Information Sheet

6.2 Soil organic matter

Soil organic matter (SOM) is an important indicator of soil health as it influences the physical, chemical and biological properties of soils. Soils used for agriculture are generally low in SOM and the addition of SOM improves its fertility. In general, higher amounts are more beneficial to soil health and the soil's ability to support crop production. Improving SOM has also been encouraged as a key strategy to help lower excess atmospheric carbon (C) levels thereby mitigating global climate change.

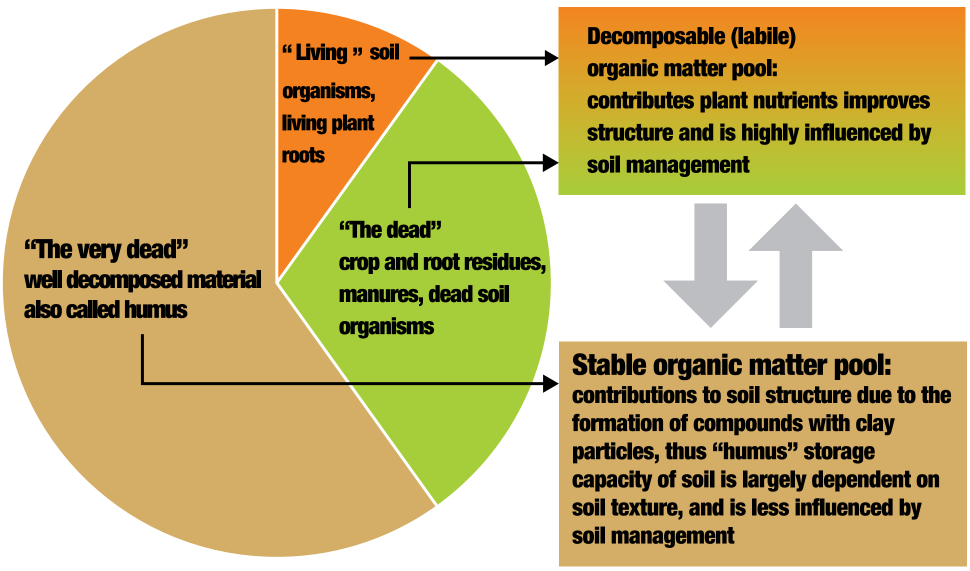
This information sheet outlines the various sources and components of SOM, their importance in soil health and sugarcane production, as well as provides guidance on key management practices that aim to increase and maintain SOM levels of your soils.

What is SOM?

SOM consists of plant and animal residues on the soil surface (living and dead), as well as the decomposing plant and animal residues, soil organisms and plant roots and a wide range of organic molecules produced from the decomposition or released by the living components.

When organic residues are added to the soil, they quickly decompose so that approximately one-third of the original material remains as SOM after a year. Typically, topsoils used for agriculture contain between 1 - 6% organic matter, though this can be almost zero in pure sands to as high as 15% in some humic and organic soils. Subsoils contain much lower levels (typically <1 %).

SOM comprises about 50 to 60% carbon (C), while the rest is made up of oxygen (30 to 40%), nitrogen (2 to 4%), sulphur (1%) and minor amounts of phosphorus (P) and microelements. Organic matter is broadly divided into three main fractions (closely linked with one another) that contribute in different ways to soil function and health – "living" (about 15%); "dead" (about 15%) and "very dead" (about 70%).

