SOIL ORGANIC CARBON STORAGE IN THE WESTERN AVON BASIN, WESTERN AUSTRALIA

Key points

- Actual soil organic carbon storage (0–30 cm) ranged from 7 to 55 tonnes of carbon per hectare on deep sandy soils, with marginally higher levels on pasture-dominant rather than crop-dominant systems.
- Carbon modelling showed soils had less organic carbon than the 'attainable' storage (or upper limit) predicted by soil type and climate.
- Soil pH was not significantly correlated with soil organic carbon storage, due in part to the low pH values across this region.

Soil Carbon Research Program—Australia's farming future

Sustainable management of soil, in particular soil organic carbon, is essential for the continued viability of Australian agriculture. Increasing the amount of organic carbon retained in soil improves soil quality and can also help to decrease atmospheric carbon dioxide. The Soil Carbon Research Program aimed to identify land uses and management practices that growers could use to increase soil organic carbon storage and improve production in a changing climate.

Soil organic carbon storage

The amount of organic carbon (C) that soil can store varies due to:

- Clay—as clay content of the soil increases the ***potential*** organic carbon storage of soil improves.
- Climate—climate governs the ***attainable*** organic carbon storage capacity by influencing net primary productivity (e.g. higher rainfall results in increased plant biomass and net returns of organic matter to the soil) and the rate of soil organic matter decomposition by microbial activity.
- Management—soil and agronomic management for optimising resource-use efficiency and maximising productivity influence to what extent ***actual*** organic carbon storage reaches the ***attainable*** organic carbon storage.

Western Avon basin region

The sampling area incorporated 24 farms (161 sites) in an area approximately 40 km by 115 km in the west of the Avon River basin, at the western margin of the Western Australian (WA) wheatbelt (figure 1). The soils in this region are generally sandy at the surface (more than 50% of the area) but are highly variable at depth, ranging from shallow sand over clay, to deep sands, to gravel or clay dominated profiles. Common land uses include continuous cropping, mixed cropping in rotation with annual pasture, and permanent annual pasture with the livestock enterprise being mainly sheep-based.

Acidic soils are widespread in the western Avon basin. In crop and pasture systems, liming is required to maintain optimum soil pH to both increase production and protect the soil resource over the long term. The sampling program was designed to (1) provide a snap shot (2011) of organic carbon storage values across typical soil and agricultural production systems in the western Avon basin and (2) evaluate whether across this large region there is a consistent pattern between soil pH and organic carbon storage. Soil organic carbon storage varies with climate and the amount and type of soil clay, so sampling targeted a particular rainfall zone (300–400 mm annual average rainfall) on one soil type (deep sandy soils, at least 80 cm).

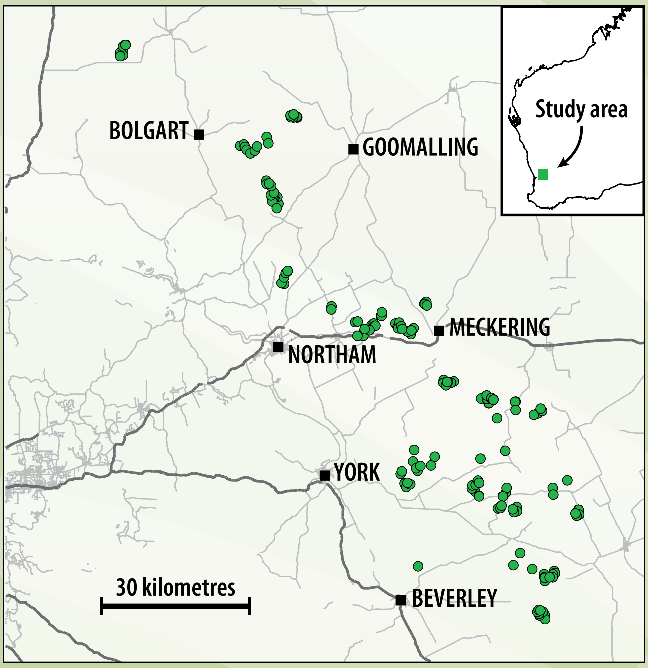

Figure 1: *Map of the 161 soil sampling site locations in the western Avon basin.*

What are typical carbon levels?

