

# THE HEALTHY PLANT ↔ HEALTHY SOIL CYCLE

Plant health (and yield) depends on soil health, and soil health is largely determined by plant health and nutrient and water availability.

The Health Soils Initiative promotes the identification and management of soil constraints to plant health so that healthier plant and root growth can help to build and maintain soil health.

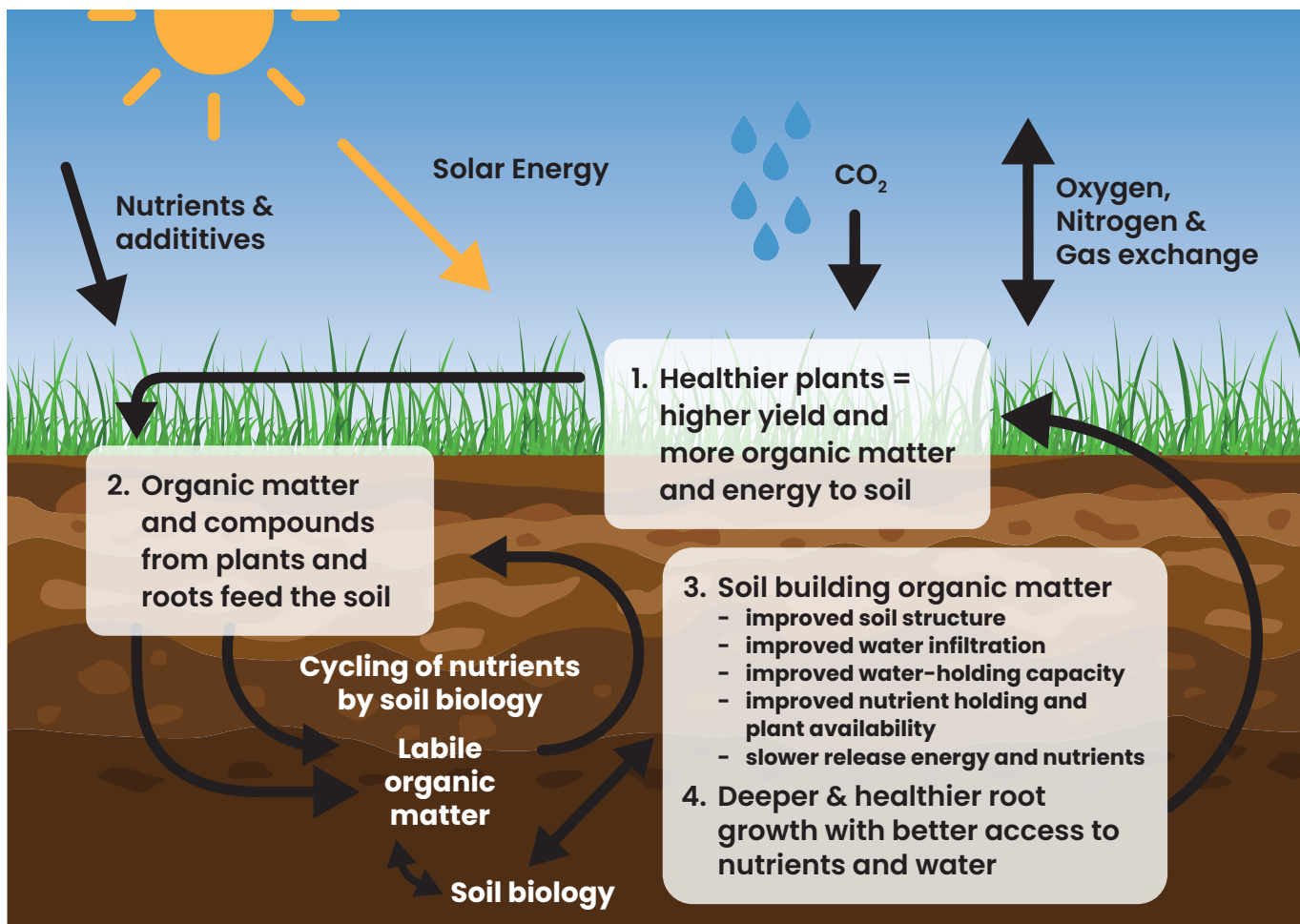
## Key drivers of soil and plant health

Soil health is largely determined by soil depth and levels of: plant-available nutrients; plant-available water; and soil porosity and aeration down the soil profile. These factors are all influenced by the levels of beneficial soil microbial activity which are determined by the levels soil organic matter and soil moisture down the soil profile. The organic matter is typically provided by root and plant growth. This means that not only to healthy plants need healthy soils, but healthy soils need healthy plant and root growth too. This cycle determines the levels of plant and soil health on a farm, and can be boosted by addressing constraints to plant and root growth and working to build and maintain higher levels of soil organic matter and beneficial soil biology.