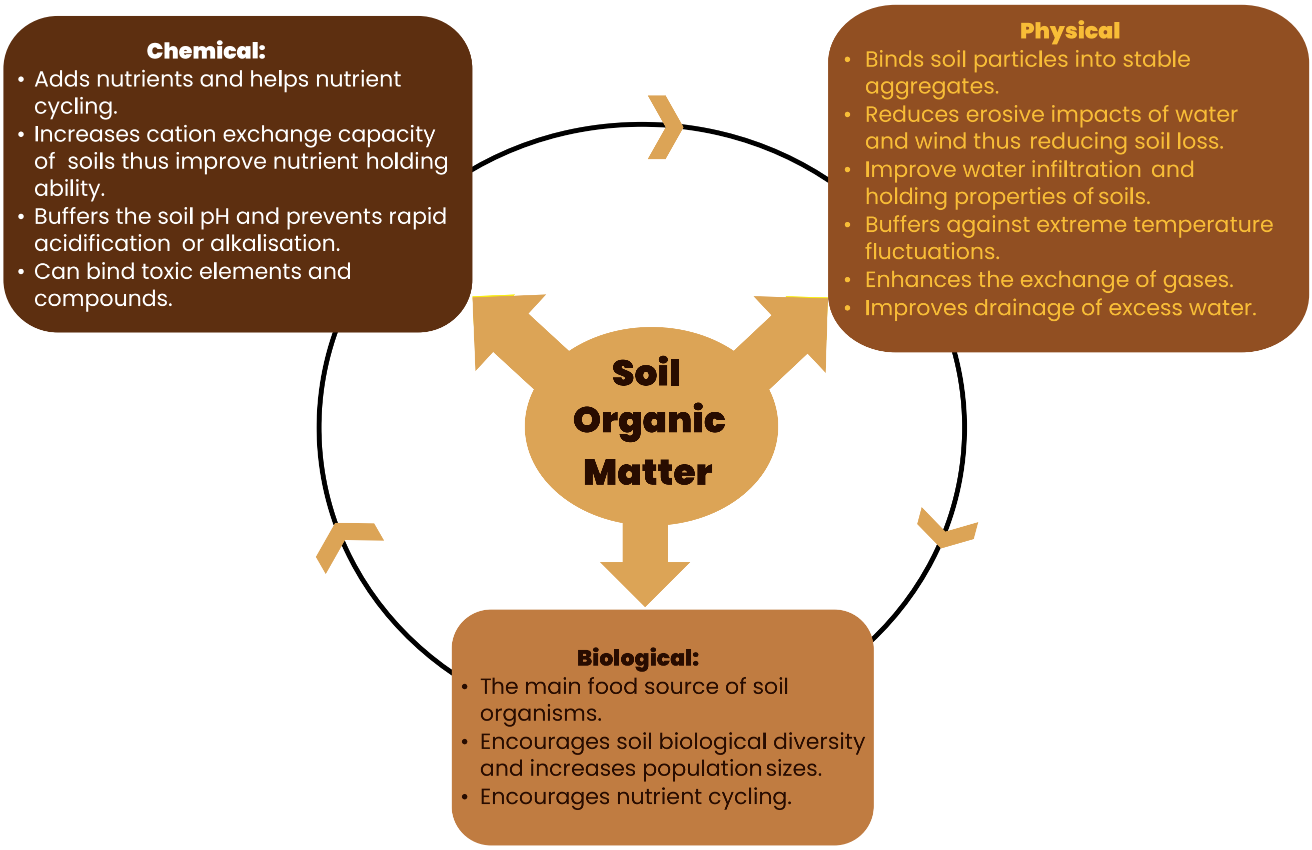


There is also a distinction made between SOM and soil organic carbon (SOC), the latter referring only to the C component of the SOM. SOC is often used to quantify carbon stocks in different environments and allows some level of standardisation across different environments. Most soil tests that report SOM actually measure SOC and convert it to a SOM estimate using the following generalised equation:

SOM = SOC (%) x 1.72 (a conversion factor which assumes that, on average, 58% of SOM is made up of the carbon fraction).

The benefits of SOM

Soils that contain less than 2% organic matter are considered highly susceptible to erosion. The decline in organic matter in sugarcane producing fields in South Africa are well documented and have been linked to declining yields and reduced long-term sustainability. The addition of organic matter through green cane harvesting and mulching, adding manures, adoption of minimum till practices and control of erosion are critical in conserving and building SOM levels over the long term. Its most important role is to act as a binding agent between soil particles to create structure. This is key and leads to other beneficial effects SOM has on soil properties (see diagram below).



