INCREASING THE AMOUNT OF CARBON STORED IN SOILS COULD HELP REDUCE AUSTRALIA'S EMISSIONS OF GREENHOUSE GASES BY OFFSETTING SOME OF THE CARBON DIOXIDE (CO_2) EMITTED INTO THE ATMOSPHERE.

Gathering soil samples

Australian Government
Department of Agriculture, Fisheries and Forestry

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SOIL CARBON

climate change research program

May 2011

FACT SHEET

About the Climate Change Research Program

The Climate Change Research Program is part of Australia's Farming Future, the Australian Government's climate change initiative for primary industries. The program funds research projects and on-farm demonstrations to help prepare Australia's primary industries for climate change. Research focuses on reducing greenhouse gas pollution, improving soil management and climate change adaptation. The program is providing practical management solutions to farmers and industries. The Department of Agriculture, Fisheries and Forestry manages the Climate Change Research Program.

Partnerships

The Soil Carbon Research Program is supported by funding and in-kind support from the following partners:

- CSIRO's Sustainable Agriculture Flagship
- Department of Agriculture and Food, WA
- Department of Environment and Natural Resources, SA
- Department of Primary Industries, Vic
- Grains Research and Development Corporation
- Industry and Investment NSW
- Murray Catchment Management Authority
- Queensland Department of Environment and Resource Management
- Tasmanian Institute of Agricultural Research
- University of New England
- University of Western Australia.

Also in this fact sheet series:

- Adapting to a changing climate
- Biochar
- Livestock emissions
- Nitrous oxide emissions

Acknowledgement

Information contained in this fact sheet was obtained from a CCRP progress report provided by CSIRO and:

Bureau of Rural Sciences. (2010). *Science for Decision Makers—Soil Carbon Management and Carbon Trading*. Canberra: Department of Agriculture, Fisheries and Forestry.

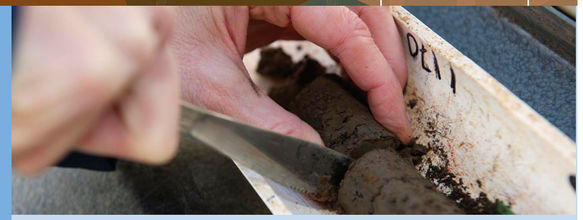
For further information on the Climate Change Research Program or any of the funded projects please contact:

Australia's Farming Future hotline
1800 638 746

www.daff.gov.au/climatechange/ccrp

Key points

- **Through the Climate Change Research Program, the Australian Government is funding research to better understand the potential of Australian soils to store carbon.**
- **Research is establishing one of the most detailed national benchmarks of soil carbon levels in the world.**
- **Soil samples have been taken from over 2,500 sites to help paint an accurate picture of how different farming practices affect soil carbon levels.**
- **Researchers are identifying effective ways to measure soil carbon levels across Australia's agricultural regions.**
- **Early trials show that perennial grasses, including kikuyu grass, can increase soil carbon levels.**



The amount of organic carbon stored in Australian soils could be increased by changing land management practices. This will help offset greenhouse gas emissions, increase farm productivity and potentially create offsets under the Carbon Farming Initiative[1].

The Soil Carbon Research Program is:

- developing a standard for measuring soil carbon across Australia
- assessing the capabilities of new cost-effective soil carbon measurement methods
- increasing knowledge on how management practices affect the amount of carbon stored in soils
- providing soil carbon data to improve the National Carbon Accounting System.

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Measuring soil carbon

Traditional methods

Traditional methods for measuring the amount of organic carbon in soils are slow, laborious and time consuming, making them expensive to undertake regularly.

The three major steps in determining the amount of organic carbon in soils are:

1. Take soil samples (enough to validly represent the field or farm)
2. Measure soil density
3. Measure the concentration of carbon in the soil samples.

All this information is needed to precisely calculate the amount of organic carbon stored in soils so any changes in land management use can be measured accurately.

Sampling improvements

The first outcome of the Soil Carbon Research Program has been to develop an appropriate method to measure the amount of organic carbon from a range of soils and different farming systems. This work is being done to show the effects of agricultural land-use and management practices on soil carbon at a regional level. Over 2,500 sites have been sampled across many of Australia's agricultural regions and results are showing strong variations in the amount of carbon stored in soil. As more samples are taken and data is compiled, researchers will become more confident about the potential for particular management practices to increase soil organic carbon.

Improving measurement of soil density

In order to measure soil carbon levels confidently, the soil carbon research program is investigating two new methods for estimating soil density.

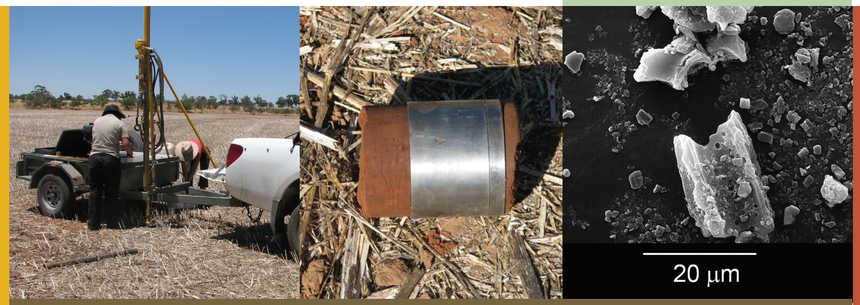
The nuclear density meter, originally designed to measure the density of road bases, can measure the density of soil samples on site without the need to collect soil cores. This meter was also tested on artificial soils and gave results of similar accuracy to traditional methods.

