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SOIL HEALTH

This section provides an overview of what 'Soil health' is, why it is important, and how to build, maintain and protect soil health.

A healthy soil will allow plants to grow as well as they possibly can within climatic and seasonal constraints, whilst also maintaining soil structure, fertility and beneficial soil biology from season to season. Most farms in Central Victoria fall well short of their potential, with crops and pastures typically yielding only 30-50% of their seasonal yield potential[1]. Although other factors such as plant disease, weed competition and pests can reduce yields, soil health constraints to root and plant growth are a major factor limiting yields and farm productivity.

Useful indicators of farm soil health are plant growth and yield per hectare as well as the depth of root growth.

What is soil health

'Soil health' is a broad term, with many definitions and components. The National Soil Action Plan defines it as *'the capacity of soil to function as a living system', and states that soil health 'is the product of physical, chemical and biological soil processes working together to sustain productivity, diversity, and ecosystem services'.*

Figure 1.1 (next page) shows some key physical, chemical, and biological characteristics and interactions in soil.

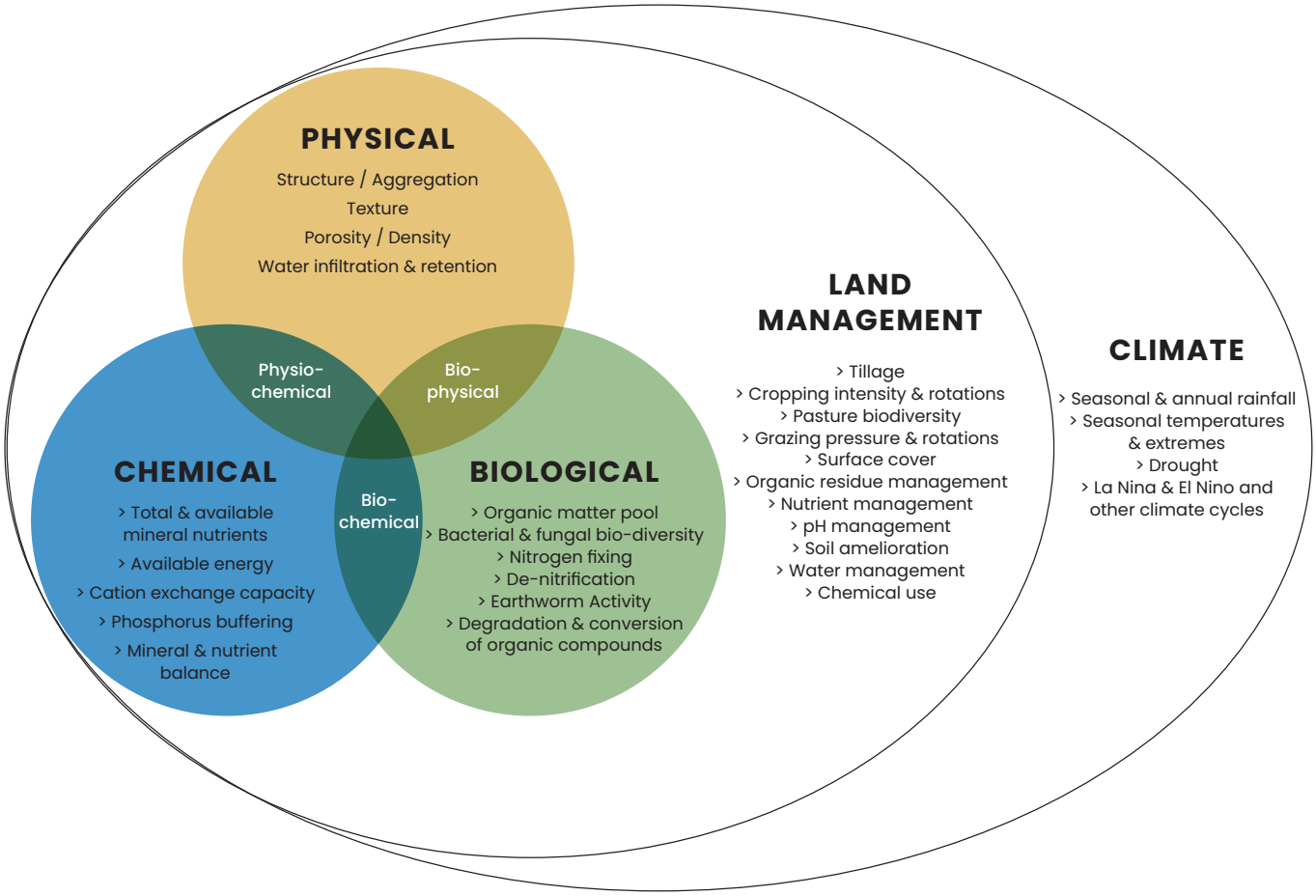
- It also shows that farm management practices and climatic and seasonal factors.
- Impact on soil health is driven by the health of plants and the depth and vigour of plant roots.
- The objective of maintaining higher yielding plants is largely compatible with the objectives of building and maintaining soil health if attention is also paid to management practices that enhance and protect beneficial physical, chemical and biological conditions in the soil.

