Building Farmer & Advisor Knowledge in Carbon Farming

The Carbon Farming Knowledge Project involves a series of workshops to increase the understanding of 30 independent agricultural advisers in south-east Australia on reducing greenhouse gas emissions, carbon in farming systems and the Emissions Reduction Fund – where farmers can earn credits for storing carbon or reducing greenhouse gas emissions on their properties. The project helps advisors prepare their clients for potential environmental, economic and social benefits of future carbon management policy.

Session 4: Soil Carbon

Summary of March 2106 advisers workshop presentation by Lynne MacDonald and Clive Kirkby, CSIRO and Brian Murphy, NSW Office of Environment and Heritage.

ERF methods

The Emissions Reduction Fund (ERF) allows farmers to sell Australian Carbon Credit Units in return for enhancing carbon in agricultural soil. Two methods are approved, one based on direct measurement and one based on modelling by a qualified person.

For the direct measurement method, it is important to consider the spatial variability across the project area to define a number of carbon estimation areas (CEA). CEAs should take into account how variation in land-use, landform and soil type might influence soil carbon content. Each CEA should be as homogenous as possible to minimise the error around the mean and make it easier to measure a statistical change in carbon content.

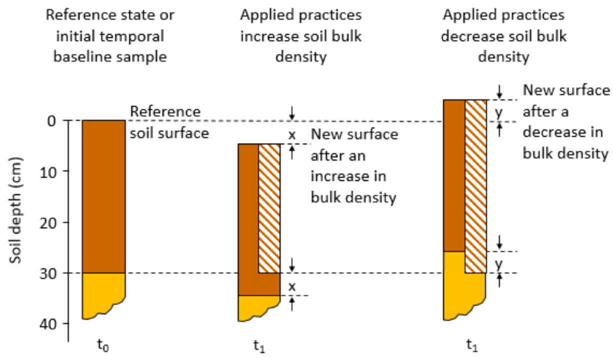

Figure 1: Sampling depths for methods that effect soil bulk density. (source: Jeff Baldock)

For direct measurement, a careful sampling regime should be put in place for accurate results, taking into account the number of required samplers for each CEA, sample depth and sample preparation and analysis. For example, if practices are applied that affect the soil bulk density, a different depth of core should be sampled to represent an equivalent soil mass (Figure 1).

Soil organic carbon fractions

It is useful to consider soil organic carbon as different components/fractions that have different turnover times;

1. Particulate (POC): relatively fresh with defined structure, decomposes annually.
2. Humic (HOC): no identifiable structure, associated with minerals, and relatively stable with slower decomposition.
3. Resistant (ROC): highly stable with turnover times greater than 100 years.

The relative proportions of these types of carbon affect how stable any sequestered carbon is within the soil. The CSIRO are investigating cost effective methods of measuring the different fractions, with the possible future aim of considering POC, HOC and ROC separately in the ERF.

Mid-infra red spectroscopy is rapid and cost effective, but is reliant on a calibration dataset. The CSIRO calibration dataset has been developed from a national database collected during the Soil Carbon Research Program (SCaRP) which sampled more than 20,000 samples from 4,500 sites. The method is still in development, performing well on most soils, but requiring better calibration for certain soil types (such as calcareous soils).

Soil organic matter

Soil organic matter (SOM) is the active material in the soil with soil organic carbon (SOC) being one component of SOM. SOM also comprises of nitrogen, phosphorus and sulphur in generally consistent ratios of 1000C : 90N : 19P : 14S and also includes oxygen and hydrogen. Commonly, only the SOC component in SOM is measured and reported. SOM and SOC are linked with SOM being approximately 1.72 x SOC.

SOM has several key positive effects on soil physical properties and fertility, including:

- Improved plant available water capacity,
- Lower bulk density,
- Lower soil strength and compacted density,
- Improved cation exchange capacity,
- Increased buffering capacity to acidification, and
- Source of nutrients for plant growth.

Crop residue breakdown

When crop residues break down, they either *assimilate* or *disassimilate*. Disassimilation is the breaking down of complex substances into simpler ones with the release of energy and CO_2, while assimilation is the building up of complex organic molecules or organisms and storage of carbon (for example microorganisms in the soil) from simpler precursors (such as the nutrients in crop residues).

The relative degree of these processes depends on the ratios of specific elements in the crop residues. Soil organic matter consists of these elements in consistent ratios (1000C, 90N, 19P and 14S), so if any of the elements are limiting (e.g. if there are less than 19 P atoms for every 1000 C atoms), there will be leftover carbon which will disassimilate and result in greenhouse gas emissions.

When trying to store carbon, if other nutrients are limiting, then increasing the supply of these nutrient can increase carbon conversion to SOM (Figure 2).

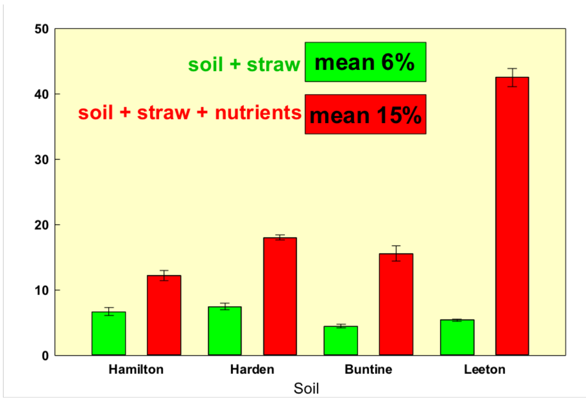

Figure 2: Trials in Hamilton showed that adding nutrients (red) improves carbon storage from straw as SOC compared to straw alone (green).

Methods to improve soil carbon

The best process to improve soil carbon involves the following strategies:

- Maximise biomass production,
- Maximise return of the biomass to the soil,
- Improve the quality of biomass returned to the soil,
- Minimise disturbance, and
- Improve soil fertility (nutrition).

The maximum level of SOM/SOC that can be reached depends on a combination of climate and soil type.

Useful resources

- Method information: Sequestering carbon in soils in grazing systems. http://www.environment.gov.au/climate-change/emissions-reduction-fund/methods/sequestering-carbon-in-soils
- Managing soil organic matter: http://www.grdc.com.au/GRDC-Guide-ManagingSoilOrganicMatter

More information: Lynne Macdonald, (08) 8273 8111, Lynne.Macdonald@csiro.au; Clive Kirkby, 0418 253 003, clive.kirkby@csiro.au; Brian Murphy, 0412 261 230, brian.amaroo@bigpond.com.au.