The second method scans the entire soil core. Combined with a calculation of water content, this measure is as accurate as conventional methods.

These two methods for measuring soil density are being tested across a wide range of soil types, densities and with varying soil water content to determine their usefulness for field measurements.

What is the difference between organic and inorganic carbon?

Carbon exists in two forms in soils – organic and inorganic. Organic carbon includes decaying plant matter, soil organisms and microbes and can be increased through land management practices. Inorganic carbon is mineral-based and is relatively stable. With the exception of liming, inorganic carbon is not strongly influenced by land management practices.



Field sampling of soil cores. Left: trailer-mounted soil corer (Photo: L Macdonald, CSIRO). Middle: a soil core sample (Photo: Josh Tefler, Rural Solutions SA). Right: A magnified image of charred organic carbon fragments.

New methods for measuring the concentration of carbon

The Soil Carbon Research Program is testing various techniques to automate and improve measuring the amount and form of carbon in soils[2]. For example, improvements were made to an automatic sieving process for separating small pieces of plant residues, including roots, from the more biologically stable organic material in soil (referred to as humus). Researchers are working to develop a process that eliminates carbonate in order to obtain accurate measurements of total organic carbon.

The major new method for measuring the concentration of organic carbon is with a mid-infrared spectrometer (MIR). Once established, this method can simply and affordably measure total organic carbon, inorganic carbon and potentially the amount of carbon in plant residues and humus.

The Soil Carbon Research Program is developing a method for measuring how much carbon exists as charcoal in soil samples. This form of carbon is very stable and generally accumulates in soils prior to the implementation of agricultural practices. Understanding how much carbon exists as charcoal, pieces of plant residue and humus is necessary to measure the influence of management practices on soil carbon. This information will improve modelling carried out by Australia's National Carbon Accounting System[3].

1 For more information on the Carbon Farming Initiative visit www.climatechange.gov.au/cfi
2 For more information on the forms of carbon in soils please see *Bureau of Rural Sciences 2010 Soil Carbon Management and Carbon Trading*.
3 The Australian Government established the National Carbon Accounting System (NCAS) in 1998 to provide a complete accounting and forecasting system for human-induced sources and sinks of greenhouse gas emissions from Australian land-based activities. It enables reporting on land use, land use change and forestry categories for both the United Nations Framework Convention on Climate Change National Greenhouse Gas Inventories and the Kyoto Protocol Greenhouse Gas Inventory.

Predicting the impact of management on soil carbon change

Computer models can be used to predict the potential impact of changes in agricultural management practice on the amount of soil organic carbon. The Soil Carbon Research Program is analysing soils collected from 11 long term field experiments to better understand how management practices affect soil carbon levels through time. This data will be made available for the testing of soil carbon models.

Managing changes in soil organic carbon

How does soil organic carbon change?

The amount of carbon stored in the soil is the balance between the rate at which organic matter is added and the rate at which it decomposes, releasing CO_2 into the atmosphere.

Carbon can be added to the soil through the decay of plants, manure and microbes. For example, increasing the production of plant biomass could increase organic carbon in soils.

Carbon can be lost from the soil through the conversion of organic carbon to CO_2, through erosion and by leaching of dissolved carbon through the soil.

There is limited information on the effect that soil disturbance, crop rotations and land-use history have on soil carbon levels in Australia. It is well known that cultivation reduces soil carbon, although it is not clear how much this is influenced by factors such as the intensity of cultivation, the type of soil, the type of plant material grown, crop residue handling practices and environmental conditions.

What practices will increase soil carbon?

Perennial pastures

The Soil Carbon Research Program is investigating the effect on soil carbon when introducing perennial grasses into annual grass pastures. Early results suggest that where soil carbon was previously run down by more intensive practices, perennial kikuyu grass can capture more soil organic carbon. However, mixed panic and Rhodes grass pastures appear to have provided only small changes in the amount of soil carbon. Where soil carbon contents were high prior to conversion to perennials, further build up of carbon under the perennial pastures has generally not occurred.

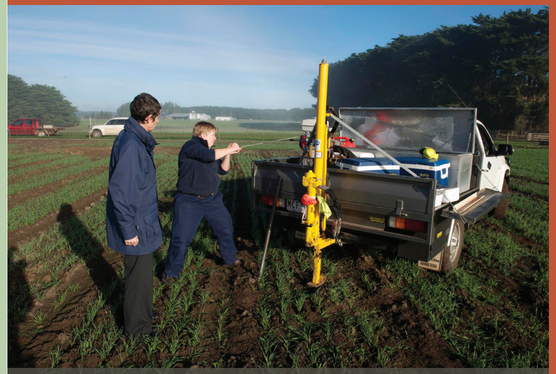
Other practices being investigated

A range of other farm practices are being investigated to determine their long-term effect on soil carbon. These practices include:

- fallow management
- tillage practices
- grazing practices in rangelands e.g. between cell grazing, rotational and continuous grazing
- crop rotations in irrigation areas (with vegetables and pastures)
- fertiliser application and timings.

Where are the opportunities for sequestering soil carbon?

The Soil Carbon Research Program is an extensive program of soil sampling across Australia. Understanding how much carbon is currently stored in Australian soils is important to establish a baseline for change. Once this baseline is established it will be easier identify areas with the highest potential for increasing soil carbon.



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