

- SOIL ORGANIC CARBON - A REWARD for GOOD LAND STEWARDSHIP

NUTS & BOLTS

- Soil organic carbon (SOC) enhances the chemical, physical and biological functioning of soils and is a critical component in the resilience of soils to stress.
- Loss of SOC is a major threat to agriculture due to having a major influence on soil condition.
- SOC levels are influenced by climate, land use, soil type and plant residue management.
- Adoption of management practices that enhance plant productivity and residue return to the soil will contribute to increasing soil organic carbon levels.

The decline in fertility attributed to diminishing concentrations of soil organic carbon (SOC) is a major threat to the productivity and sustainability of our agro-ecosystems.

Although conventional broad-acre land management practices tend to result in the loss of SOC, economically viable changes to land management

may reverse this trend and allow some soils to store much larger quantities of carbon.

For example adoption of no-till technologies, selecting crops and pastures that maximise plant growth, incorporating perennial pasture species and modifying grazing management to maintain pasture cover.

WHAT IS SOIL ORGANIC CARBON? ●●●

SOC is a complex and heterogeneous mixture of materials that play a critical role in a variety of soil processes, thereby having a major impact on soil condition.

It is the measurable component of soil organic matter (DAFWA, 2015).

The mixture that contains this carbon (organic matter) acts as a repository of nutrients, provides energy for soil organisms and helps to bind soil particles together.

These functions enhance numerous soil properties such as nutrient supply and retention, biological activity and diversity, soil structure,

water-holding capacity, and resilience to erosion.

The amount of SOC at any given time results from the balance between carbon inputs and carbon losses and the potential maximum quantity of organic carbon a soil can hold.

Carbon inputs are determined by the amount of plant residue added to the soil.

Any management practice that enhances plant productivity and residue return to the soil enhances carbon inputs.

This is why ameliorating constraints to productivity, such

as soil acidity, compaction and infertility, are beneficial investments for both enhanced profits and soil condition.

Conversely, SOC can be lost rapidly under intensive cropping systems due to the reduced biomass production of crops versus pastures, but also due to the removal of a large portion of biomass in grain and/or straw.

Ultimately, economic considerations will direct the choice of land use and while lengthy cropping phases may initially rapidly draw down SOC, a return to highly productive pasture phases can reverse this trend over time.

WHAT ARE THE DIFFERENT TYPES? ●●●

SOC exists in several distinct chemical and physical fractions and is generally divided into three compounds (NSW DPI, 2015).

Particulate organic carbon consists of fresh residues and living organisms or material that is readily available for decomposition by soil organisms. Soil organisms break down particulate matter to create humus, the final product of the decaying process (it will break down no further).

Humus is important for binding soil particles together. It improves the water and nutrient holding capacity of soils which are essential for plant growth. Humus can store or

sequester carbon for decades, or even centuries.

Resistant organic carbon (charcoal) is a result of incomplete burning of plant material or fossil fuels. It's believed to be biologically and chemically unreactive compared to other soil organic matter components, so carbon stays locked into the soil's charcoal and isn't readily released or taken up by soil organisms.

The only way to enhance soil organic carbon over the long term is to increase the proportion of humus material through the addition of fresh residue and living organisms (particulate organic carbon) available for decomposition.

WHAT INFLUENCES SOIL ORGANIC CARBON? ●●●

SOC levels are influenced by climate, land use, soil type and plant residue management and is concentrated in the top few centimetres of soil.

Generally speaking, of the organic materials returned to the soil, anywhere between 50 and 85 per cent of the mass of this material is lost to the atmosphere as carbon dioxide in the first year.

While land management affects how close a soil comes to its potential, this potential varies due to the clay content and depth of soil.

The enhanced fertility, surface area and physical protection from clay particles ensure the threshold will be smaller for a light textured soil than one with a heavy texture.

SOC is highly variable, spatially and temporally and requires several years to quantify the effects of management treatments.

Furthermore, concentrations change very slowly and are subject to seasonal variability due to the differences in inputs and outputs of carbon to the soil.

