THE UNIVERSITY OF MELBOURNE

Soils: the least understood part of science yet vital for all of us

Royal Society of New South Wales
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On behalf of General Michael Jeffery, Founder, Soils for Life


Major General Michael Jeffery
Founder, Soils for Life

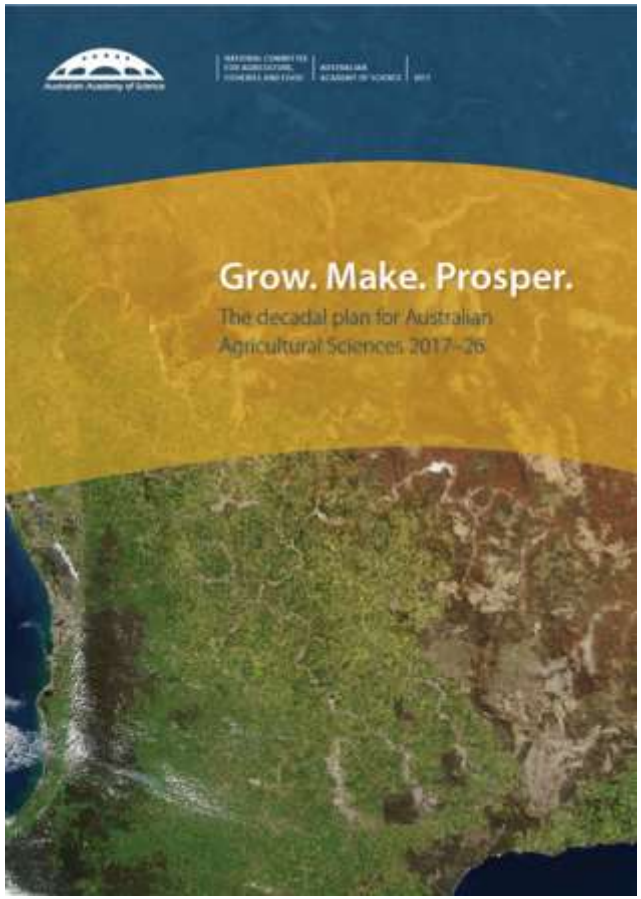
- **A long and proud history of understanding our soils**
- Where are we now?
- What is the national opportunity in soils?
  - In regenerative agriculture?
  - In negative emissions?
  - And do we separate the two?

Australian agriculture has competed globally for more than a century

- Climate and soils are very different to many other “food bowls”, yet we are competitive
- This is no accident, a track record of focussed support and trail blazing science
- As an example, the Waite

- Large amount of land donated in 1924
- Followed by large donations of money
- Soils research centre set up in 1929
- The Waite is now a joint centre with CSIRO, SARDI, ACPFG ($27m from ARC, SA Gov, GRDC in 2002)
- Further $30m in 2010 for plant accelerator from SA Government
- BUT, we must not rest on past achievements but continue to invest strongly in soil science