Figure 2.1 (next page) shows how healthy soils sustain healthy plant growth, and how healthy plant growth feeds soil health. This shows:

1. Healthy plants convert solar energy, nutrients and water into organic matter (or biomass) which is delivered to the soil via plant root exudates, dead plant matter, and grazing animals' manure.
2. The organic matter and nutrients in organic matter feed soil biology that break the organic matter down, making nutrients available to plants and other soil microbes.
3. Organic compounds from decomposed biomass and produced by soil biological activity help to improve and maintain soil structure/porosity through the formation of soil aggregates and the action of earthworms and insects in a healthy soil. The organic matter also improves the potential for soil to hold water and nutrients and make available to plants.
4. Improved soil health resulting from organic matter and nutrients, improves root and plant growth, and drive the Healthy Plant ↔ Healthy Soil cycle.

Figure 2.1: The Healthy Plant ↔ Healthy Soil cycle



The level of plant and soil health achieved over time will depend on how well plants and roots grow and how land is managed to ensure soil, roots and soil biology have access to air, water and nutrition, favourable soil pH and chemistry, and adequate levels of organic matter and biological activity to ensure cycling of nutrients and the production of soil building organic compounds.

### How soil organic matter and ecosystems produce soil-building organic carbon

There is increasing interest in how organic matter and soil biological activity improves the fertility, structure, and water and nutrient-holding characteristics of soils.

The amount of organic matter in the soil largely depends on how much root and vegetative

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biomass and exudates added to the soil each year and how quickly this is biodegraded. Some organic matter (SOM) will be held and cycled by soil microbiology or partially protected from biodegradation within soil aggregates and by 'binding' to clay minerals, but most biomass and exudates will be biodegraded within 1-2 years of being added to the soil. This means SOM needs

to be constantly replenished and that it will hit a plateau where the amount added each year is equal to the amount that degraded each year, so there is minimal net increase, just a pool of soil carbon in different stages of decomposition. It has been conservatively estimated that to maintain a 'healthy' level of 2 percentage points of soil organic matter in the upper 30cm of soil, an average of around at least 30-60 tonnes per hectare of plant

and root biomass and exudates needs to be added to the soil per year. If roots provide half of this, around 15–30 tonnes per hectare or 1.5–3.0 kg per square metre of above ground plant biomass needs to be added to the soil each year. This can be achieved in central Victoria under pastures in most years, but is more difficult under cropping.

### Key messages

- Healthier plants add to soil organic matter through healthier root growth, plant matter and the manure of grazing animals.
- Deeper root growth is important to increasing soil organic matter and making soils deeper, but is often constrained by chemical and physical factors.
- Organic matter helps to hold water and nutrients, and can also help to neutralise acidic soils.
- The activity of soil biology (fungi, bacteria, earthworms, insects and other organisms) cycles plant-available nutrients, aerates and manures the soil.
- Some soil fungi and bacteria produce and cycle longer-lasting organic compounds that improve soil structure and water- and nutrient-holding characteristics. This longer-lasting soil carbon can also mitigate greenhouse gas emissions.
- The combined effects of increased organic matter and ‘humic’ carbon are better structured, more fertile, deeper and more productive soils and healthier plant growth.
- Plant health drives soil health, so improving yields and crop and pasture management can also improve soil health and productivity.
- Soil organic matter feeds beneficial soil biology and helps to make nutrients and water more available to plants.
- Organic matter and the soil biology it feeds also help to improve soil structure and buffer soil pH.
- Healthy plants need to be able to grow deep roots and access the nutrients and water they need to achieve their potential. Many central Victorian soils have significant physical, chemical and biological constraints that need to be addressed before plants can grow deeper and healthier root systems.