Land Management Actvities to encourage farmers to increase Soil Carbon

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Abstract
To improve soil health of farming lands, the Central West Catchment Management Authority (CWCMA) is implementing a project titled "Land Management Activities for Increasing Soil Carbon". The project will engage landholders across the Central West of New South Wales to undertake specific land management activities to increase soil carbon on designated areas of their properties. These areas will be benchmarked for soil carbon levels and spatially mapped. Over time soil carbon levels will be monitored and any improvements linked to land management practices, soil type and climatic factors.
The data from this project will contribute to a platform for any future activities towards the development of a soil carbon matrix methodology to estimate soil carbon. This also has implications to providing base Australian data for potential soil carbon trading.

Introduction
To increase soil carbon farmers need to incorporate the following principles into their land management activities: -

- Increase biomass production for improved groundcover and a biological food source
- Reduce soil disturbance and compaction
- Balance soil chemistry and nutrition for optimum plant growth
- Increase pasture or crop perenniality and / or increase the rooting depth of annual plants such as crops
- Increase pasture and reserve species biodiversity and crop rotations.

These principles will improve soil carbon and the general soil health important for establishing a resilient farming system. The intent of the project is to identify and document land management activities being implemented, determine the impact of these systems on the five principles above, benchmark and monitor soil carbon levels over time. Any soil carbon improvements will be linked to specific land management activities, soil type and climatic factors. Incentive funding will be provided by the CWCMA for farmers to adopt improved farming systems on a sustained basis to increase soil carbon levels.

Figure 1. Map showing extent of Central Western NSW

Cropping Management: pasture cropping, (Warden *et al.* in press) cover cropping, no tillage, zero tillage, and control traffic activities to increase the amount **of organic**

Grazing Management: time control & rotational grazing practices, to increase the amount **of organic carbon in the soil.**

Figure 2. Examples of improved land management activities that increase soil carbon include:

Methods
The Central West CMA will target 50 farmers and graziers from each of the Tablelands, Slopes and Plains areas of the catchment who express an interest in adopting and implementing a land management activity on a designated area of their property to increase soil carbon. The process detailed below will call for expressions of interest from farmers who will be selected for an incentive payment of $3000. The rationale behind the incentive payment is based on achieving higher soil carbon sequestration rates in the wetter and cooler climates in the catchment. The $3,000 correlates to areas of land to be managed as follows:

- **Tablelands $30/ha** (recommended project area is equal to or greater than 100ha).
- **Slopes $20/ha** (recommended project area is equal to or greater than 150ha).
- **Plains $10/ha** (recommended project area is equal to or greater than 300ha).

How do they apply?
To be eligible for the incentive all farmers have to submit an Expression of Interest (EOI) form which outlines all relevant project standards to be met.
Once returned the entries will be prioritised for a farm inspection by a CMA officer.

Project Standards

1. *Project implementation time* – Landholders must be willing to keep a record of their land management activities on the designated area of land over the next 10 years.
2. *Soil Testing Requirement* – Landholders agree to GPS located soil test at the commencement of the project and again at 5 and 10 years. The soil test will benchmark the current soil carbon level and then quantify any soil carbon increases over time. McInnes Clarke and Chapman (2008).

How are projects assessed?
Expressions of interest will be assessed against the specific criteria specified below by a panel of three experts who assign a ranking based on the answers provided by the landholder. The criteria to be used are:

1. Maximum Biomass Production and Groundcover Retention (max score 20)
Aspects to be considered in these criteria are farming operations such as not burning or overgrazing stubble and pastures (Geeves *et al.* 1995, Murphy *et al.* 2003,). Burning releases greenhouse gases, exposes soil to erosion, (Packer *et al*. 1992) loss of soil moisture and depletes soil nutrients and carbon. As an example of how applications will be ranked is a cool burn just before sowing has a higher score than an early hot burn after harvest. However to gain a greater score all stubbles need to be maintained and not grazed with stock. To achieve this criteria agronomy cannot be ignored to maximise biomass production. Aspects such as those listed below should be implemented:

- Controlling weeds, pests and diseases with appropriate rotations and sprayings; and

- Optimising soil nutrients by the use of fertilisers (organic/inorganic) and legume rotations.
- Maximising soil water storage to depth for optimum plant growth (Water Use Efficiency) (Chan and Pratley 1998)

Another example would be the implementation of a time controlled grazing system as opposed to a set stocking or a slow rotational grazing system.

