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Farming carbon

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Offsets from increased soil carbon on farmlands are eligible for generation of carbon offset credits under the federal government's National Carbon Offset Standard (NCOS). Adam Barclay looks at the hurdles that need to be cleared before Australian farmers can take advantage of this.

Credit: Photo Rusell Ellis

On 1 July this year NCOS came into effect.[1] It is designed to give Australian businesses, particularly farm businesses, opportunities to develop offset credits for voluntary carbon markets. Emissions from revegetation, forest management, and cropland and grazing land management – while not currently counted towards Australia's obligations under the Kyoto Protocol target – are eligible for the generation of carbon offset credits under NCOS.

The inclusion of offsets from increased soil carbon through farmland management has stirred a lot of interest. In brief, if farmers adopt land management strategies that sequester carbon from the atmosphere into their soils, they will be eligible to receive carbon credits that can be sold to organisations aiming to offset their greenhouse gas emissions. A company with high emissions, for example, could pay farmers for their credits and thus promote themselves as carbon neutral.

On paper, it's a win-win situation. Healthy, fertile, productive soils depend on good levels of soil carbon. In Australia, soil carbon has been alarmingly depleted since the spread of wide-scale agriculture after European settlement. Over the past decade, there has been a fast-growing awareness that Australia's farming practices need to change if the country's severely degraded soils are to continue to support the production – and deliver the increases in productivity – that farmers have come to expect.

'On average, it's safe to say there have been 30 to 70 per cent losses of soil carbon under cultivation compared with the native, uncultivated conditions,' says Jonathan Sanderman, a soil organic matter biogeochemist in CSIRO's Carbon and Nutrient Cycling Research group (Sustainable Agriculture Flagship).

However, several hurdles need to be cleared if Australian farmers are to become carbon traders. First, there is no

well-established, cost-effective method of accurately measuring and monitoring soil carbon. Second, while NCOS offers guidelines for voluntary trading, there is no guarantee that the scheme will take off. And third, scientists still don't have a very good idea of how effectively the various 'carbon-friendly' management strategies actually increase soil carbon.

Regarding the first problem, accurately monitoring changes in soil carbon is currently prohibitively expensive.

'If the cost of monitoring is greater than what you're paid for the carbon – which it pretty well is at the moment – the system's not going to work,' says research scientist Elizabeth Schmidt at CSIRO Land and Water.

Credit: CSIRO

One way to keep costs down is to award carbon credits based on carbon modelling according to land use and soil type, rather than through actual measurements. For example, modelling might predict that zero-till, direct-drilling crop management in a particular region will sequester a certain mass of carbon per hectare per year. Provided that farmers stick to that type of land use, they can claim carbon credits, with compliance monitored through an auditing system.

Central to the third problem – the question of effectiveness – is the issue of ensuring that sequestering soil carbon is indeed a good way to mitigate or reduce greenhouse gas emissions. Ultimately, this will depend on how policy dictates that farmers who plan to trade carbon use their land. Dr Sanderman notes that there are a number of approaches that, although they will increase the amount of carbon sequestered, will also increase emissions –which farmers don't need to account for in the current iteration of Australia's voluntary market.

'For example, if you converted crop land to pasture, you'd increase the amount of carbon in the soil,' says Dr Schmidt. 'But as soon as you start grazing it, the sheep start producing methane, and the greenhouse gas potential of the methane is generally well in excess of the carbon tied up.'

Another practice that might have a negative environmental effect – despite building soil carbon – is the application of large amounts of inorganic nitrogen to boost plant growth, followed by incorporation of large amounts of plant residue back into the soil.

'You'll probably gain carbon, but your nitrous oxide emissions will be huge,' explains Dr Sanderman. 'So, it really depends on how other gases are included in the agricultural sector and how soil carbon will play into that. Changes in soil carbon in terms of greenhouse gas potential are quite small compared with methane or nitrous oxide emissions, so if you have to account for these gases, soil carbon might offset your emissions at best.'

According to Peter Fisher, principal research scientist at the Victorian Department of Primary Industries (DPI), the effectiveness of any scheme also depends on how and where you set a baseline. This could penalise farmers who have been practising carbon-friendly management for some years and have already built up their soil carbon stocks.

'As you start to raise soil carbon, it gets harder and harder to raise it further,' says Dr Fisher. 'If you start from a low base, you can raise it much faster initially.'

Nevertheless, there's a virtual consensus among soil scientists that Australian farmers shouldn't need any extra incentives to increase their levels of soil carbon. Known more accurately as soil organic carbon, it is part of soil organic matter, which is made up of decaying plant and animal matter, and essential elements for good plant growth such as

calcium, phosphorous, and nitrogen. Soil organic matter is universally regarded as the critical factor in soil health, conferring a whole range of benefits for soil. It provides nutrients for plants, energy and nutrients for soil microorganisms that make nutrients available to plants, and promotes a robust soil structure that can better withstand rainfall extremes and hold water for use by plants.

