Carbon Farming

Key Messages

- There is considerable uncertainty regarding the future of carbon trading in agriculture
- The UNFS group is working on several project to help identify how growers might take advantage of the carbon market in the future
- Improved production and sustainability needs to be the key driver of any management changes with carbon credits being a bonus, not the drivers of change.

Carbon Farming Initiative

The Carbon Farming Initiative (CFI) is a carbon offsets scheme that will enable farmers and other land managers to access carbon markets. Farmers and land managers will be able to generate carbon credits for taking action to increase carbon stored in the landscape, or reduce emissions by changing farm practices.

Credits generated under the CFI that are recognised for Australia's obligations under the Kyoto Protocol can be sold to companies with liabilities under the **Carbon Price Mechanism**. This includes credits earned from activities such as reforestation, savanna fire management and reductions in emissions from livestock and fertiliser use.

The ongoing **CFI non-Kyoto Carbon Fund** will provide incentives for other activities, including revegetation and soil carbon projects.

Two types of offsets

1. Sequestration projects = projects to store C in living biomass, dead organic matter (dead wood or leaf litter) or soil
2. Emissions avoidance projects = reductions in emissions from agriculture (e.g. savanna burning, livestock (methane) fertilizer (nitrous oxide)) waste (i.e. legacy waste in landfill) and feral animals (camels and goats).

What is standing in the way of the CFI?

The obvious issues

1. Political uncertainty – prospect of termination of carbon pricing scheme with a new federal government
2. Carbon price – prospect of a low C price under the European Union model.

Legal obstacles

1. International climate rules
2. CFI rules
   - positive and negative list exclusions
   - project restrictions
   - methodologies (need to develop a complex methodology before a practice is included)
   - permanence requirement (100 years)
3. Project- level legal complexity

If CFI is going to work, there is a need for greater interest in ways of reducing the legal complexity and lowering transaction costs.

1. The current focus on science is good BUT science won't make the CFI work
2. There will be a need to sort out the economic and legal aspects.

What is happening in the Upper North?

The Upper North Farming systems group is involved in several Carbon Farming projects, which are trying to identify areas which have the greatest potential for soil carbon sequestration or reductions in greenhouse gas emissions.

1. Storing Carbon in the Soil

The Upper North Farming Systems is working with CSIRO to evaluate the impact of different pasture and grazing management systems on soil carbon stocks as well as identify the soil types and management practices most likely to give the largest gains in soil carbon stocks.
Clearing and cultivating native land for agriculture has typically decreased soil organic carbon (SOC) stocks by 40 to 60%. Recapturing even a small fraction of this through improved land management would significantly reduce greenhouse gas emissions.

There is currently a lot of uncertainty and debate within Australia, about the total potential of agricultural soils to store additional carbon, the rate at which soils can accumulate carbon, the permanence of this sink, and how best to monitor changes in SOC stocks. To help clarify some of these issues, the CSIRO have recently reviewed the mechanisms of carbon capture and storage in agricultural soils and analysed the evidence for SOC stock changes resulting from shifts in agricultural management.

On average, improved management of cropping land, through improved rotations, adoption of no-till or stubble retention has resulted in a relative gain of 0.2 – 0.3 Mg C ha-1 yr-1 compared to conventional management across a range of Australian soils. However, even the improved management often showed significant declines in SOC stocks, which, is most likely a direct result of the initial cultivation of the native soil. The traditional management practice often lost SOC at a greater rate and at the end of the trial there was a relative SOC gain in the improved management treatment. Therefore these improved agronomic practices may only be reducing losses in Australian soils and not actually sequestering additional atmospheric carbon. Also, sequestration rates were found to decline over time with the largest gains generally found within the first 5 to 10 years dropping to nearly 0 after 40 years.

The limited data available indicates that pasture improvements, including fertilisation, liming, irrigation and sowing of more productive varieties, generally have resulted in relative gains of 0.1 – 0.3 Mg C ha-1 yr-1. Larger gains of 0.3 – 0.6 Mg C ha-1 yr-1 have been found for conversion of cultivated land to permanent pasture.

Most of the trial data comes from a fairly narrow range of management options for the main agricultural systems of Australia and little data exists on numerous management options which hold potential to sequester large quantities of SOC. Within an existing agricultural system, the greatest theoretical potential for C sequestration will likely come from large additions of organic materials (manure, green wastes, etc…), maximizing pasture phases in mixed cropping systems and shifting from annual to perennial species in permanent pastures. Perhaps the greatest gains can be expected from more radical management shifts such as conversion from cropping to permanent pasture and retirement and restoration of degraded land. These options are summarized in the accompanying table.

Many of these management options that may increase SOC tend to also increase overall farm productivity, profitability and sustainability, and as such are being rapidly adopted in various regions of Australia. However, numerous other management shifts (for example, converting from annual crops to pastures) which may have the greatest positive impact on SOC stocks will likely need incentives, either in the form of direct government subsidies or credits from an emissions trading market, before wide-scale adoption is seen.
There is potential to store (sequester) carbon, however further research is required.

