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Clarifying Carbon: what are carbon stocks?

There is a lot of talk about sequestering carbon in vineyard soils, and for good reason. Building carbon in soil can improve soil health, help achieve carbon neutrality, and open-up opportunities to participate in carbon farming. Central to the sequestration of carbon in soils is measuring carbon stocks, which raises the question:

What are carbon stocks and how are they measured?

What is a Carbon Stock?

In simplest terms, a carbon stock is the amount of carbon within a known volume of soil, and is typically reported as tonnes of C per hectare. To calculate a carbon stock you need to know two things: the first is the concentration of carbon in a soil sample, and the second is the bulk density of the soil sample. While carbon stocks can be measured at any depth, they are typically taken from 0-30 cm soil layer where most organic carbon is found.

Carbon and soil

Soil carbon comes in many 'forms', that is, carbon containing molecules or materials. At the broadest level, soil carbon can be divided into either organic or inorganic, carbon. Inorganic carbon is typically derived from rock containing calcium carbonates, such as those in the Limestone Coast region of South Australia. Organic carbon is derived from once-living material – typically plants and microbes. While inorganic carbon is important, it is the organic carbon pool that we are trying to grow when sequestering carbon in agricultural soils.

Did you know?

A carbon credit is equivalent to one tonne of CO_2 which, because of the presence of oxygen, doesn't require one tonne of carbon to be produced.

1 tonne C makes 3.67 tonnes of CO_2.

In other words, every tonne of carbon you sequester is worth 3.67 carbon credits!

Limestone in a Coonawarra soil

Photo: Wine Australia

Soil organic carbon (SOC), soil organic matter (SOM) and total C.

The terms SOC and SOM are often used interchangeably, however, they are not exactly the same thing. Where SOC refers to the amount (or concentration) of carbon present in an organic form in the soil, SOM refers to the amount of organic matter, of which about 58% is carbon. Total C, another commonly used term, refers to the total amount of carbon, be it in an organic or inorganic form. When it comes to increasing carbon stocks, it is SOC that we are interested in.

Measuring carbon stocks

Carbon stocks are a combination of two measurements: carbon concentration and bulk density.

1. Measuring carbon concentrations requires a specific method of processing. A soil sample must be air-dried and sieved to collect a sample of soil particles less than 2 mm in diameter.
2. Once soil processing is completed, a subsample can be used to measure the carbon concentration. The most common method in use is dry combustion, which involves heating sample to very high temperatures, and measuring the CO_2 released by infrared analysis. If the soil contains inorganic carbon, this first must be removed using acid.
3. These analyses are generally conducted at a commercial laboratory, with results presented as SOC with units of %, parts per million, or mg C per kg soil. Many routine soil tests include a measure of SOC, but this is only half of the information needed to calculate a carbon stock.
4. Measuring bulk density is a simple, yet precise procedure. There are several methods, however, the most common requires the careful collection of a undisturbed soil core using a metal open-ended core of known volume. The soil sample is weighed immediately and then dried at 105°C and re-weighed (dry) to account for soil moisture.

In-tact Soil Core

Photo: Joseph Marks

The first step to growing soil carbon stocks is measuring baseline levels. Once your baseline is established, you can consider how to grow your carbon stocks, but it all starts with a good understanding and measure of soil carbon stocks.

Bulk density can then be calculated using the dry soil weight and the volume of the core, as follows:

Bulk density (g/cm^3) =
dry soil weight (g) / soil volume (cm^3)

When calculating bulk density, it is important to account for the mass and volume of rocks (gravel content) within the sample core, and where soils have been compacted between measures of carbon stocks, a correction for soil compaction may also need to be considered.

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