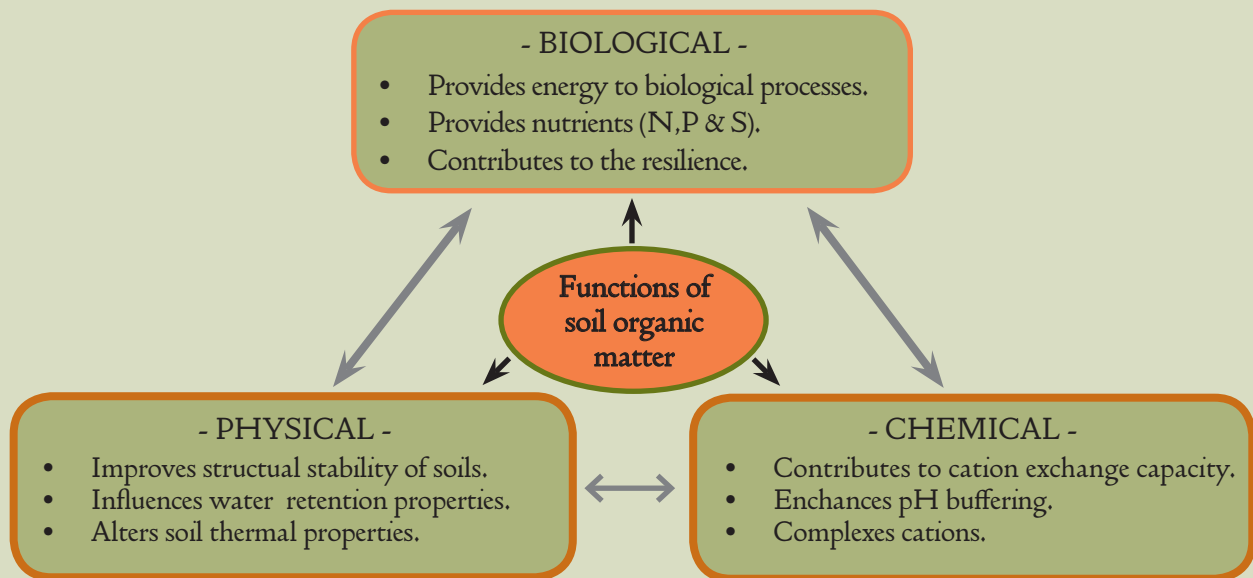
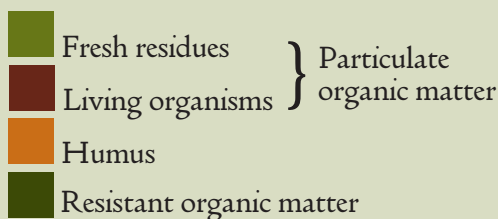
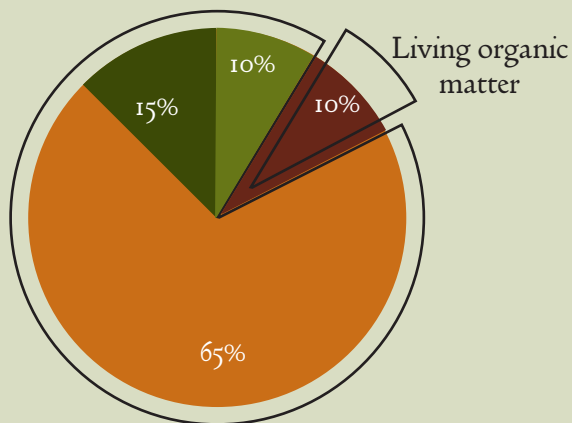


Diagram 1. Black arrows represent the various classes of function, while grey arrows indicate the interactions which can occur between the classes (Baldock & Skjemstad 1999). NOTE: For the purpose of this case study, diagrams describing soil organic matter have been used to represent the fractions of soil organic carbon.



DEAD & DECAYING ORGANIC MATTER ●●●

Diagram 2. The vast majority of soil organic matter is dead or decaying with living organisms making up less than 10 per cent of the soil organic matter pool (DAFWA, 2015).

HOW TO IMPROVE SOC ●●●

SOC enhances the chemical, physical and biological functioning of soils and is a critical component in the resilience of soils to stress.

