

SUSTAINABLE SOILS IN NORTH QUEENSLAND

Soil Health for Bananas



**Wet Tropics
Major
Integrated
Project**

Putting local knowledge into Reef action



What is soil health?

People are the most important asset in any banana farm business. The next most important asset is your soil. Soils underpin the growth of all plants including bananas. If your soil is in poor condition then both plant health and crop yield will be impacted. Therefore as a banana grower it is important that 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.

A healthy soil is one in good condition, with key physical, chemical and biological properties in reasonable balance for the soil type. These key properties include ground-cover, soil structure, the pH and the level of organic matter. A healthy soil cycles nutrients effectively and maintains its structure. Soil health is also important for landscape and catchment functions.

Soil health is not the same as soil fertility, which refers to the level of nutrients in soil. A banana paddock may have a high level of nutrient fertility due to soil type or fertiliser applications, however if the soil is unhealthy, then the bananas won't be able to access these nutrients effectively. In a paddock with good soil health you will tend to achieve a banana crop that is more resilient to pest, diseases and/or climate stresses. This in turn may mean less losses and more profits for the farm business.

There are two key aspects to soil management: managing your soil's health and managing its nutrients. The two are interconnected but you need to manage soil health well or you will not be able to optimise the fertility potential of banana crops. You will be wasting your fertiliser 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 banana enterprise. When your soil is healthy and performing well, you will achieve a number of positive outcomes for your farm business.

Stores & cycles nutrients efficiently

Healthy soils have adequate levels of organic matter, biological activity and root biomass. Fertiliser nutrients applied to a soil that is in good condition are more likely to be taken up and used by a plant or stored and cycled through the topsoil rather than being lost to the atmosphere or waterways.

Provides optimal conditions for plant growth & health

Bananas need a healthy soil to maximise their long-term yield potential. Grown in a well balanced and biologically active soil, banana plants develop healthy root systems that take up nutrients evenly and exhibit good plant health.

Reduces soil borne pests & diseases

Yields of banana crops are greatly impacted by a range of soil borne diseases and pests that attack the roots. These include root knot nematodes and fungal diseases like Fusarium. Research has indicated that banana crops growing in soils high in biological diversity, with good levels of organic matter and that have good structure are less prone to a number of soil borne pest and diseases.

Improves soil water dynamics

A well structured soil has good porosity which assists with water infiltration, root growth and movement of good 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 to reduce prolonged water-logging.



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 the table below:

PHYSICAL PROPERTIES	
Structure	Structure is the way that the physical particles of a soil are arranged together into aggregates or crumbs. Ideally, these aggregates are in a range of sizes. Between them are air spaces also known as soil pores. Soils need structure to be porous, well aerated and for plant roots to grow effectively.
Bulk Density	Bulk density measures the weight of soil against its volume. A dense, compacted soil reduces root growth, water infiltration and air movement.

CHEMICAL PROPERTIES

pH	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 and some trace elements may become available at toxic levels.
Soil Salinity	Soil salinity 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 the yield of bananas will be impacted.
Exchangeable Sodium	This is the amount of sodium that is exchangeable on a soil's active surface area (called colloids). High levels of exchangeable sodium results in a sodic soil which usually has poor plant growth and poor structure.
Exchangeable Aluminium	This measures the amount aluminium that is exchangeable on a soil's active surface area (the colloids). High levels of exchangeable aluminium can be toxic to banana growth.

BIOLOGICAL PROPERTIES

Groundcover	Ground-cover is the plant litter/mulch or living plant biomass on the soil's surface. Protection of the soil's surface by ground-cover is important to prevent erosion, increase organic matter and help maintain soil structure.
Organic Matter	Organic matter contains carbon and includes all the plant and root residues in the soil along with the humus. A soil needs adequate organic matter to hold and cycle nutrients, to hold water and for structure.
Carbon To Nitrogen Ratio	The C:N ratio provides an estimate of the overall quality of a soil's organic matter. If there is not enough nitrogen in a soil's organic matter then the release of nutrients for banana growth as it breaks down will be too slow.
Root Activity	Good root depth and root volume is an essential part of a banana soil. Roots help build soil structure and contribute large amounts of carbon to the soil.
Soil Microbes	Soil should contain trillions of bacteria, along with fungi and protozoa. All of these play an important role in nutrient cycling, soil structure and plant health.
Soil Organisms	Healthy soils contain a range of soil insects and other organisms such as earthworms, mites and spring-tails. These also play an important role in nutrient cycling, soil structure formation and plant health.

Attending field days will help you build your soil knowledge



Managing for soil health in bananas

Improving soil health may require making changes to your current farming practices. The first step is to assess the range of key soil health properties, both in the field and the lab, so you can identify any 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.

