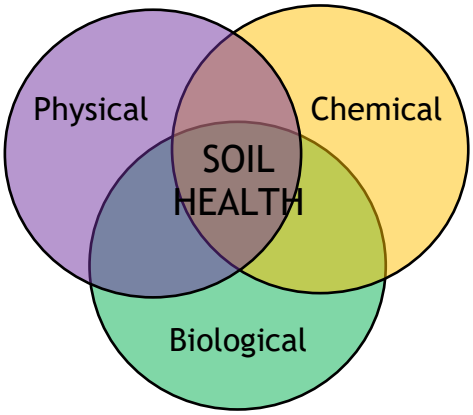
Holbrook Landcare Network

SOIL HEALTH
in pasture systems

What is soil health?

Three key properties influence a soils fertility and condition – physical, chemical and biological. All three properties are important and influence each other. A 'healthy soil' is one that is in good condition across all three properties.



A soil in good condition will capture rainfall and cycle nutrients more effectively and minimize soil-borne diseases. This leads to healthier pastures and therefore higher productivity and profitability for your farming business.

Physical properties

A term commonly used to describe a soil's physical condition is the soil's **structure**. A soil with 'good structure' will have a mix of aggregate sizes and spaces between (called pores) to allow water and roots to penetrate, and hold enough water and oxygen to support plant growth. Soil structure can be degraded by external forces such as compaction from machinery or animals or by certain nutrient levels such as high sodium and low organic carbon levels. Soil structure can be improved by lowering sodium levels, increasing organic carbon and plant root volume.

Chemical properties

"Managing soil health is a separate task to managing soil fertility."

A soil in good chemical condition will have sufficient levels of nutrients essential for plant growth and low levels of toxic elements.

Soil pH is critical to plant health and soil function. Low pH reduces the productive potential of many pasture species by reducing root growth and altering the availability and the plants' ability to access nutrients and water. As pH declines some nutrients become unavailable to plants, such as phosphorus and molybdenum, while other elements, such as aluminium and manganese can reach toxic levels. Extremely low or high soil pH also creates a hostile environment for soil microorganisms like to nitrogen-fixing rhizobia, reducing or stopping their function.

Salinity is the presence of high levels of soluble salts (often sodium, chloride and boron ions) in the soil. It effects plants by reducing water uptake or even reversing uptake in severe cases (through reverse osmosis). Excessive concentrations of ions can also cause toxicities in plants and limit the uptake of other ions (e.g excess chloride reduces the uptake of nitrate).

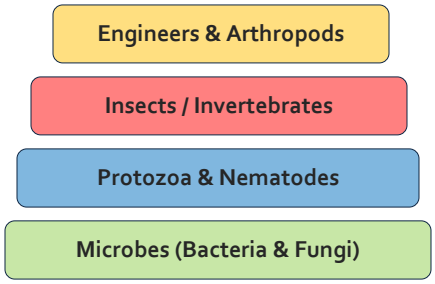
Sodicity is the presence of a high proportion of sodium ions relative to other cations in the soil. A high proportion of sodium attached to clay particles weakens the bonds between particles when they are wetted. As a result, the small clay particles swell, detach and disperse, and move through the soil, clogging pore spaces. This results in a dense, structureless soil that can impede root, water and air penetration and become more susceptible to erosion.

Biological properties

"Plants live in partnership with a whole complex community of life – they live in a symbiotic relationship where the plant needs the soil organisms and the soil organisms need the plant"

Whilst most people are familiar with how physical and chemical properties affect soil health and productivity, the effect of soil biology is often less clear. A variety of organisms live in the soil, including microbes (bacteria and fungi), protozoa, nematodes, invertebrates, insects, dung beetles and earthworms – named the 'soil biological community'. These organisms perform a number of vital processes, including enhancing the cycling of nutrients, converting nutrients from one form to another and assisting plants to uptake nutrients from the soil.

Soil biological community



The drivers of soil biological health are:

1. Sufficient soil water/moisture
2. Optimal temperature
3. Food/energy (organic matter)
4. Plant diversity

Farmers can improve soil biological health by; maximising soil structure for air and water, returning organic matter to the soil through good grazing management, and increasing plant diversity in pastures.

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How do you measure soil health?

There are two ways you can measure and monitor soil health in your paddock:

- Soil test from a soil laboratory
- Field measurement

Physical health

Infiltration – hammer a ring into the ground and fill with water. Time how long the soil takes to absorb the water. This determines how much porosity and well-structured the soil is. The higher the infiltration rate generally the healthier the soil is.

Aggregate strength/stability – place an aggregate in water and see how well it holds together.

Other more complex ways you can measure physical health are with a **bulk density** test or using a **penetrometer** to determine how compacted your soil is.

Chemical health

The key chemical properties of soil health - pH, exchangeable aluminium, salinity and sodicity can be measured using a standard agronomic test from a soil laboratory or in the field.

Soil pH – use a field pH kit to determine your pH level.

Salinity – electrical conductivity (EC) of a 1:5 soil water solution can be measured using a handheld EC meter.

Sodicity – using the **aggregate strength/stability test** (above). Soils with a high proportion of sodium will disperse and turn the water cloudy.

Biological health

Soil respiration meter – measures the activity of the soil community by how much it is respiring (breathing) carbon dioxide.

'Soil Your Undies' / Calico strip test – bury a pair of cotton underpants or strip of calico in the topsoil and see how long they take to decompose. This determines how active the decomposing microbes are in the soil.

Root depth/root volume – dig up a cube of soil and assess the roots. The same cube of soil can be used to do **earthworm counts** and **organism counts** (species diversity).

Laboratory tests for soil biology have come a long way over the years and can help assess the biological function of your topsoil and the link between production and profit on your farm. Things like soil-borne diseases and how effective nutrients are cycling (e.g. phosphorus) can all be measured.

Useful laboratory tests for biological health include:

Soil organic carbon – carbon component of soil organic matter due to biological function.

Labile carbon – carbon available to microbes that season.

Bacteria:fungi ratio – proportion of the microbes that are bacteria compared to the proportion of microbes that are fungi.

Microbial biomass carbon – carbon contained within the living component of soil organic matter (bacteria and fungi).

Microbial diversity – diversity of microbes in the soil.

DNA – diversity of the whole soil community including microbes and invertebrates.

Managing soil health in pastures

The most important way to manage soil health in pastures in the long term is through grazing management.

The key aspects to good grazing management are:

1. **Leaving enough pasture dry matter / biomass all year round**. This allows the plants in your pasture to maintain their root systems and above ground biomass to regrow especially in the active growing period after rainfall. Keeping roots in the ground also maintains soil function, soil organic matter and soil structure.
2. **Maintaining groundcover all year round.** This is critical for minimising erosion and maximising water infiltration into your paddocks. Groundcover also protects the surface of the soil from heat and evaporation, and provides a home and food source for soil biology.

More information:

- Watch our 4 part 'Soil Health' video series on YouTube
- Google search 'Rapid Assessment of Soil Health (RASH)

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