	12	Annual Pasture
Wilson	7, 8	Sand over clay	<500mm	Pasture - Kikuyu	6	Annual Pasture
Short	9, 10	Ironstone	7-800mm	Pasture - Kikuyu	5	Annual Pasture
Clarke	11, 12	Sandy loam over clay	6-700mm	Pasture - Kikuyu	20	Annual Pasture
Berry	13, 14	Sandy loam over clay	<500mm	Crop - continuous	20	Annual Pasture
Mills	15, 16	Sand over clay	5-600mm	Crop - continuous	15	Annual Pasture
Pontifex	17, 18	Ironstone	<500mm	Crop - continuous	19	Annual Pasture
Stanton	19, 20	Sand over clay	5-600mm	Pasture - Multi species	5	Annual Pasture

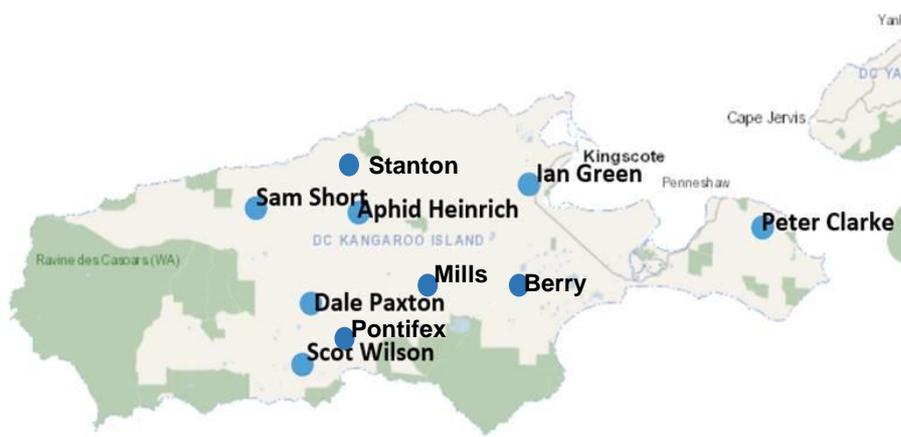


Figure 1. Location of ten sampling sites

At each site bulk density was measured to depth and ten soil cores were collected along 2 transects within the grid for depths; 0-5, 5-10, 10-30, and 30-50 cm and bulked to have one sample for each depth. Soil was analysed for organic carbon (Walkley and Black method), total carbon (Dumas method).

Carbon values are generally expressed as a concentration in the soil (Mg/g or percentage %). To consider the carbon on an area basis (stock as t C/ha) the bulk density (g/cm^3), gravel content and soil thickness (depth cm) needs to be included.

Carbon stock (t/ha) is calculated by OC % x depth (cm) x bulk density (fine earth¹) g/cm^3

However, this conversion does not account for differences in soil mass between soils with a fixed depth. As soil mass is responsive to changes in land management, carbon stock was calculated using a standard or equivalent soil mass (ESM) of 3700 tC/ha in the 0-30 cm and 6500 tC/ha in the 0-50 cm depth (close to median (50th percentile) mass of the 20 sites). Stock data have been reported as tonnes of carbon per hectare of soil for the specified depth. To convert to tonnes of carbon dioxide equivalent multiply the t C /ha value by 3.67.

Results

Most agricultural soil analysis report carbon using the Walkley and Black method. However, carbon accounting requires that total carbon is reported. This analysis has not been used in the past and there is little understanding how the tests compare to each other. As a guide for the results on Kangaroo Island, a multiplication factor of 1.12 for OC WB to total C can be used, refer to Figure 2.

