



Measuring and monitoring changes in soil organic carbon accurately

Factsheet of the Department of Agriculture and Food, Western Australia



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Soil organic matter is increasingly being recognised for its contribution to nutrient cycling, water retention, biological function and optimising crop growth. In addition the potential for soil to store carbon is viewed as a possible way of mitigating greenhouse gas emissions. Therefore it is becoming increasingly important to accurately measure the impact of changes in organic carbon on the functional value of soil.

It is important to ensure that measurement of soil organic carbon (SOC) is done accurately to determine the impacts of specific management practices on SOC over time. Accurate measurement and monitoring is essential to establish baseline SOC stocks (tC/ha) which may be used in future to verify changes associated with environment and management.

SOC refers to the carbon component of soil organic matter (SOM) that is measured in mineral soil which passes through a 2mm sieve. It is the largest component of SOM (approximately 45%) and the easiest and cheapest to measure. The SOC content of agricultural soils is generally between 0.5 and 4%, though soils where grains are grown are commonly in the range of 0.8-2.0%.

Significant changes in SOC occur very slowly, often over the space of 10 years or more. In West Australian grain production systems the rate of change in SOC is often less than 5% of the total SOC stock. Figure 1 gives an estimate of how to calculate the amount of soil carbon per hectare and the change which might occur after retaining 3 tonnes of stubble. Depending on both retention capacity and inputs the rate of change in SOC may be negative in some cases.

To accurately measure changes in carbon stocks you'll need: a representative sampling strategy that takes into account natural variation in carbon stocks across the paddock; a measure of the SOC concentration; and an estimate of the bulk density of the soil to adjust for changes in soil mass at specified depth intervals. For example, sampling the top 10cm of a compacted soil without adjusting for the change in bulk density can lead to overestimates of organic carbon stocks (see Figure 2). This can result in a misinterpretation of the effects of management practices on SOC, giving the impression that measurable changes in SOC have occurred over a short period of time.

SOC measurements from a commercial laboratory will typically represent the soil that passes through a 2mm sieve, so in some soil types you will need to adjust for gravel content. An online

calculator is available on the soil quality website to help you convert a raw soil analysis into measurements adjusted for bulk density and gravel content, and to then express these values on a per hectare basis. Measurements on a per hectare basis often help to make for more meaningful interpretations of the data and may be a requirement under carbon farming schemes.

Soil sampling should take into account the spatial distribution of organic matter in paddocks which is often concentrated within seeding rows (Image 1) or where organic residues are windrowed for example, to be able to more accurately reflect the 'average' organic carbon content of the paddock. Time of sampling, depth of soil sampled and changes in soil type within a paddock also require consideration. Avoid sampling in areas such as headlands where you can get large differences in inputs.

Further information is available in the GRDC publication *Managing Soil Organic Matter: A Practical Guide* authored by Dr Frances Hoyle of the Department of Agriculture and Food Western Australia.

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Step 1. Calculate the amount of soil organic carbon (SOC) per hectare (ha)

Initial soil has 1.2% organic carbon* and a bulk density of 1.2g/cm³ (same as 1.2t/m³) with measurements made to 0.1m depth.

To calculate tC/ha:

- (Hectare)(depth)(bulk density)(SOC*)
- (10,000m²/ha)(0.1m)(1.2t/m³)(1.2 tC/100t soil)
- 14.4 tC/ha

*assayed commercially as per a standard soil test

Step 2. Calculate the new organic carbon after a crop

For example, assuming:

- 3t/ha of stubble = 4 to 5t/ha of organic matter (OM) when including roots
- OM is 45% C
- a sandy soil might retain 20% of the C that is added as OM
- (t of OM added)(the %C in OM)(retention) = the tC/ha added
- (5t OM)(0.45)(0.2) = 0.45 tC/ha

The new SOC is:

- 14.4+ 0.45 tC/ha = 14.85 tC/ha
- %SOC = [(SOC)/(Hectare)(depth)(bulk density)][100]
- [14.85 tC/ha /((10,000m²/ha)(0.1m)(1.2t/m³))][100]
- [14.85 tC/ha/1200][100] = 1.24%

Figure 1 Example calculation of the rate of change in SOC stocks from one year to the next when retaining 3t/ha stubble

Extent of compaction increases

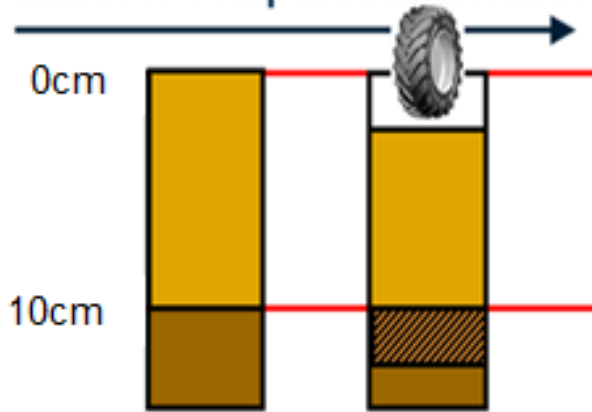


Figure 2 One possible source of error in the measurement of SOC is failure to take into account changes in bulk density at different soil depths due to compaction



Image 1 SOC can vary substantially across space and time in a paddock, as such, a well-planned sampling strategy is essential

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