But we are very, very far from a reasonably full understanding of the science

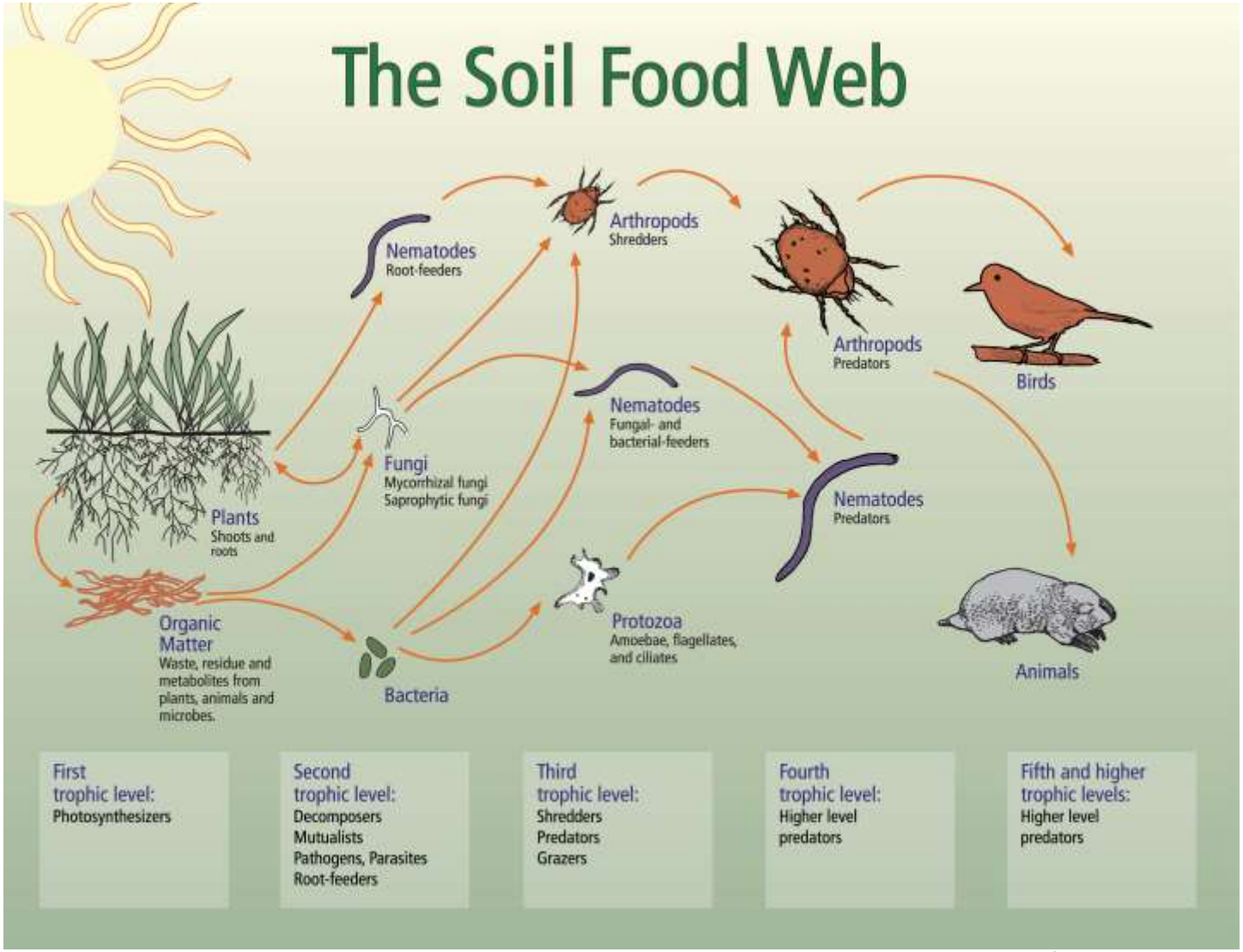


Soils are the most complicated biomaterial on the planet, it is not surprising that, in contrast to the huge amounts of information available with regard to above-ground plant performance, knowledge concerning the physical and biological soil–plant interface is still very patchy.

A healthy soil is incredibly complex: "One cm^3 of healthy soil contains 1 billion bacteria of between 20,000 and 30,000 species, several metres of fungal hyphae, several thousand protozoa and a few dozen nematodes" (US DoE).