2. Increased Plant Rooting Depth (with perennials or healthier crops) (max score 20)
Enabling plants to root deeper in the soil will potentially build soil carbon to depth in the soil profile. Having perennial plants in a farming system has two advantages in producing more biomass for conversion to soil carbon by:

- Being able to respond quicker than annual species when moisture is available. This is particularly the case in summer and after dry periods when there is some green material for rapid photosynthetic activity when rains are received.
- The ability to store more carbon deeper in the soil as perennials are deeper rooting.

Deep soil carbon is also increased (but to a lesser extent) by increasing the rooting depth of annual crops (Jayawardane *et al* 1994) and pastures in healthy soils. This can be done by addressing surface and subsoil constraints and having adequate soil nutrition.

3. Increased Biodiversity by increasing the number of species (max score 20)
In diverse pastures and cropping rotations, diversity of plant residues in the soil leads to a more complex food chain (Drew *et al*. 2004) and better soil health for biomass production (Chan and Heenan 1993). As soil microbial communities become more diverse and complex, they become more stable and create a 'suppressive' environment for pests & weeds (Roget 2002). A greater diversity of perennial pastures increases the potential of more biomass production.

4. Reduced soil disturbance and compaction (max score 20)
This is achieved by reducing cultivation (ploughing) and stock (Packer et al 1996) and machinery compaction to a minimum when cropping, sowing pastures and grazing (Packer *et al.* 1992). Having a litter layer from stubble retention, dormant pastures and brown manures will reduce the compactive effort and soil disturbance (Packer 1998). Both of these are essential to increase soil carbon. Also compaction is reduced by adopting controlled traffic techniques when cropping and using rotational time controlled grazing techniques to retain a protective cover of pastures.

5. Balanced soil nutrition (max score 10)
Building soil carbon requires balanced soil nutrition to maximise plant growth and encourage healthy biological activity (Kirkby 2009). To ensure a balanced nutrition farmers and graziers should regularly test their soil and plant tissue and monitor crop / pasture production to identify soil nutrient deficiencies. Land management actions to address any imbalances include activities such as fertiliser application (organic/inorganic and macro and micro nutrients), legumes for soil nitrogen, lime to address acidity issues and applying ameliorants such as gypsum and lime to address surface sodic soils.

6. Reduced of Greenhouse Gas Emissions from the Farm (max score 10)
To acknowledge a total farm commitment to reducing gas emissions points are rated for the adoption and use of renewable energy sources and innovative ways of reducing emissions or storing carbon on their farms.
Property inspection prior to payment
Following an EOI cull, successful farms are visited by a CMA field officer to check standards have been met and whether the land management practices have been implemented on the proposed area. If standards have been met, the proposed area is mapped and recorded, monitoring sites established and an agreement signed once reviewed by the landholder.

Conclusion
From our practical and scientific knowledge of soils and farming systems we conclude that the 5 basic principles described in this paper must be adopted by land managers and farmers to improve soil carbon. The amount will be influenced by biomass production and maintenance, soil type and climatic factors.

The project in this paper outlines a funding incentive program to aid farmers to implement land management practices on a sustained basis to improve soil carbon. Improved soil carbon is analogous with improved soil health. Likewise improved soil health has the advantages of improved farmer resilience and profitability as well as improved environmental outcomes.

The results of this project after 12 months will be available for presentation at the congress. It will then be possible to refine model showing the potential increase of carbon in Central Western NSW predicted by (Lawrie *et al.* 2006).

An added outcome of this project is providing data to improve a proposed soil carbon matrix model to enable farmers assess their potential to improve soil carbon. (Murphy 2009). Also the project will train CMA staff in land management and soil carbon issues.

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