Soil organic carbon in Wheatbelt cropping systems

Why manage soil organic carbon?

Soil organic carbon is important for:

- cation exchange capacity (CEC): CEC indicates the potential capacity of soil to store nutrients. The three main cations essential for plant growth are potassium, calcium and magnesium. These influence soil structure, colour and aggregate stability.
- soil structure: soil organic carbon interacts with and influences the formation of soil structure, helping the formation of soil aggregates.
- water holding capacity in soils: carbon acts like a sponge for soil water... more carbon = more plant available water holding capacity. Although these increases may be small, they may be valuable in below average rainfall years.

What are the forms for soil organic carbon?

Types of soil organic carbon and their role in agricultural soils:

- crop residues- above and below ground plant residues (leaves, stalks, roots) less than 2 mm long or wide
  - break down quickly
  - source of energy for soil biological processes
- particulate organic carbon- plant residues that are smaller than 2 mm but larger than 0.053 mm
  - breaks down relatively quickly but more slowly than crop residues
  - important for soil structure
  - source of energy for biological processes
  - source of nutrients
- humus decomposed materials less than 0.053 mm that are dominated by molecules stuck to soil minerals
  - important for all key soil functions
  - provides nutrients - for example the majority of available soil nitrogen derived from soil organic matter comes from the humus fraction
- recalcitrant organic carbon- biologically stable carbon, most common form is charcoal
  - decomposes very slowly and is therefore unavailable for use by micro-organisms
  - carbon that will not be readily-emitted to the atmosphere as CO_2

How can we sequester soil organic carbon?

Plant photosynthesis is the only process by which carbon is taken from the atmosphere and a fraction deposited in the soil through inputs of plant organic matter.

- Soil organic carbon input rates are determined by the root biomass of a plant, but also include stubble and leaf litter deposited from above-ground plant material.
- Practices that improve plant water use and growth (e.g. early sowing) are desirable because they also increase organic inputs into soil.

The capacity of a soil to store soil carbon over a long period of time is largely determined by the characteristics of that soil and climatic factors (this is referred to as ‘attainable’ soil carbon). Soils that have more clay content and occur in higher rainfall environments have been found to be able to store more carbon, while sandier soils in drier environments tend to be lower in soil carbon. Increasing the rate of organic inputs on course sandy soils may therefore not result in stable increases in soil organic carbon but may help to maintain the current soil carbon stock.

Soil management activities can be used to move soil carbon stocks towards their attainable levels. For example, in the Avon Arc region, maximum attainable carbon levels in cropping systems on sandy soils have been estimated to be approximately 40t-C/ha, while studies have measured an average actual carbon level of 19t-C/ha in this area.

Limiting gaseous emissions (respiration) of carbon from soils is a sequestration process. There are a number of ways to do this, the easiest to achieve are below:

- Limit soil disturbance to ensure the carbon protected from decomposition by soil microbes by clay or soil aggregates continues to be protected.
- Increase plant cover to ensure there is an input of carbon to the soil from root and above-ground biomass. Soil left fallow is a net source of carbon to the atmosphere because there is no addition of carbon to counterbalance the loss of carbon from erosion or microbial respiration

Respiration rates are highest when conditions are warm and moist, meaning that summer rainfall can cause the rapid release of soil carbon, particularly if there are no active plants to replace the lost carbon. A recent Wheatbelt study by UWA suggested that soil organic carbon levels had on average dropped between 2006 & 2011, with most of this drop attributed to high summer rainfall in 2011, suggesting that soil organic carbon levels can change more quickly than was previously thought.

Practices that help to maintain or even increase soil organic carbon in Wheatbelt cropping systems include:

- conservation tillage, most ideal is zero-tillage cropping practices
- crop residue retention
- eliminating or reducing the frequency of fallow in rotations
- shifting from annual to perennial pastures and summer active crops
- using crops and pastures with maximum biomass production given soil and climate constraints

These practices have been recognised by the Australian Government's Emissions Reduction Fund, and projects incorporating these practices of storing carbon in soils on Wheatbelt farms can be undertaken to receive Australian Carbon Credit Units (ACCUs). For more information on the ERF, go to the Clean Energy Regulator website at
http://www.cleanenergyregulator.gov.au/ERF/Pages/default.aspx
or the My Carbon Farming website at http://www.mycarbonfarming.com.au/

We are still learning about soil organic carbon in our cropping systems and how best to adjust management practices to optimise productivity and soil organic carbon storage. However, we know that soil organic carbon interacts with a number of aspects of soil health and productivity, and as such has been identified by Wheatbelt NRM as one of 11 'thresholds of potential concern' that we should be tracking as an indicator of the condition of our soils and farming systems. For more information check out the Wheatbelt NRM strategy and dashboard at: http://www.wheatbeltstrategy.com.au/