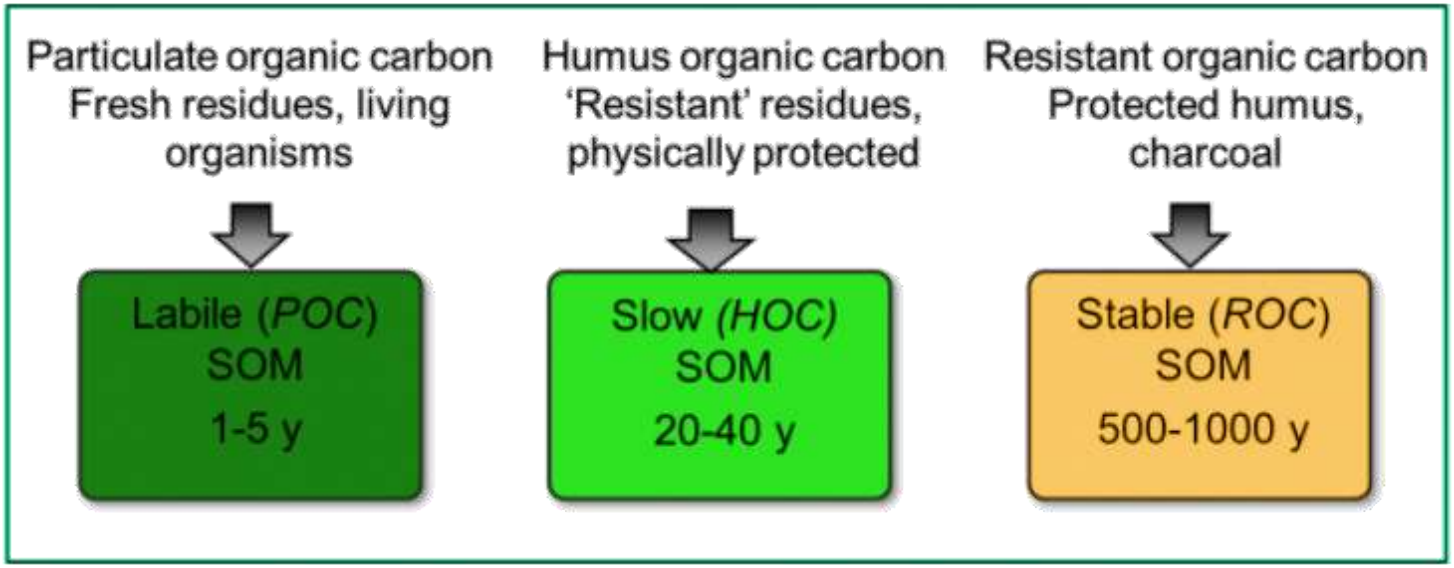
Source: https://www.science.org.au/support/analysis/decadal-plans-science/decadal-plan-agricultural-sciences-2017-2026

Relationships between soil food web, plants, organic matter, and birds and mammals



Source: USDA Natural Resources Conservation Service

Traditional view of SOC

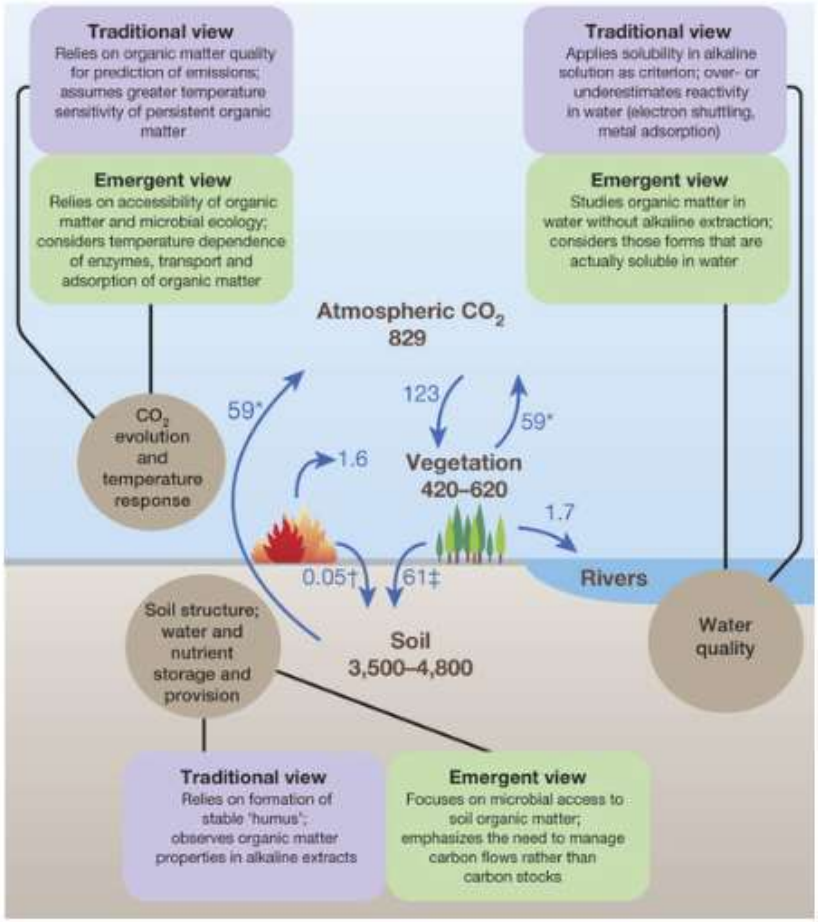


Different fractions of soil organic matter decompose in the soil over different time frames

Source: https://www.agric.wa.gov.au/measuring-and-assessing-soils/what-soil-organic-carbon

Soil organic matter is critical: and poorly understood

Traditional 'humification' concepts limit observations of soil organic matter to its solubility in alkaline extracts, unlike the emergent view of organic matter based on solubility in water and its accessibility to microorganisms.