The best practices will depend on the farmers' objectives and priorities, the farming system, climate, and inherent characteristics of the soil. There is no single 'right' solution – there is only what is right for you and your farm.

Good indicators of soil health are plant yield and root depth. Plants should grow strongly without discolouration and the roots of cereals and other grasses such as wild oats roots should growth strongly to at least 30-40cm depth in September/October. Compare your crop yields, stocking rates and livestock production with the district average and the more productive farms in your area and consider the extent to which poor soil health is holding you back. Compare plant growth on different parts of the farm and dig to check root depth. Where yields are lower than they should be, or plants and roots are obviously stunted, use Sections 8 and 9 of this guide to identify the physical, chemical and biological constraints.

[1] Seasonal yield potential is the yield a crop pr pasture should achieve if only constrained by seasonal constraints of rainfall, temperature and evaporation.

Figure 1.1: Key interactions of soil physical, chemical and biological factors and the land management and climatic factors that impact on these interactions. Soil health management requires consideration of all of these factors, and how farm management can build and maintain soil health within a productive and profitable farming system.



Characteristics of a healthy soil

A healthy soil ensures plant roots have access to water, nutrients and air so plants can grow to their full potential within natural seasonal constraints. This requires soil to have:

- **Porosity and aeration.** Soil porosity is vital to allow soils to 'breathe'. Plant roots and beneficial soil biology need oxygen. Nitrogen fixing bacteria need access to nitrogen gas in air. Gas 'wastes' produced by root and soil respiration need to be able to escape the soil. Porosity is sometimes referred as 'soil structure'. A soil with good soil structure will have a lot of spaces or 'pores' between soil particles or 'crumbs' through which air and water can freely flow. A poorly structured or compacted soil will lack such pores and constrain root and plant growth. Unbalanced soil chemistry, high clay content and low levels of organic matter, as well as heavy tillage and traffic can all contribute to poor soil porosity.
- **Water infiltration and holding characteristics.** The better and deeper the soil structure and porosity, the more readily water can infiltrate / flow into the soil. Good infiltration means rainfall flows into the soil rather than running off the surface. Water holding capacity is the ability of soil to hold water in the root zone. This depends on the clay and organic matter content of soils. Sandy soils with low organic matter are typically poor at holding water. Clay soils are better, but

some can 'swell up' when wet and become impermeable to further water infiltration. Some clays also hold water too strongly for roots to access it. Higher organic matter levels and associated soil biology in any soil will improve the structure, porosity and water holding and plant available water characteristic of soil.

- **Plant available nutrients.** Plants require a range of nutrients to grow well, particularly those in soluble forms that roots can take up in water. Deficiencies in one of more nutrients can limit plant growth and reduce the quality of pasture and crops. Nutrients in mineral form (e.g. in rocks) are not immediately available to plants, and active soil biology can help to make these more available. A healthy soil ecosystem also constantly 'cycles' plant available nutrients, giving roots constant access to these.

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- **Favourable pH.** Strongly acidic and - more rarely in central Victoria - alkaline soils can reduce the plant-availability of many nutrients. Acidic soils may also develop 'toxic' levels of aluminium, manganese and/or iron that reduce plant root growth and the ability of plants to use other key nutrients (pH should be within the 5.5-8.0 range, and ideally within 6.0-7.0).
- **Organic matter.** Organic matter sustains soil biological activity and diversity. Many studies suggest soil organic matter soil (SOM) levels should be maintained above 4-6% dry weight of soil (or around 2-3% organic carbon soil (SOC)) as far down the soil profile as possible to improve soil conditions and sustain levels of biological activity. Many soils in Central Victoria have low levels or organic matter in the upper 20-30cm of soil, and even less further down the profile. This indicates shallow root growth and reduced yield potential.
- **Depth.** Many soils in central Victoria are shallow due to physical and chemical constraints as well as historic cropping and grazing practices. As a result these soils also have low levels of organic matter and beneficial biology down the soil profile, which also reduces nutrient availability and good soil structure. Shallow soils and roots give plants less access to water and nutrients, reducing their yield and making them more susceptible to dry periods and drought. A key objective of the Healthy Soils Initiative is to help farmers to make their soils deeper by improving porosity, addressing nutrient deficiencies and unfavourable pH constraints, and managing pasture and crops to build and maintain high enough levels of soil organic matter to support beneficial soil ecosystems.