Factors affecting SOM levels

Factors affecting SOM levels can be divided into two broad categories which are natural factors and management factors. Natural factors are beyond the control of growers while management factors are tools available to manipulate natural factors within the limitations they pose.

Natural factors

- **Climate:** Cooler and wetter climates tend to have higher levels of SOM, mainly due to high plant biomass production and slow breakdown of the SOM, which leads to an accumulation in the soil. The effect of this is perhaps best represented by the humic soils of the KwaZulu-Natal Midlands. Dry climates often have low SOM levels due to low biomass production, while warm, moist environments (often coastal areas), also have lower SOM levels due to rapid breakdown of plant residues (despite high biomass producing potential).

- **Soil texture:** Clay soils generally have higher SOM levels compared to sandy soils (in certain climatic zones) as clays can bind with organic molecules more strongly which protects them from break down by soil organisms.
- **Topography:** Both the position on a slope and the direction the slope faces can affect SOM levels. Soils on south-facing slopes generally contain higher levels of SOM compared to north-facing slopes. The wetter foot slopes of hills tend to have higher clay content and are richer in SOM compared to the top of the hill which are drier and contain less clay. Changes in temperature, moisture and erosion can alter the accumulation of SOM in different parts of the landscape.

Generally, for any given environment and climate, the soil will only be able to store a certain amount of SOM. Thus, in some conditions it will be difficult to increase SOM levels much beyond its natural capacity to store SOM. To do this requires vast inputs, which is not always feasible in an agricultural production system. However, even small increases in organic matter have disproportionately large benefits to soil health, so any practices that improve SOM accumulation are advisable. It is still important to add organic matter to soils that have reached their equilibrium SOM level to maintain that level.

Management factors

Numerous practices used in intensive agriculture lead to declines of SOM. These include:

- **Bare fallows:** The lack of continuous plant biomass retention on the soil will lead to decline in SOM levels over time due to the lack of organic inputs. A green manure fallow is always recommended to protect the soil and promote SOM maintenance.
- **Soil disturbance:** Tillage operations expose SOM to the atmosphere and thus increase the rate of breakdown. Conservation tillage operations aim to minimise soil disturbances to better preserve SOM levels.
- **Burning and/or biomass removal:** These activities either destroy or remove plant residues and cover from the soil, thus lowering organic matter inputs into the soil. Green cane harvesting and mulching are advocated as an essential practice to increase SOM levels.
- **Practices that lead to poor soil health:** Compaction, acidity, excess salts and water-logging negatively affect the growth of root systems and biological functions. This can result indirectly in poorer SOM accumulation and cycling over time.
- **Erosion:** Any activity that leads to erosion and soil loss (crusting, compaction, run-off) also leads to loss of SOM as particulates in the eroded sediments. Poor surface water flow control structures, lack of soil cover and soil disturbance are leading contributors to erosion losses.

Management practices that promote SOM

While many management practices can promote the loss of SOM, appropriate use and application can be highly beneficial to reverse losses, maintain levels and, in some cases build levels. Key strategies include:

- Minimise bare soils and adopt green manure fallowing.
- Minimise soil disturbance by adopting conservation or minimum tillage practices.
- Adopt green cane harvesting and mulching where possible (or where burning is necessary, cool burns with tops retained).
- Do not burn mulches or residue windrows.
- Apply organic amendments where these are available.
- Make use of contour banks, cane rows that follow the contour, strip cropping, mulching and well-designed grassed waterways to prevent and control erosion losses.
- Accurate application of inorganic fertilisers at recommended rates based on soil analysis.

▲ Burning of cane lowers organic matter returns to the soil.

Thandile Mdlambuzi (Soil Scientist)

July 2022