

# Soil Health Workshop Notes - Presenter: David Hardwick, Soil Land Food



# 1. Photosynthesis and Soil Carbon Fundamentals

- Plants require sunlight, water, nutrients and CO<sub>2</sub> to photosynthesise
- CO<sub>2</sub> is a trace gas in air (currently ~400 ppm, up from ~320 ppm pre-industrial)
- Plants capture carbon from CO<sub>2</sub> and convert solar energy into stored carbohydrate energy
- All plant biomass - stems, leaves, roots, waxes, oils, lignin, cellulose - is derived from this process
- Around 100 water molecules are needed per carbohydrate molecule produced; the remaining water is transpired, which cools the landscape

## 2. How Plants Feed the Soil

- Actively growing plants exude sugars from their roots into the soil
- This feeds soil microbes (bacteria, fungi, earthworms, dung beetles etc.), driving nutrient cycling
- Microbes eat each other and organic matter, releasing nutrients back into the soil food web
- Nitrogen passed through the food chain remains largely attached to carbon, which stabilises it
- Plants change the type of root exudates through the season to recruit specialised microbes as needed
- Bare or compacted soils have much lower microbial activity, less soil structure, less aeration, and stay waterlogged longer

## 3. Soil Organic Matter and Carbon

- Organic matter enters soil via root material, surface litter, and root exudates
- In most environments, organic matter breaks down relatively quickly through microbial respiration, releasing CO<sub>2</sub>
- Carbon either respire back to the atmosphere or stabilises as humus - there is no third pathway
- The carbon percentage on a soil test represents the balance between inputs and losses
- To convert carbon % to organic matter %, multiply by approximately 1.5
- Humus acts as a colloid, buffering pH and salinity, and contributes to soil structure and water holding capacity

## 4. Minimum Carbon Benchmarks (David Hardwick Rules of Thumb)

- Sandy / light soils: minimum ~2% carbon to start driving functional soil improvement
- Heavier soils (more silt and clay): minimum ~3-4% carbon
- Low carbon = insufficient energy to drive the soil food web, regardless of nutrient inputs

## 5. Participant Soil Carbon Results Discussed

Participant	Carbon %	Context
Nicole	3.2 - 3.8%	Loamy sand, annual pasture
Group member	3.14%	Sandy loam, annual pasture
Group member	3.5%	Annual base pasture
David (landholder)	7.51%	Heavy/gravelly soil, long-term pasture, well managed last 5 years
Andy	~1%	Thatch present - lab may have screened some material
Other	2.1%	Annual pasture

*Carbon numbers should always be interpreted in context of soil texture, topsoil depth, and observed structure - not read in isolation.*

## 6. Factors Influencing Soil Carbon Levels

- Climate: cooler, wetter conditions slow breakdown and allow accumulation
- Soil texture: more clay generally means greater capacity to hold organic matter
- Vegetation management: the biggest single influence on carbon levels
- Tillage: increases oxygen, speeds microbial respiration and accelerates carbon loss
- Ground cover and canopy: reducing surface temperature slows respiration rate
- Root depth and diversity: deeper, more diverse roots build more carbon through the profile
- Excessive nitrogen: can over-stimulate microbial activity, accelerating carbon loss

## 7. Nitrogen Dynamics

- Nitrogen in soil lives in organic matter - not as a free soluble form
- Fertiliser nitrogen uptake efficiency is commonly less than 50%, and can be much less on degraded soils
- Unused nitrogen can: volatilise as a gas, leach (especially on light sandy soils), or be temporarily immobilised by microbes
- Microbes need carbon (energy) to stabilise nitrogen; without it, excess nitrogen cannot be held in the system
- Organic matter is the primary storehouse for nitrogen in the soil

## 8. Bioaccumulator Plants

- Some plants are specialist nutrient scavengers, technically known as bioaccumulators
- Example: chicory has a deep tap root and is known to access nutrients unavailable to other plants
- Useful for targeted nutrient cycling in deficient or compacted paddocks
- Different plants have different specialisations - some are generalists, others are highly targeted

## 9. Practical Takeaways for Landholders

- Keep ground cover and living roots in the soil for as much of the year as possible
- Avoid over-tillage - every cultivation event burns carbon and disrupts soil structure
- Do not apply excessive nitrogen to low-carbon soils - it will be lost, not held
- Build organic matter first to give nitrogen somewhere to live in the system
- Interpret soil test carbon numbers in context of soil texture, topsoil depth, and observed structure
- A visual soil assessment alongside a soil test gives a much more complete picture
- SAP testing (plant sap analysis) was offered alongside soil tests to understand what the plant is actually accessing

*Notes compiled from workshop recording. Some passages were unclear due to audio quality or cross-talk and have been omitted.*