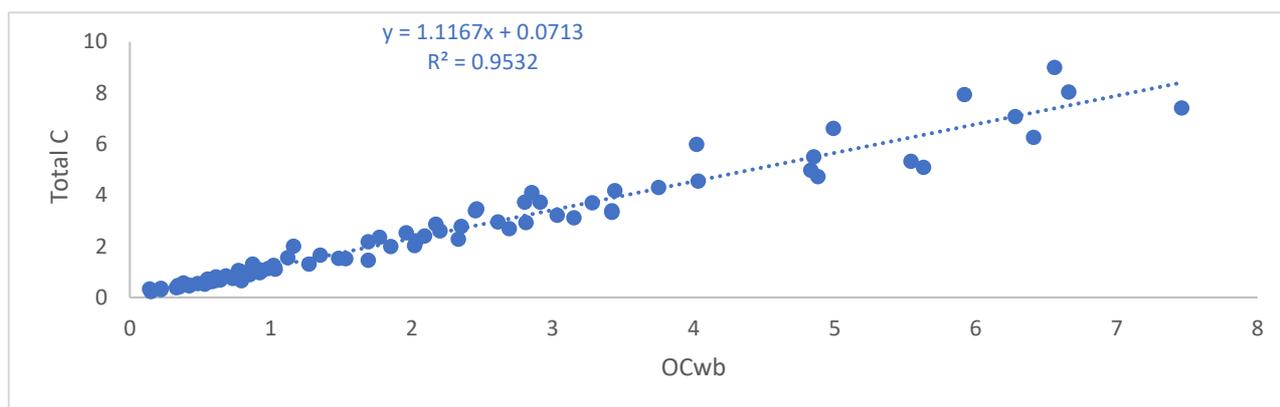


Figure 2. Correlation between Total C (Dumas) method and Organic C (Walkley and Black method)

There was a strong positive relationship between carbon stock and rainfall and soil type where sand over clay soils had lower carbon and ironstone soils higher carbon. There appears to be a sharp increase in C stock at rainfall > 600 mm. Management practice had a more variable effect on C stock (Figure 1) and it is difficult to define a pattern.