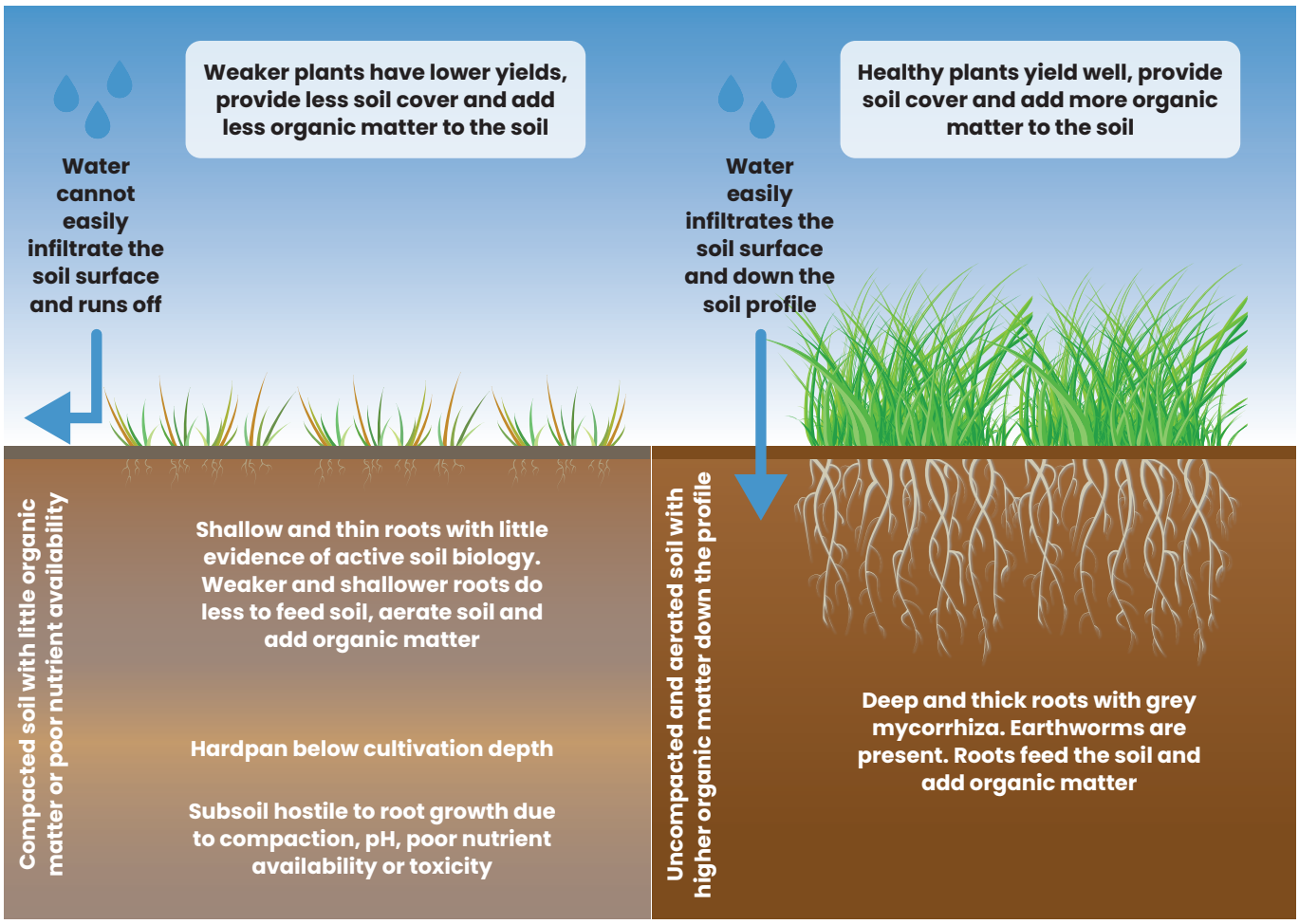
Constrained' vs 'Unconstrained' soils

Figure 1.2 compares a 'constrained' soil with poor soil structure, nutrition and pH with a healthy soil that has:

- good aeration
- good water infiltration and drainage
- good nutrient and pH levels
- healthy root and plant growth contributing to organic matter and healthy soil biology down the soil profile.

Unfortunately, many Central Victorian soils suffer from one or more of the constraints shown. This means many farmers are producing crops and pastures in shallow soils and not making the most of annual rainfall and nutrients deeper down in their soils, and are also more susceptible to dry summers and drought.

Figure 1.2 Typical soil constraints (LHS) compared to on unconstrained soil.



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