Actual soil organic carbon storage in the 0–30 cm layer ranged from 7 t C/ha in a crop-dominant system to a maximum of 55 t C/ha in a pasture-dominant system for these sandy soils. Land use had a small, statistically significant, influence on soil organic carbon storage. Pasture-dominated systems had the highest average soil organic carbon (21 t C/ha), followed by continuous cropping (20 t C/ha) and crop-dominant systems (19 t C /ha).

Modelling was used to estimate the ***potential*** soil organic carbon storage after 50 years for a perennial-based system that used all available rainfall and was not grazed; this is compared to the ***attainable*** carbon storage for this climatic zone under three land use scenarios (figure 2). The 50-year ***attainable*** soil organic carbon levels range from 37 to 47 t C/ha, and increase to between 53 and 63 t C/ha longer term (500 years: not shown). Pasture-dominant systems were predicted to sequester slightly more soil organic carbon than mixed or crop-dominant systems (respectively 0.5 versus 0.3 and 0.4 t C per year over 50 years).

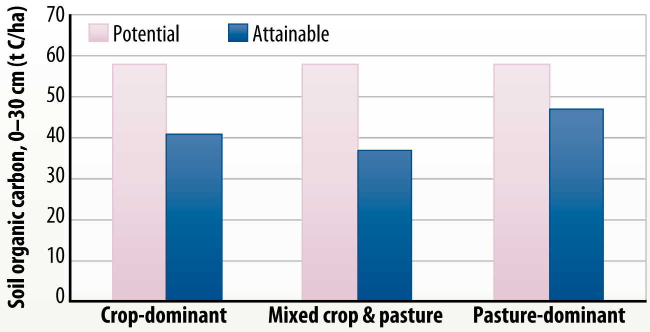

Figure 2: *A comparison of* ***potential*** *and* ***attainable*** *soil organic carbon storage modelled for soils with less than 2% clay, base soil organic carbon of 20 t C/ha.*

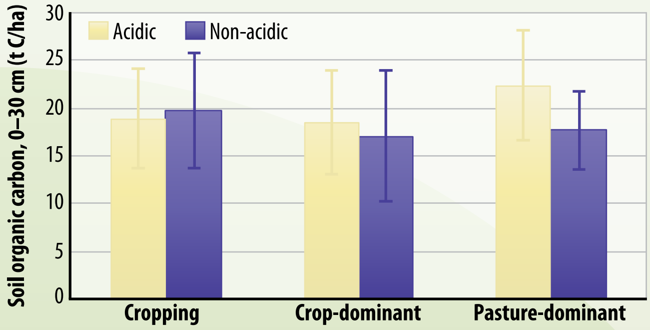

Figure 3: *Average* ***actual*** *soil organic carbon on acidic soil profiles (pH below DAFWA targets in 2 of 3 layers) and non-acidic soil profiles.*

Did soil pH help explain soil organic carbon storage?

Deep sands in the western Avon basin have low buffering capacity, and therefore tend to acidify when farmed. Soil pH in the study samples ranged from 4.3 to 6.4 in the 0–10 cm layer and from 3.7 to 5.2 in the subsurface. Only 9 sites, 6% of sites sampled, had a pH profile which met or exceeded the Department of Agriculture and Food, Western Australia (DAFWA) recommended targets (5.5 in the topsoil and 4.8 in the subsurface) and fewer than 20% of farmers applied lime to the sampled paddocks in the last 10 years.

Over the region as a whole, soil organic carbon storage did not vary with soil pH (figure 3). This could have several explanations:

1. Management of soil pH may not affect soil organic carbon storage in a consistent way across this area.
2. The natural variation within sandy soils across this region, land management effects and other production constraints may make the data too 'noisy' to see a consistent pattern between pH and soil organic carbon.
3. The sample sites may not represent an adequate range of soil pH values.
4. Liming and related increase in production may also increase the microbial population, leading to faster carbon cycling rates but no increase in the total organic carbon.

This study has documented regional patterns, but additional research will be required to determine how liming impacts soil organic carbon storage on a paddock by paddock basis. It has been well documented that maintaining recommended soil pH levels can increase crop and pasture productivity and sustainability of the soil resource; how this management impacts soil organic carbon storage is still not clear. The intent of this study was to survey organic carbon levels on common soils across a regional extent, and in this context, soil organic carbon and pH were not correlated.

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