

SUSTAINABLE SOILS IN NORTH QUEENSLAND

# Soil Health for Sugarcane



Wet Tropics  
Sugar Industry  
Partnership



## What is soil health?

People are the most important asset in any sugarcane farm business – but soil is a close second. Soil underpins all plant growth, but if it's in poor condition then plant health and cane yield will be impacted. Therefore as a farm manager it is important you maintain your soil like any other valuable farm asset.

**Soil health is a term used to describe the physical, chemical and biological condition of soil and its capacity to support a profitable and sustainable farming enterprise.**

Soil health is not the same as soil fertility, which refers to the level of available nutrients in soil. For example, a cane paddock treated with artificial fertilisers can have a high level of fertility but be in poor health.

On the other hand, the same paddock with good soil health will have increased nutrient availability but also:

- Fertility that is more balanced and therefore more durable
- A crop that is more resilient to pest, disease and/or weather pressures
- Fewer nutrient losses to the environment
- More potential profits at the paddock, farm and catchment level.

There are two key aspects to soil management: looking after your soil's health and managing its nutrients. The two are interconnected but you need to manage soil health well or you will be wasting your nutrient dollars.



**Managing soil health can save you nutrient dollars**

# Why is soil health important?

Soil health is important because your soil asset is the foundation of a productive and profitable sugarcane enterprise.

### Stores & cycles nutrients efficiently

Healthy soil has adequate levels of organic matter, biological activity and root biomass. Fertiliser nutrients applied to soil in good condition are more likely to be taken up and used by a plant rather than being lost to the atmosphere or in a waterway. In some instances, fertiliser inputs can be offset by natural sources of nutrients, such as legume crops, which have multiple soil health benefits. Planted in fallow periods, legumes help store and cycle nutrients by biologically fixing nitrogen. They also contribute organic matter to the soil.

### Provides optimal conditions for plant growth & health

Whilst cane is a hardy plant, it needs healthy soil to maximise its long-term yield potential. Grown in a well-balanced and biologically active soil, cane plants develop vigorous root systems that take up nutrients and resist pests and diseases. Industry research, such as the Sugar Yield Decline Joint Venture project, has shown that many cane soils are in poor health due to intensive farming practices over several decades. Problems with compaction and low levels of organic matter are especially widespread.

### Reduces soil borne pests & diseases

Yields of sugarcane are greatly impacted by a range of soil borne diseases and pests such as root-feeding nematodes and grubs. Yield losses of up to 40% from soil borne pests have been measured in trial work. Research has shown that soils high in biological diversity, with good levels of organic matter and good structure, are less prone to damage from soil borne pests and diseases.

### Improves soil water dynamics

A well structured soil has good porosity that assists with water infiltration, root growth and the movement of beneficial soil biota amongst the root mass. Soils with good structure will have a greater volume of plant available water, which reduces irrigation requirements and farm energy costs. Improved soil structure can help reduce prolonged water-logging, a condition which can cause denitrification.



*Root development is greatest in healthy soils.*



*Legumes fix nitrogen through root nodules.*



# Key soil health properties

Soil is a complex system that balances physical, chemical and biological characteristics. The important soil health properties are outlined in these tables:

PHYSICAL PROPERTIES	
<b>Structure</b>	Structure is the way that the physical particles of soil are arranged together into aggregates or crumbs. Ideally, these aggregates are in a range of sizes. Between them are spaces for both air and water, also known as soil pores. Soil needs structure to be porous and well aerated so that beneficial soil organisms can survive and plant roots can grow effectively.
<b>Bulk Density</b>	Bulk density measures the weight of soil against its volume. Dense, compacted soil impacts root growth, water infiltration and air movement.

CHEMICAL PROPERTIES	
<b>pH</b>	pH indicates the overall balance of acidity or alkalinity in the soil. When pH is too high or too low, nutrients may not cycle effectively.
<b>Soil Salinity</b>	This measures the amount of water soluble salts present in the soil. These salts may be from the natural soil chemistry, from soluble fertiliser applications or from irrigation water. When soil is too saline it impacts cane plant yield.
<b>Exchangeable Sodium</b>	This measures the amount of sodium that is exchangeable on the soil's active surface area. High levels of exchangeable sodium (over 15% in the subsoil) result in a sodic soil that usually has poor plant growth and poor structure such as soil surface hardening and compaction. Due to their chemical properties, sodic soils have a high erosive potential.
<b>Exchangeable Aluminium</b>	This measures the amount of aluminium that is exchangeable on the soil's active surface area. High levels of exchangeable aluminium can limit cane growth.

BIOLOGICAL PROPERTIES	
<b>Groundcover</b>	Groundcover is the plant litter/mulch and living plant biomass on the soil's surface. It helps prevent erosion by providing a protective cover. It also helps maintain soil structure and reduces moisture loss due to evaporation.
<b>Organic Matter</b>	Organic matter is the energy source that sustains the soil's biological community. It contains carbon and includes all the plant and root residues in the soil, along with the humus. Soil needs adequate organic matter to hold and cycle nutrients, improve water retention and maintain its structure.
<b>Carbon To Nitrogen Ratio</b>	The C:N ratio provides an estimate of the overall quality of the soil's organic matter. If there is not enough nitrogen in the organic matter then nutrients will not cycle adequately and this will slow the breakdown of organic matter.
<b>Root Activity</b>	Good root depth and root volume is an essential part of cane soil. Roots help build soil structure and contribute large amounts of carbon to the soil.
<b>Soil Microbes</b>	Soil should contain trillions of bacteria, along with fungi and protozoa. All of these play an important role in nutrient cycling, soil structure formation, and plant health.
<b>Soil Organisms</b>	Healthy soil contains a range of nematodes, soil insects and other fauna. Earthworms, mites and springtails are three examples. These organisms play an important role in nutrient cycling, soil structure formation and plant health, and many predate on root pests and pathogens.

