LANDSCAPE
SOUTH AUSTRALIA
KANGAROO ISLAND

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

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1. Photosynthesis and Soil Carbon Fundamentals

- Plants require sunlight, water, nutrients and CO_2 to photosynthesise
- CO_2 is a trace gas in air (currently ~400 ppm, up from ~320 ppm pre-industrial)
- Plants capture carbon from CO_2 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_2
- Carbon either respires 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.