Increasing OC in the SAMDB

Soil organic carbon can play a key role in improving plant production, soil biological activity, water infiltration and storage in the soil and make soils more resistant to erosion. Interest in carbon sequestration has raised questions about how much organic carbon (OC) can be stored in soil and how much OC is currently in the SAMDB region's soils

A recent study undertaken in the region established baseline soil OC values across a range of soil textures, times of sampling, land uses and NRM districts. It also determined the proportion of soil test results that fell into the low, moderate and high OC values regarded as practically achievable given to the range of factors that influence soil OC content

The SAMDB NRM region covers a large area and given the range of soil types, rainfall and land use in the region, there is variability in OC (Figure 1). Across the SAMDB, there was:

- an increasing trend in OC concentration from 1989. This probably reflects the adoption of reduced tillage and stubble and residue retention practices as well as increased plant production.
- an increasing trend in OC in topsoil textures from sand to clay. Clays naturally have more OC because of their ability to "store" organic matter. They are also more productive soils because of their water holding capacity and inherent fertility so can produce more plant growth. .
- the highest average organic carbon values were in pasture- based systems with most samples (85%) in the high organic carbon range. Cropping and vegetable production systems were represented by the greatest proportion of samples (55%-59%) in the moderate organic carbon range, whilst orchards and vineyards had the largest proportion of samples (36%) in the low organic carbon range.

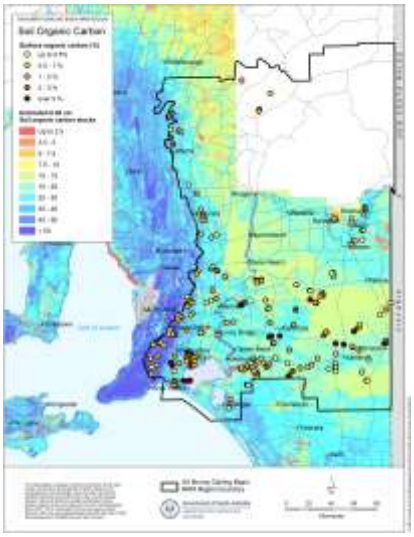

Figure 1. Calculated OC stock of the surface 0-30 cm overlaid with topsoil OC values (%) from individual characterisation sites from the State Soil and Land Information Framework for the SAMDB NRM region. *Source: Department for Environment and Water, Science and Information Group.*

Can OC be too low or too high?

Soil OC less than 1% is believed to affect a soil's ability to drive microbial functions such as releasing nitrogen from organic matter. It also reduces a soil's capacity to store water and nutrients.

There is an upper limit for soil OC that can be practically achieved. It is assumed that soils reach a stable balance between inputs of carbon and decomposition by soil microorganisms so trying to increase OC concentrations above this equilibrium amount is likely to be uneconomical and of little benefit. Some soil conditions, such as waterlogged soils and strongly acidic or alkaline soils, can severely inhibit or kill soil microorganisms, slowing the breakdown of organic matter and resulting in accumulations of soil OC. In this example, a high SOC value is a reflection of a poorly functioning system. If the soil is remediated and microorganism numbers increase, the OC value is likely to decrease.

Management of OC content of agricultural soils should aim to maximise productivity, profitability and soil biological functionality rather than achieve a particular SOC value.

Opportunities to increase soil carbon

The potential for storing more carbon depends on a soil's measured (base) level of OC and its storage capacity. Climate and management practices affect the amount of organic matter that can be grown and put into the soil. Soil type determines the amount of soil OC that can be protected and stored long term. Any organic carbon that is surplus to the protective capacity of the soil type remains susceptible to decomposition from microbes. The rate of breakdown will depend on the form of organic matter, soil type (clay percentage and mineralogy) and climatic factors.

Ultimately, the opportunity to increase soil OC depends on

- the soil's capacity to store more OC
- additions of OC exceed losses
- converting OC inputs into forms of OC more resistant to decomposition for long-term storage
- a soils ability to minimise rapid losses of SOC (e.g. residue burning or soil erosion)

This can be achieved through

- comparison of soil analysis OC% compared to the SAMDB NRM OC average and OC standards (Table 1) to determine if it is below the average or moderate range
- identification of soil constraints limiting productivity and organic matter addition. Constraints need to be considered as to whether or not there are practical, economic means of overcoming them. Consideration of management practices that can build and/or minimise loss of OC.

There is a wide range of management options and farming practices that can increase SOC levels by either increasing inputs or decreasing losses. Mechanical and chemical fallowing, cultivation, stubble burning or removal, and heavy grazing can lower SOC by reducing inputs of organic material to the soil, accelerating the decomposition of soil organic matter and/or making the soil susceptible to erosion. Soil OC content increases when more organic matter is retained in the paddock. Practices that lead to increasing OC input to the soil under various land uses include:

- **Pastures:** increase the number of perennial plants in the mix to extend the plant matter production period; include a variety of types of plants – grasses, legumes, broad-leaf plants to encourage a diversity of root growth forms and microbial activity; ensure pastures have adequate nutrition and soils are within a desirable pH range; manage grazing pressure so that plant growth is stimulated and surface cover is maintained
- **Crops:** ensure sound agronomic practices are used eg adequate nutrition, suitable pH, appropriate crop and variety selection, sown at optimum time, pest management to promote vigorous crop growth; retain stubbles, minimise tillage, alleviate compaction in soils.
- **Horticulture:** grow cover crops or swards in orchards to provide surface cover and generate growth of organic material that can supply OC to the soil; import composts and manures to supply OC to the soil carbon cycling process.

It is not always possible in an agricultural system to maximise plant growth and return all of this material to the soil. A considerable amount of biomass is removed in hay production. Pastures provide feed for animals; occasionally tillage or burning is required to manage pests and diseases. It might take many years to see management practices causing a consistent, positive change in OC. A change in practice needs to be carefully considered in relation to what is practical, economical and appropriate to the long-term aims of the enterprise as well as the manager's capacity to implement the change well.

Table 1. Average measured soil OC% from the SAMDB NRM region and practical ranges of OC in topsoil (modified from SAMDB NRM report and Maschmedt and French)

Topsoil texture	SAMDB Average measured OC %	Moderate OC standard %	Land use Average measured OC (%)				Rainfall zone (mm)			
			Cropping	Vegetable	Orchard or Vineyard	Pasture	<325	325 400	400 450	>450
Sand	0.9	0.5-0.9	0.6	1.2	1.2	1.2	0.6	0.7	0.8	1.0
Loamy sand	1.3	0.5-0.9	0.8	0.8	0.8	2.1	0.8	1.0	1.2	1.4
Loam	1.9	0.7-1.3	1.2	1.0	0.9	2.8	1.0	1.1	1.4	1.6
Clay loam	2.3	0.9-1.7	1.4	1.8	1.3	3.1	1.1	1.3	1.5	1.8
Clay	2.2	1.2-1.9	1.5	2.1	1.6	3.1	1.3	1.8	1.8	2.0

Note: OC values are derived using Walkley Black analysis

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For more information

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