Summary of major management options for sequestering carbon in agricultural soils

Management	SOC benefit[a]	Conf.[b]	Justification
1. Shifts within an existing cropping/mixed system			
a. Maximizing efficiencies - 1) water-use 2) nutrient-use	0/+	L	Yield and efficiency increases do not necessarily translate to increased C return to soil
b. Increased productivity - 1) irrigation 2) fertilization	0/+	L	Potential trade-off between increased C return to soil and increased decomposition rates
c. Stubble management – 1) Eliminate burning/grazing	+	M	Greater C return to the soil should increase SOC stocks
d. Tillage –			1) Reduced till has shown little SOC benefit; 2) Direct drill reduces erosion and destruction of soil structure thus slowing decomposition rates; however, surface residues decompose with only minor contribution to SOC pool
1) Reduced tillage	0	M	
2) Direct drilling	0/+	M	
e. Rotation –			1) Losses continue during fallow without any new C inputs – cover crops mitigate this; 2) Pastures generally return more C to soil than crops; 3) Pasture cropping increases C return with the benefits of perennial grasses (listed below) but studies lacking
1) Eliminate fallow with cover crop	+	M	
2) Inc. proportion of pasture to crops	+/++	H	
3) Pasture cropping	++	M	
f. Organic matter and other offsite additions	++/+++	H	Direct input of C, often in a more stable form, into the soil; additional stimulation of plant productivity (see above)
2. Shifts within an existing pastoral system			
a. Increased productivity - 1) irrigation 2) fertilization	0/+	L	Potential trade-off between increased C return to soil and increased decomposition rates
b. Rotational grazing	+	L	Increased productivity, inc. root turnover and incorporation of residues by trampling but lacking field evidence
c. Shift to perennial species	++	M	Plants can utilize water throughout year, increased belowground allocation but few studies to date
3. Shift to different system			
a. Conventional to organic farming system	0/+/++	L	Likely highly variable depending on the specifics of the organic system (i.e. manuring, cover crops, etc…)
b. Cropping to pasture system	+/++	M	Generally greater C return to soil in pasture systems; will likely depend greatly upon the specifics of the switch
c. Retirement of land and restoration of degraded land	++ +++	H	Annual production, minus natural loss, is now returned to soil; active management to replant native species often results in large C gains

[a] Qualitative assessment of the SOC sequestration potential of a given management practice (0 = nil, + = low, ++ = moderate, +++ = high)
[b] Qualitative assessment of the confidence in this estimate of sequestration potential based on both theoretical and evidentiary lines (L = low, M = medium, H = high)

2. Nitrous Oxide

Nitrous oxide (N_2O)is a greenhouse gas with around 300 times the global warming potential of carbon dioxide (CO_2). A major source of N_2O emissions is the application of nitrogen fertiliser, however, limited research has been conducted around the grains industry's contribution to emissions, particularly in lower rainfall areas.

Farmers are already using nitrogen more efficiently by including legume break crops in their rotations and taking a more prescribed approach to nitrogen fertiliser applications that better match crop demand and the seasonal conditions. But how much N_20 is being emitted from soil remains unclear.

A number of demonstrations are being managed and coordinated by the Birchup Cropping Group, (BCG) across the low rainfall areas of southern Australia, including one in the Upper North that will attempt to measure N_2O emissions from soils under varying cropping regimes.

The first will compare the N_2O output when nitrogen is applied through synthetic fertiliser. The second will measure the N contribution made by a vetch legume crop that is terminated at various times in the establishment year and the corresponding effect of N_2O emissions from a non-legume crop in the subsequent season will also be measured.

If N_2O is released to the atmosphere; nitrogen has not been used by the crop, which ultimately means that input dollars have been wasted.

The main aims of this demonstration are to: increase farmer knowledge about the N_2O emissions made from fertiliser and legumes; reveal options available to reduce N_20 emissions; and to provide information about nutrient use efficiency that maximises productivity.

Additionally, growers and advisors will have a better understanding about how nitrogen application in the system can deliver the best result in terms of production per tonnes of carbon dioxide equivalents (CO_2e) emitted.

3. Methane from Livestock (R. Eckard, Primary Industries Climate Challenge Centre)

Methane makes up 68% of agricultural greenhouse gas emissions. Of this dairy cattle account for approximately 10%, beef cattle 47% and sheep 13%. Research on livestock methane production is not new, however research into reducing methane production (abatement) is new.

Animal methane production is a complex issue and research is likely to take decades to develop sustainable, practical and cost-effective solutions. The problem is the CFI wants options now and the research funding is only for 3 years.

Cost-effective abatement options are limited and the impact on production has not been fully measured. Most abatement options will only provide no more than 20% abatement and this is only from part of the system.

Livestock producers have been able to reduce emissions through improved productivity and sustainability.
• Increase growth rates, lower time to turnoff, improve perenniality and NRM outcomes
• Dual goals of adaptation to climate change and mitigation has been achieved

Incentives for producers to adopt new practices are currently low as CFI income is not sufficient to drive change alone and productivity gains must remain a focus.