

PRACTICE FACT SHEET

PROMOTING SOIL HEALTH



Project Catalyst is a grower-led innovation project in sugarcane that was formed to explore, validate and broadly adopt management practice changes for productivity gains and improved water quality for the Great Barrier Reef.

WHAT IS SOIL HEALTH?

Soil health is the condition of the soil in relation to its inherent (or potential) capability to sustain biological productivity, maintain environmental quality and promote plant and animal health. A healthy soil is productive, sustainable, and profitable. Soil health is different from soil fertility, which refers to the level of nutrient elements in a soil. In general, soil health is a measure of soils condition and can be defined as the optimum status of the soil's biological, physical, and chemical functions. This means healthy soils can sustain plant and animal productivity and soil biodiversity.

A handful of healthy soil has as many living things in it as there are people on Earth. Soil is a complex, living system and in this system, living and non-living parts all interact and self-organize into a stable productive balance which combines chemistry, biology, and physics. When disrupted, this balance can be lost and a soil system can degrade, resulting in a range of problems.

"Tropical Soils" A Guide to Soil health. (Soilskills.net.au., David Hardwick. Terrain NRM.) Page 11. 2019.

A healthy soil will function in a way that supports the growth of vigorous high yielding crops but also safeguards the surrounding environment from degradation.



Banded Mill mud 75T



Mixed legumes with worms & nodules

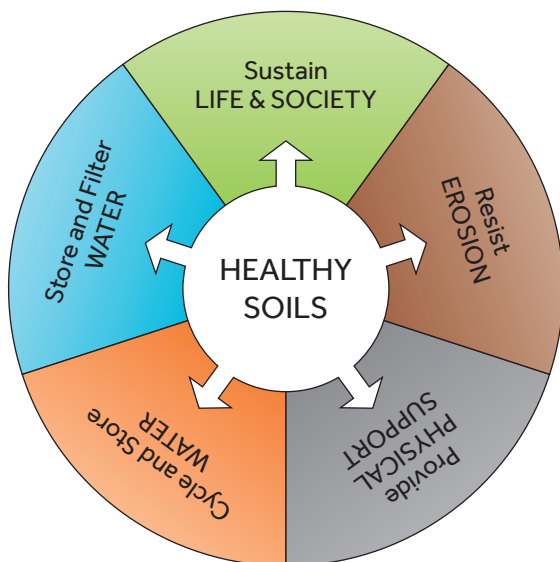
HOW CAN I BUILD MY SOIL HEALTH?

Building soil health back into your agricultural land can be done by taking an integrated approach to implementing several small but significant changes into your farming practices.

- 1. Growing mixed species** – Growing legumes, grasses and graminoids can help promote and build soil biodiversity and increase incorporated organic matter. Organic matter is one of the most important parts of the topsoil profile and has copious soil health benefits. Growing multiple species of plants together can create a diverse food source for all different types of soil biota to live in and populate. The biodiversity that comes with growing a multi species crop can keep pests, such as pathogenic nematodes under control by creating a natural balance and order within the soil profile. Mixed species, including legumes also provides a range of nutrients and organic matter for subsequent crops, improves the water holding capacity of the soil profile and helps with both resistance and resilience of the soil during periods of high plant stress like extreme weather events. Growers are often heard saying that the best result they notice after a mixed species crop is the improvement in their soil structure and texture when it comes time to incorporate soils for planting.
- 2. Adding organic inputs like mill by-products and compost** – Compost and mill by-products are another excellent source of organic matter that is rich with nutrients. Organic materials like mill mud have considerable amounts of nutrients for sugarcane but also have high amounts of sugars and proteins that soil biota like to feed on. This encourages the soil profile to start cycling nutrients which then become available for the plant to utilise without the need for inputs such as considerable amounts of fertiliser. The microbial population encourages soil life to work together to create a whole host of beneficial soil improvements including nutrient cycling, structure, water holding capacity and soil texture.
- 3. Controlling traffic** – By using a controlled traffic system, growers can minimise the amount of compaction the soil profile has to endure. Soil structure is another important part of the soil health chain, as soil cannot function efficiently when substantial compaction occurs as it reduces air and water flow through the soil profile. Once air and water flow are restricted, problems like waterlogging, water penetration and hard surface pans restrict potential for root anchorage and plant yield. Waterlogged soils are highly prone to soil diseases and cause oxidation of the soil that halts the soil biota/ nutrient cycling system and limit optimal growing conditions for the plant. Compaction of the soil will also minimise the amount of soil fauna within the soil profile as they cannot move through hard and compacted layers.
- 4. Reducing tillage** – Reducing the amount of cultivation before cane is planted can also greatly improve soil health. Tillage from heavy machines can break down the delicate soil structure when done excessively and destroys soil fauna such as earth worms and other important macro soil fauna. It also breaks down fungal hyphae within the soil profile. Fungal hyphae are beneficial to the soil system and spread through the top layers of the soil profile like a spider's web and support important synergies between plants and soils. Sugarcane soils are notorious for having high bacteria to fungal ratios due to the traditional cultivation methods used, but when minimised/zonal tillage is introduced, large soil fauna, fungal hyphae, organic matter levels and soil structure improve.
- 5. Addressing soil constraints like acidity and sodicity** – Soil constraints should not be overlooked when growers are seeking to improve the yield of their crops as constraints like acidity and sodicity can have negative impacts to yield when not correctly addressed. Sodicity creates instability in the soil structure of soils prone to dispersion when cultivated or large rain events occur. Dispersion causes the soil aggregates to breakdown and structural decline and soil erosion is usually the result. Soil pH is also an important indicator of soil health which affects crop yield, plant nutrient availability and soil micro-organism activity that influence key soil processes. When soil pH moves too far from the neutral point of 7, plant nutrient availability is limited, and soil micro-organism activity is decreased. Low pH levels often correlate with high aluminium saturation, which is toxic to roots and inhibits soil biota within the system. All these factors affect productive yield outcomes. By correcting sodicity and acidity within the soil profile, soil health will improve.
- 6. Drainage** – Like many areas of Queensland, the Wet Tropics belt deals with flooding, inundation, and waterlogging on a yearly basis. Therefore, a well thought out drainage management plan and design is an essential component to building soil health. Inundation and waterlogging can cause depleted oxygen levels in the root zone and inhibit soil micro-organism life and root growth. It also reduces soil nitrate levels due to denitrification and can increase manganese and iron levels resulting in toxicity. Wet soils are also prone to smearing and compacting when heavy machinery is used. This causes damage to the soil structure which hinders the health of the soil system and requires time for the soil to fully recover. Healthy soil systems are more resilient to extended wetting and come back into optimal production quicker than degraded unhealthy soils.
- 7. Pest and disease resistant varieties and variety rotation** – Resistant sugarcane varieties and a well-managed variety rotation can help control soil pests and diseases by keeping levels to a minimum. *Pachymetra* is one disease that can only be managed by resistant variety rotation. There has been little evidence to suggest that newer farming systems will reduce the impacts of *Pachymetra* on sugarcane yield decline, so choosing cane varieties that are resistant to such pathogens is an important management tool when thinking about overall soil health and productivity goals.