A number of farm practices have been shown to be effective in improving soil health in the banana industry. These include using legume cover crops, controlled traffic, retaining crop residues in the plant row and using carbon based soil amendments like compost and mill ash.

Other important farm practices that may help improve soil health include using soil amendments such as lime, dolomite or gypsum. The use of biological inoculant and stimulant products through fertigation may also help improve soil health but many of these inputs are new technologies and need to be trialled to see if they provide an agronomic and economic response.



Assess your soil to identify soil constraints.

Why fungi are essential in your soil

Over 99% of fungi are beneficial for plant health. In fact, they are essential. Yet fungi get a bad rap. That's because most of us think of pathogens like fusarium when we think of fungal species in agriculture. It is important not to tar all fungi with the pathogen brush, as the overwhelming majority provide soil infrastructure and services for your crop to improve productivity.

The Benefits of Fungi

FUNGI ARE BENEFICIAL TO THE SOIL. To start with, fungi are not really microbes. Fungi are multicellular organisms. Mostly, they grow as hyphae: long thin cells like fine plant roots (only smaller). The collective term for hyphae is mycelia. Mycelia can be visible to the naked eye, so fungi are not really microbes at all. The mould you see on bread is an example. The nature of hyphae gives fungi many of their beneficial properties within the soil.

COMPACTION LIMITS THE BENEFITS OF FUNGI.

Fungi are much larger organisms than bacteria. On average, a fungal cell is 1000 times the size of a bacteria cell. As a result, fungi are restricted by compaction more than bacteria. This means management practices can initiate a cycle of improvement: as the soil health improves, the fungal activity improves, which then accelerates soil health improvement.

The same is true for soil health degradation: the more compacted your soils become, the less fungal activity there is and the less cellulose digestion occurs. The overall result is a lower percentage of functioning organic matter and further loss of soil health.

FUNGI ACT AS SECONDARY PLANT ROOTS. The nature of hyphae allows fungi to bridge soil air gaps and grow long distances (relative to microbes). This means they grow and explore fine pore spaces within the soil matrix, allowing them to access nutrients the plant roots cannot. In this way, arbuscular mycorrhizal fungi (AMF) or other beneficial fungi can act like an auxiliary root system for your crop, helping to improve nutrient use efficiency.

FUNGI ARE YOUR CARBON STORAGE. Fungi are your carbon storage. They create a lot of biomass as they grow. When they die, their necro-mass (their dead biomass) acts as a significant store of stable carbon in

your soil. The more fungi you have, the more organic matter you can accumulate.

FUNGI ASSIST OTHER MICROBES. Fungi are also microbial highways. Their hyphae provide roads for other microbes, such as bacteria. Thus, they assist other microbes to travel and disperse through the soil.

FUNGI ARE ALSO MINERS. Their equipment is extracellular enzymes. These are proteins they secrete into the environment. The enzymes help to release nutrients that are bound to the soil matrix. Fungi are known to mine phosphorus with the phosphatase enzyme. When fungi interact with plants, they can trade the mined phosphorus for carbon from the plant.

Improving Carbon Metabolism

GOOD FUNGI SUPPRESS PATHOGENS.

Fortunately, most fungi are not pathogenic and it's a fungi-eat-fungi world. In other words, there are a lot of fungi that can help to suppress pathogens.

- Some are mycoparasites that feed specifically on the pathogen.
- Some grow on the spores, whilst others feed on the hyphae, such as Trichoderma.
- Some fungi inhibit pathogens through competition.

Fungi release β -glucosidase, an enzyme to break down cellulose in the carbon cycle. Generally, the higher the β -glucosidase, the higher the suppression of the pathogen. This is because more carbon metabolism generally means more competition, so it is harder for the pathogen to survive in the soil before it reaches a host.

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For further support or information about soil health and bananas contact:

SOIL HEALTH PROJECTS, EVENTS, GRANTS:

Terrain NRM: <https://terrain.org.au/>, NQ Dry Tropics: <https://www.nqdrytropics.com.au/>,
Department of Primary Industries and Forestry Bananas, Soil Land Food: <http://soilandfood.com.au/>

BEST MANAGEMENT PRACTICE AND INNOVATION:

Australian Banana Growers' Council: <https://abgc.org.au/environmental-bmp/>

RESEARCH AND DEVELOPMENT:

Australian Banana Growers' Council: www.abgc.org.au
Department of Agriculture and Fisheries: www.daf.qld.gov.au

LOCAL ADVICE:

Talk with your local Australian Banana Growers' Council Extension Officer
who can connect you to advisors and workshop opportunities.

MORE INFORMATION:

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.
Pattison & Lindsay. (2006): *Banana Root and Soil Health Users Manual : Department of Primary Industries and Fisheries, Qld Government*



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