*Attending field days will help you build your soil knowledge*



*A legume crop fixes nitrogen and breaks root pathogen life cycles*

## Improving soil health in sugarcane

Improving soil health may require making changes to your current farming practices.

The first step is to assess a range of key soil health properties, both in the field and the lab, so you can identify your soil constraints. Based on this you can develop a plan of action to address any soil health issues systematically, to avoid wasting time and money. The sugar industry has researched and validated a number of approaches that are shown to be effective. These include:

- Using legume cover crops
- Rotating with other crops
- Controlled traffic
- Direct drilling
- Minimum tillage
- Retaining crop residues as a trash blanket

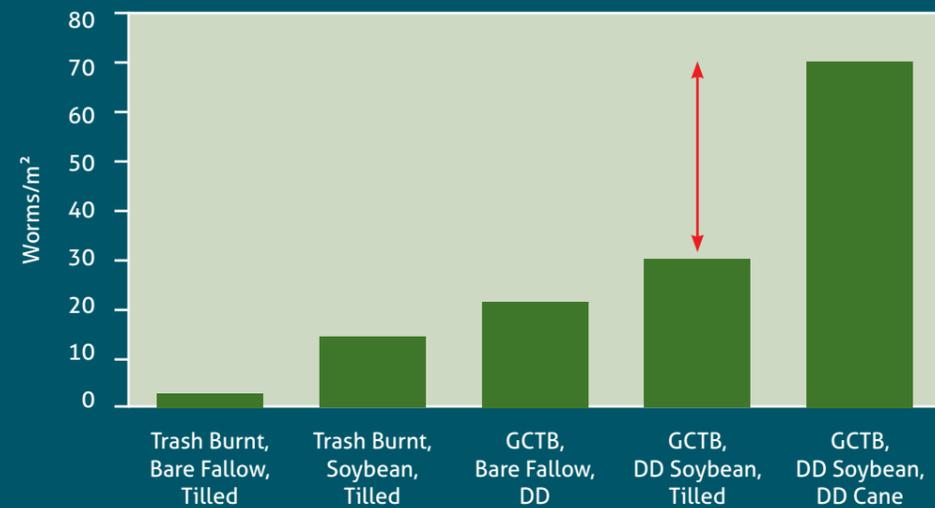
Other important farm practices that may help improve soil health include using soil ameliorants such as lime, gypsum, mill mud and compost. Trials show that using multi-species cover crops and intercropping may also prove an effective way to build soil health.



*Assess your soil to identify soil constraints.*

## Earthworms an indication of soil health

### EFFECT OF CANE PRACTICES ON EARTHWORM POPULATIONS



The impact of burning trash, green cane trash blanketing, direct drilling and a soybean rotation crop on earthworm populations nine months after sugarcane was planted in a field at Bundaberg. Earthworm numbers increased when soybean and cane crops were direct drilled, but the red arrow indicates that numbers were reduced by ~50% when the soil was tilled before planting sugarcane. Earthworms almost disappeared when plots were burned, tilled and bare fallowed. Figure adapted from Stirling et al (2016) and reproduced with permission by A Garside (pers comm. 2018).

*Earthworms play an important role in nutrient cycling, soil structure formation and plant health.*



## Further information & resources about soil health & sustainable agriculture:

### SOIL HEALTH PROJECTS, EVENTS, GRANTS:

Terrain NRM [www.terrain.org.au](http://www.terrain.org.au), NQ Dry Tropics [www.nqdrytropics.com.au](http://www.nqdrytropics.com.au),  
Wet Tropics Sugar Industry Partnership [www.wtsip.org.au](http://www.wtsip.org.au), Soil Land Food [www.soilandfood.com.au](http://www.soilandfood.com.au)

### BEST MANAGEMENT PRACTICE AND INNOVATION:

Project Catalyst [www.projectcatalyst.net.au](http://www.projectcatalyst.net.au)  
Smartcane BMP [www.smartcane.com.au](http://www.smartcane.com.au)

### RESEARCH AND DEVELOPMENT:

Sugar Research Australia [www.sugarresearch.com.au](http://www.sugarresearch.com.au)

### LOCAL ADVICE:

Talk to your local WTSIP Extension Officer who can connect you to advisors and workshop opportunities.

### MORE INFORMATION:

[www.wtsip.org.au](http://www.wtsip.org.au), [www.wettropicsplan.org.au](http://www.wettropicsplan.org.au)

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*References: Stirling et al. (2016): Soil Health, Soil Biology, Soil Borne Diseases & Sustainable Agriculture: A guide. CSIRO Press.*

*Sunflowers encourage mycorrhizal fungi, which takes mineral phosphorus and converts it into plant available phosphorus.*



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