Therefore, the adoption of management options to increase SOC should be promoted within the context of retaining both a profitable and viable farming systems. These include:

- The amelioration of soil constraints.
- Enhanced plant productivity through optimised fertilisation.
- More productive perennial and annual pasture species and enhanced residue retention.

RESEARCH ●●●

Perennial pastures are generally expected to store more soil carbon than annual pastures due to their extensive root system which persists all year round. As part of the Climate Action on Farms project, South Coast NRM in conjunction with UWA, conducted

AIM OF OUR INVESTIGATION ●

- How soil carbon stores under kikuyu grazing systems in comparison to an annual grazing system
- How cropping into a kikuyu pasture affects soil carbon

WHAT WE DID ●

We compared total soil carbon under three different farming systems within the same farm:

- Annual grazing system
- Kikuyu grazing system (15 years)
- Crop converted from kikuyu paddock (15 years)

HOW WE DID IT ●

Through soil testing consistent with the CSIRO's Soil Carbon Research Program methodology, randomly distributed 25 x 25m quadrats were used to sample the soil profile from 0-30 cm to measure total soil carbon.

WHAT WE FOUND ●

- Total soil carbon is higher in a kikuyu grazing system compared to annual grazing systems
- Cropping for up to two years into a kikuyu grazing system does not change the total soil carbon - see fig 1.

research on a farm to determine if soil carbon increased in paddocks planted to kikuyu (perennial pasture) as opposed to an annual pasture and if cropping into kikuyu affected soil carbon stores more. Below is a summary and results of the soil research trial undertaken.

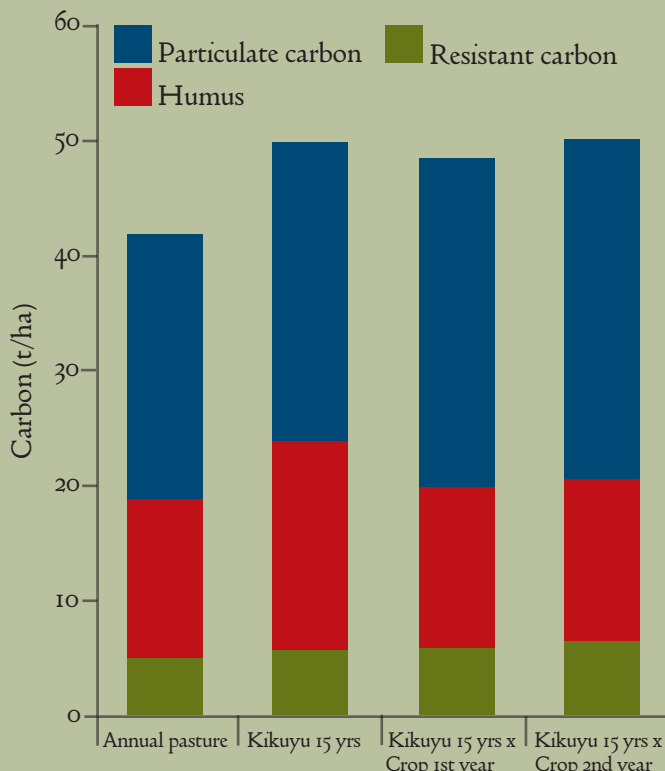


Figure 1. Mean of total carbon (0-30 cm) in different farming systems relating to the different fractions of soil carbon.

- Soil organic carbon is the basis of sustainable agriculture -



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FURTHER INFORMATION

For more information about this and other Climate Action Farming projects please visit: www.climateactionfarming.com.au.

For further information on agricultural trials in WA go to: www.agtrialsites.com. A series of short Climate Action Farming films can be viewed on the South Coast NRM You Tube channel.

Other STORIES FROM THE LAND case studies include:

- The Magic Number
- Built for this Country
- Native Grasses Improve Farmland by Storing & Increasing Carbon & Reducing Salt Scald.
- Cropping into Kikuyu, Herbicide use & Regrowth of Pastures.
- Healthy Soils Produce Happy Vines.

PHOTOGRAPHY & DESIGN

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