"Soil Health, Soil biology, Soilborne Diseases and Sustainable Agriculture" A guide. (Graham Stirling, Helen Hayden, Tony Pattison and Marcelle Stirling. "The impact of the new sugarcane farming system on soilborne pests and pathogens". Page 174. 2016.





A schematic diagram showing the five major functions of healthy soils

WHY SHOULD I BUILD MY SOIL HEALTH?

The primary role of an agricultural soil is to provide a medium that allows crops to grow without impediment, enabling them to produce the maximum yield possible for a given environment. Thus, a healthy soil will provide the following essential functions:

- Improve soil structure
- Improve nutrient cycling
- Improved balanced plant nutrition
- Improve plant resilience
- Improve yield production

Secondary roles of healthy soils include:

- Carbon Sequestration
- Maintaining biodiversity
- Detoxification of harmful chemicals
- Maintaining water quality
- Prevention of nutrient and sediment loss to waterways
- Minimising greenhouse gas emissions

"Soil Health, Soil biology, Soilborne Diseases and Sustainable Agriculture" A guide. (Graham Stirling, Helen Hayden, Tony Pattison and Marcelle Stirling. "Key soil health messages, and practices that should be included in holistic soil improvement programs. Page 2. 2016.

Soil health is fundamentally linked to land and food productivity and environmental sustainability. When soil is healthy, it enables farming and grazing businesses to be more resilient, efficient, and profitable in the long term.

KEY PRACTICES TO IMPROVE SOIL HEALTH AND SUSTAINABILITY

For an agricultural soil to provide a full range of ecosystem services (i.e., Maintain soil structure; produce, store and release nutrients; sequester carbon; detoxify pollutants; and suppress soil-borne pests and diseases) the following crop and soil management practices must be integrated into the farming system. Benefits will be limited if only some of these practices are adopted.

- Continuous inputs of organic matter
- Permanent plant residue cover
- A diverse rotation sequence
- Minimum tillage
- Avoidance of compaction through traffic control

Once these practices are integrated into a farming system, incremental improvements can then be made by focusing on the following:

- Biomass producing cover crops
- Inclusion of legumes in the rotation
- Integration of crop and livestock production
- Organic mulches
- Organic amendments
- Improved nutrient efficiency
- Optimized water management
- Site-specific management of inputs
- Integrated pest management

"Soil Health, Soil biology, Soilborne Diseases and Sustainable Agriculture" A guide. (Graham Stirling, Helen Hayden, Tony Pattison and Marcelle Stirling. "Key soil health messages, and practices that should be included in holistic soil improvement programs. Page 233. 2016.



Healthy nodules



Great Barrier
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