ORGANIC MATTER & SOIL FUNCTION

Management of productive soil requires optimising supply to and integration of the biological, chemical and physical functions.

Soil functions that support condition

Organic materials provide key supply functions that support biological, chemical and physical condition of soil. Soil functions are general capabilities of soils that are important for various uses.

Physical, chemical and biological functions are best represented by 3 overlapping circles, with overall soil function (SF) determined by the area that all three circles overlap (Figure 1). Land managers improve productivity and environmental quality by integrating and optimising the physical, chemical and biological function of their soils (Figure 1a). Supply is represented by the size of the circles in Figure 1. Reducing supply to biological, chemical or physical function reduces the size of one or more of the circles, and reduces overall soil function represented by smaller the area overlapped by all 3 circles in Figure 1b.

Not integrating the supply of biological, chemical or physical functions causes the circles to move apart (Figure 1c), limiting overall soil function even when supply is well maintained. Examples include growing crops outside their optimal range of pH or in soil that is too salty.

In these examples targeting the limiting factor would allow better access to essential nutrients and stored water. Loss of biological, chemical or physical function causes the circles to move apart, reducing the overall soil function represented by smaller the area overlapped by all 3 circles in Figure 1c.

Smaller pools of organic materials with well maintained function can sustain a more productive soil than larger pools which have partially lost some of the functions.

>> Figure 1: Concept of soil function: a) ideal management which optimises and integrates biological, chemical and physical functions; b) not optimising all functions thereby reducing the potential area that the three circles can overlap; and c) not integrating the functions thereby causing the circles to move apart, rather than overlap. Adapted by J Chapman from: Gugino, et. al (2009), http://soil health.cals.cornell.edu

Organic materials support soil function by providing:

Energy

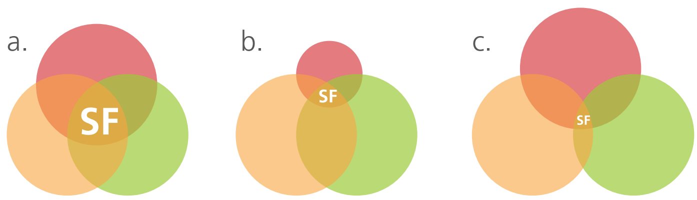
Plants convert energy from the sun into stored chemical energy. Called photosynthesis, carbon dioxide and water molecules are made into simple carbohydrates. This stored energy is used by soil organisms to power their metabolic functions. Each time organic materials are "turned over" during decomposition, some of the stored energy is used. Most of the energy is used to decompose fresh particulate residues into humus. The remaining readily available energy is used up during decomposition of humus.

Without the stored chemical energy there would be no biological function. It is therefore important to add a constant supply of fresh residues to maintain healthy populations of microbes and other soil organisms that support productive soils.

Nutrient Supply

Plants and other soil organisms have preferred chemical forms of essential nutrients used for growth. The nutrients are constantly being recycled between soil organisms, as soil organic matter (SOM) is turned over.

SOM provides a steady supply of essential plant nutrients. Supplement during periods of high crop demand for nutrients, and to support microbial populations when applying organic amendments.



The different nutrient requirements of soil organisms to plants also need to be considered and supplemented as required when organic amendments are added to soil to avoid short term nutrient deficiencies impacting crop productivity.

Negative Charge

As SOM is decomposed and continually turned over, the organic carbon is transformed into new and smaller organic products, containing groups able to form negative charge by releasing H^+. Clay particles can also generate negative charge. However humic materials and charcoal produce more negative charge than most types of clay.

Humus needs clay to bind into aggregates that protects it from attack by microbes.

The ability of SOM to release H^+ and form negative charge enables soil to:

- hold positively charged essential plant nutrients and water within plant root zones, from where they can be taken up as required;
- resist change in pH by releasing or taking up H^+;
- bind harmful substances making them inaccessible to plants and soil organisms.

Binding agents

Smaller aggregates (<0.25 mm) are bound by older and more stable forms of organic matter such as humus and organic cements. These aggregates are bound into larger aggregates (>2-5 mm) by less stable forms of organic matter such as plant roots and fungal strands. The larger aggregates are more sensitive to management effects on organic matter.

Protect aggregates from mechanic damage to retain plant available water.

3-D Structure

After rainfall or irrigation gravity will drain the applied water, unless the molecules are held by stronger forces within the pore spaces.

Water molecules are naturally attracted to the charged surfaces of clay and organic matter. However humus and charcoal have open, flexible 3-dimensional structures able to act like a sponge, absorbing many times their weight in water that can be accessed by plants. Aggregation of soil particles creates opportunity to hold water at lower energies that plants are able to readily take up at times of high demand.

Open, interconnected pore spaces also allow ready movement of air into the soil enabling oxygen to be renewed and waste gases such as carbon dioxide to be removed.

^ Figure 2: Soil with good structure and function enabled these leeks to grow healthy root systems and produce a high yielding crop Source:www.img.diynetwork.com

Dark colour

Darker soils absorb more energy from the sun, but if they contain high amounts of organic carbon which in turn holds more water, they make take longer to warm up. Sand tends to warm and cool more quickly than clay.

STEP UP SOILS

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