Credit: Photo Colin Seis

'Carbon isn't a single entity,' says Dr Sanderman. 'It's bound up in organic matter, which is also a large nutrient store. So, if you're building organic matter stocks, you're not just building carbon stocks. In fact, you're building resilience back into the system, so you're not as dependent on inorganic fertilisers and you can better handle major year-to-year shifts in climate.'

Dr Fisher and his team at DPI Victoria examined the effect of different production regimes on soil organic matter and carbon.[2] They identified pairs of adjacent paddocks with different histories of organic matter (eg crop stubble or manure) production and retention. The sample sites had been used largely for irrigated cropping, and therefore represent larger organic matter returns to the soil compared with most other Australian studies. One member of each paddock pair had a history of higher organic matter production and retention than its neighbour.

The researchers analysed the soil carbon content of samples taken from close to the boundary between the two paddocks. They found that the higher organic matter retention paddocks had higher soil carbon levels compared with the lower organic matter treatment at the paired sites. This in turn showed a positive relationship with higher soil nitrogen and higher amounts of microorganisms and microbial activity, and a negative relationship with soil bulk density – the lower the carbon content, the more compacted the soil. Perhaps most importantly for farmers, the end result was that the paddocks with the high organic matter retention systems appeared to produce equal or higher average yields than their neighbours.

Dr Sanderman and his colleagues at CSIRO Land and Water have recently written a report,[3] funded by the Australian Department of Climate Change and Energy Efficiency, which reviews the mechanisms of carbon capture and storage in agricultural soils. It also analyses the published evidence for changes in soil carbon resulting from changes in agricultural management.

According to the report's findings, almost all soil under traditional land management was losing carbon, and even most paddocks under carbon-friendly management were at best mitigating those losses.

'Relative improvement from improved management wasn't necessarily [due to] sequestration of additional carbon dioxide; it was merely losing it at a slower rate or preventing additional loss,' says Dr Sanderman. 'Pretty much the only trials that were gaining carbon over time were conversion of cropping to permanent pastures.'

Dr Fisher said this was in keeping with the DPI Victoria study which showed that although retaining more organic matter improved soil carbon levels compared with the neighbouring lower retention paddock, it is quite possible that the soil carbon levels are falling in both farming systems, especially if compared to native conditions.'

Without ways of rebuilding Australia's soil carbon stocks, says Dr Sanderman, 'it'll get harder and harder to continue

the yield gains that most farmers have come to expect out of crop breeding programs and you'll start hitting a wall.'

Dr Sanderman sees the major goal of much of our current work as giving the government, and those in the agricultural sector, a solid foundation for future decisions. This includes improving the computer model used to predict changes in carbon levels.

'Right now the modelling is calibrated on a very limited number of data sets,' he says. 'The new data generated in this project will give us an excellent opportunity to improve on this model.'

Credit: CSIRO

Pasture cropping

One relatively new method of crop management that has potential to increase soil carbon levels is pasture cropping, which was first trialled in Australia in the mid-1990s. Pasture cropping is a farming system that involves the direct drilling of a winter cereal crop into existing (usually native) perennial pasture.

The Broken Catchment Landcare Network (trading as the Gecko ClaN, a network of 23 Landcare groups operating in the Broken and Goulburn catchments in north-eastern Victoria) is running pasture cropping trials in conjunction with Landcare Victoria. The trials are supported by the federal government's Caring for our Country initiative, which funds projects across the country that aim to improve biodiversity and sustainable farm practices.

The trials, which will run until 2011, have so far revealed a small increase in soil carbon relative to conventional crop management. However, it's too early to say whether this is the result of pasture cropping or natural seasonal variation. Early observations also indicate increased water-holding capacity of the soil under pasture cropping.

Pasture cropping trial. Oat stubble with wallaby grass underneath, summer 2009. Photo Russell Ellis

A recent study[4] by the New South Wales Department of Primary Industries looked at the strategy in the central western slopes of New South Wales. The research found that pasture cropping into red grass (*Bothriochloa macra*), a summer-active native Australian grass, can successfully allow profitable cropping and grazing. Although crop yields in pasture-cropped paddocks were lower than for conventional no-till cropping, the lower input costs helped maintain farm profit.

More information

Broken Catchment Landcare Network: http://goulburnbroken.landcarevic.net.au/mgbclan/projects/pasture-cropping-project

Caring for Country: www.nrm.gov.au/about/caring

1 Department of Climate Change (2009). National Carbon Offset Standard. See www.climatechange.gov.au/government/initiatives/carbon-offset.aspx

2 O'Halloran N, Fisher P and Aumann C (2007). Organic matter management for healthy soils: Maintaining the productivity of soils under intensive cropping. Victorian Government Department of Primary Industries.

3 Sanderman J, Farquharson R and Baldock J (2010). Soil carbon sequestration potential: A review for Australian agriculture. CSIRO Land and Water. Available at www.csiro.au/resources/Soil-Carbon-Sequestration-Potential-Report.html

4 Millar G and Badgery W (2009). Pasture cropping: a new approach to integrate crop and livestock farming systems. Animal Production Science 49(10), 777–787. See www.publish.csiro.au/?paper=AN09017

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