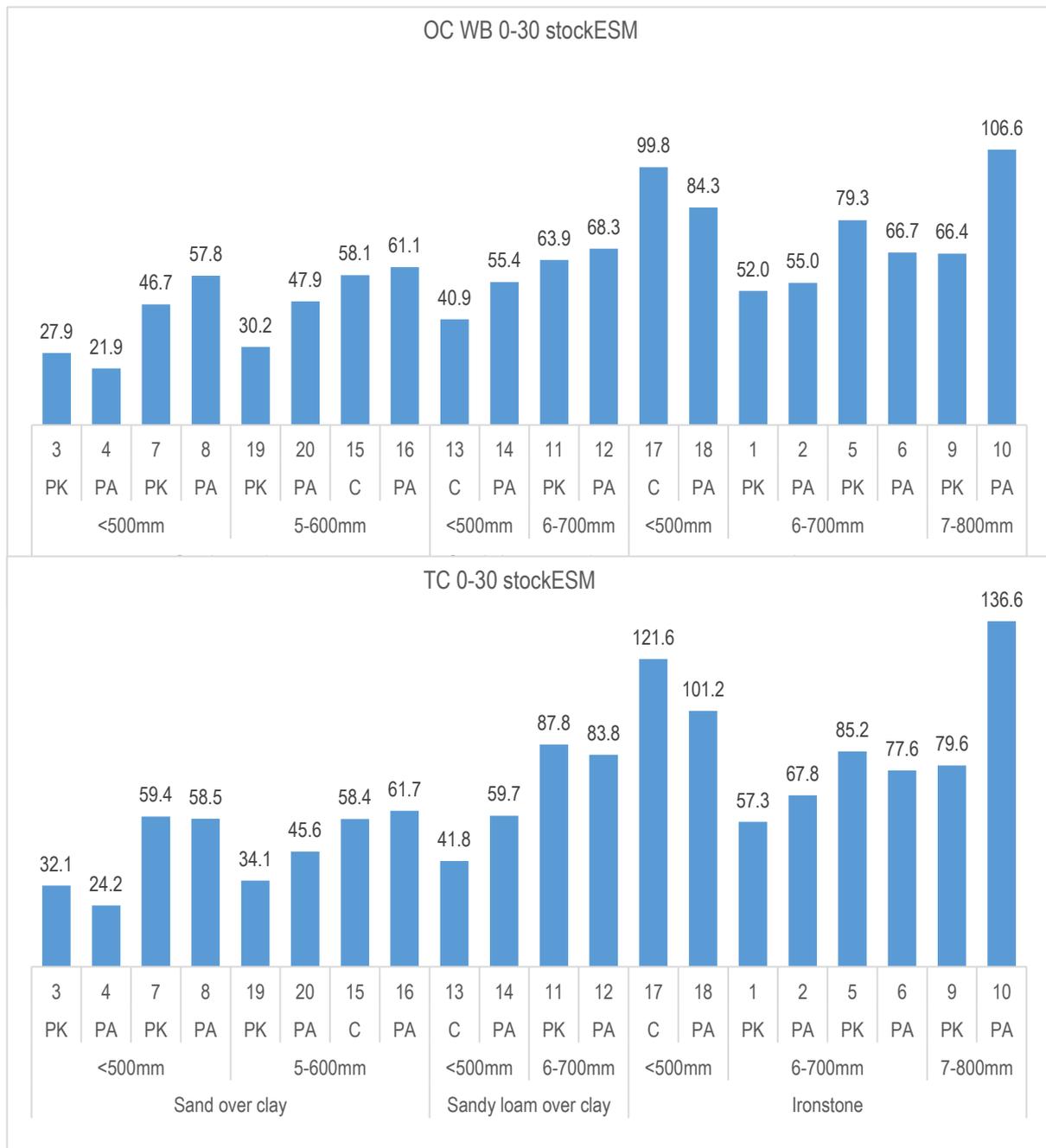


Figure 3. Carbon stock in the 0-30 cm for the equivalent soil mass (3700 t/ha) for organic carbon (Walkley and Black method) and Total C (Dumas method) ordered by soil type and rainfall. Abbreviations: P = Pasture, A = Annual, K = Kikuyu, C = Crop (no till, stubble retention).

There are contrasting results for management between OC and TC stock for sites 7 and 8 and 11 and 12. There is also a difference in magnitude of difference between OC and TC between paired sites for sites 1 and 2, 5 and 6, 9 and 10, 13 and 14 and 17 and 18.

These results require further investigation to determine what the different analytical tests are analysing in the soil. It could be possible that the total carbon analysis is including charcoal (past or recent) that the Walkley Black is known not to include.

Take home messages

- Twenty soils monitoring sites were established on a selection of rainfall, soil type and management systems on the agricultural soils of Kangaroo Island.
- Soil organic carbon (Walkley and Black method), total carbon (Dumas method) and pH (calcium chloride) were analysed for depths 0-5, 5-10, 10-30 and 30-50 cm.
- There was a good relationship between organic carbon_{WB} and total carbon_D for the results on Kangaroo Island. A multiplication factor of 1.12 can be used to estimate total carbon_D from organic carbon_{WB}.
- There was a strong positive relationship between carbon stock, rainfall and soil type.
 - There appears to be a sharp increase in carbon stock at rainfall > 600 mm.
 - Sand over clay soil type had lowest carbon stock and ironstone soil type the highest.
- Management system had a variable effect on carbon.
- There are inconsistencies in carbon stock for the sites depending on which analytical test was used organic carbon_{WB} and total carbon_D. This requires further investigation.

Funding/Sponsors

KI Landscape Board

KI farmers who provided sites for monitoring

For further information contact

Amanda Schapel, PIRSA Nuriootpa

M 0411 137 258

E amanda.schapel@sa.gov.au

Or contact the PIRSA Office Kingscote for a full copy of the report