Source: http://www.nature.com.ezp.lib.unimelb.edu.au/nature/journal/v528/n7580/full/nature16069.html

Our understanding of mechanisms is changing

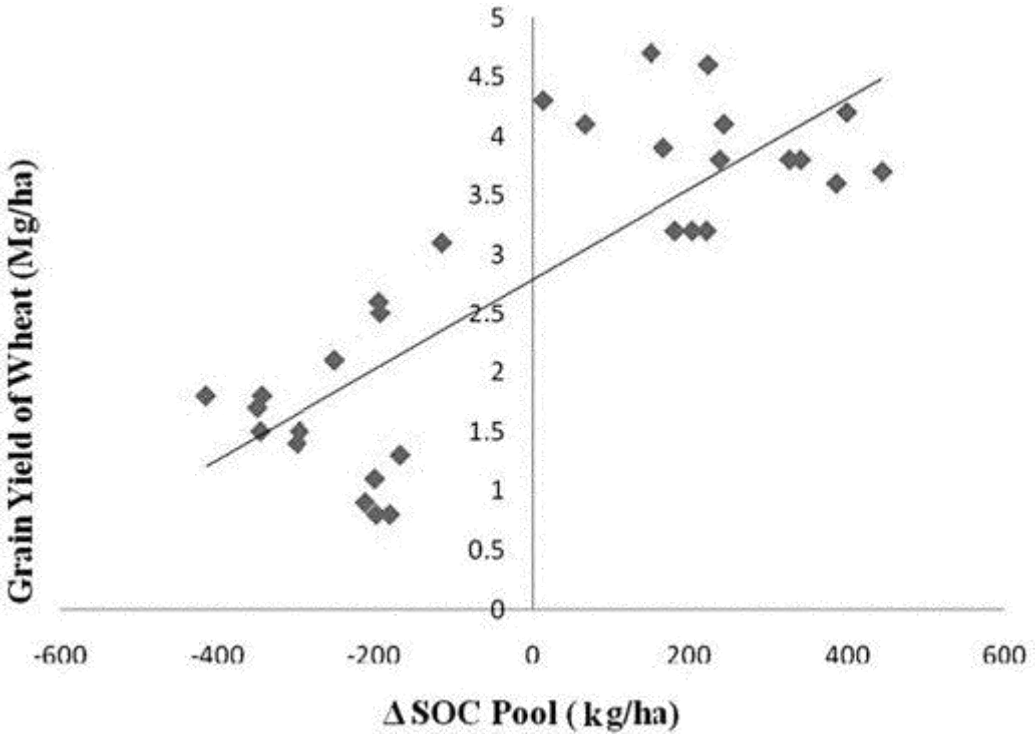
For nearly a century, SOM formation has been depicted as primarily as a function of plant inputs and their chemistry. Stable SOM was seen as the preservation of biochemically recalcitrant complex plant polymers, such as lignin derivatives and long chain lipids. However, soil microbial populations are adept at decomposing a wide range of compounds and using the C to synthezise their own biomass. The importance of soil microbes in generating SOM has only recently been recognised, in part due to advances in molecular analytical techniques.

Source: Kallenbach, C., Frey, S. & Grandy, A. Direct evidence for microbial-derived soil organic matter formation and its ecophysiological controls. Nat Commun 7, 13630 (2016). https://doi.org/10.1038/ncomms13630

Two broad reasons we focus on SOC

1. Productivity with the fascinating double effect:

1. Higher SOC delivers higher productivity
2. Higher plant growth and productivity delivers higher SOC

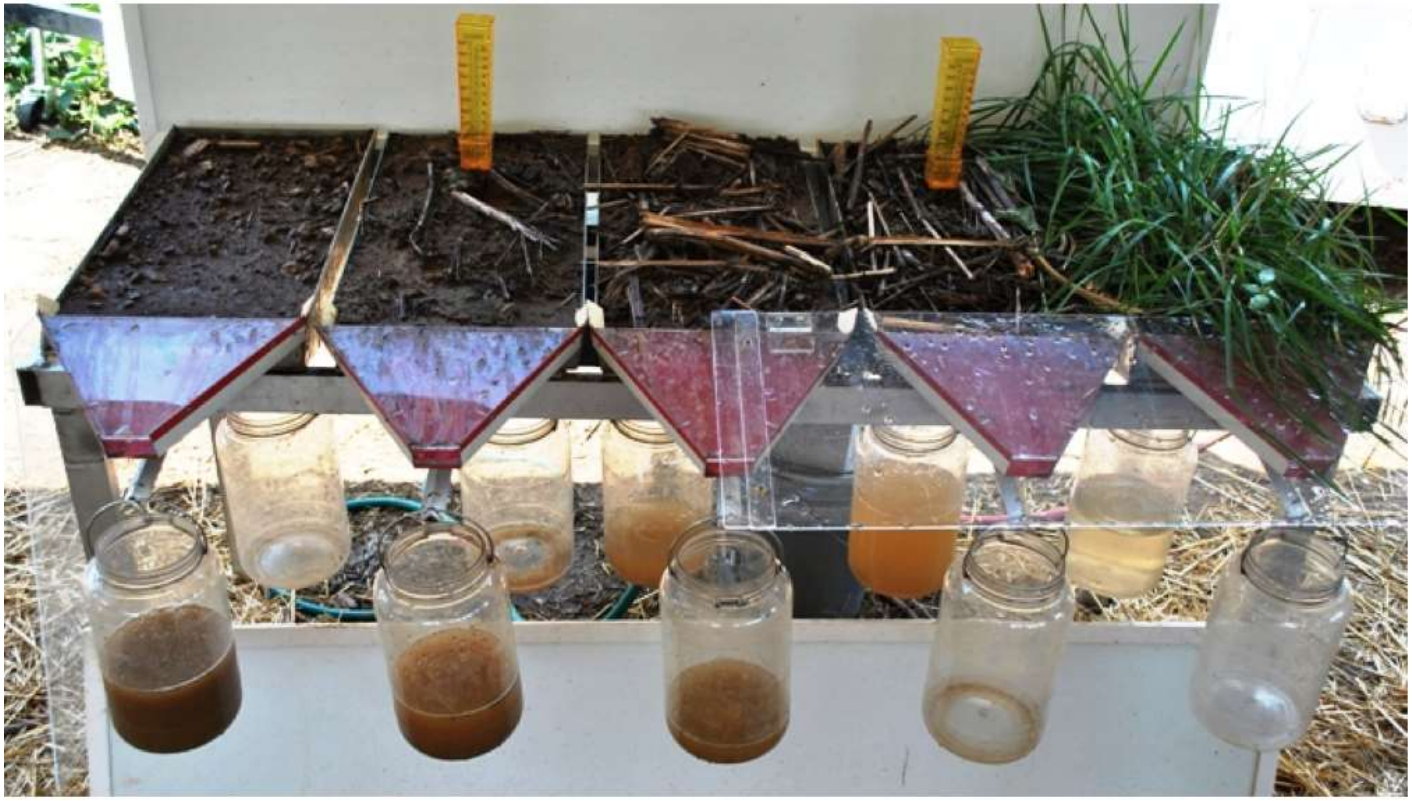


Source: Lal. R., Enhancing Eco-efficiency in Agro-ecosystems through Soil Carbon Sequestration. Crop Sci., 50, March 2010, 120-131

Two broad reasons we focus on SOC

2. SOC delivers

- Increased water holding capacity
- Drought resilience
- Less runoff and erosion
- Longer growing seasons
- As well as higher yields
- Big reduction in farm chemicals and fertilisers ($ 1-200bn/y for fertiliser alone)
- Increased animal health and well being
- Productivity increase, including ability to improve product quality and target higher value products



Source: Understanding Soil Health and Watershed Function

Source: https://soilcarboncoalition.org/learning/Soil_Health_and_Watershed_Function.pdf