

# Storing Soil Carbon with Advanced Farming Practices Central West NSW Australia - A Scoping Assessment of its Potential Importance

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## Abstract

Improving and storing soil carbon is achievable in the Central West area of New South Wales Australia. This can be achieved with advanced farming practices which follow 5 basic management principles. However overriding factors in building soil carbon are:

1. The capacity of a soil to produce biomass which is determined by climate, the physical and chemical fertility of the soil, and land management practices.
2. Suitable soil conditions to encourage biological activity to convert organic matter into soil carbon.
3. Capacity of the soil to store soil carbon, as finer textured soils can store more carbon than sandier soils.

Using current knowledge on soil carbon levels and predicted soil carbon levels that are attainable it is estimated that 1110 M Mg CO<sub>2</sub> equivalents (CO<sub>2</sub>-e) (400M Mg of soil carbon) can be sequestered in the top 30 cm by 2030 in the Central West area. This is 10 times more than the estimated total greenhouse gas emissions per person in the Central West each year. The other major benefit of improved soil carbon is the improvement of soil health. Improving soil health has implications to improved soil moisture storage and retention, improved soil nutrition and more resilient plant growth for production. A critical factor in adaptation for any expected impacts of climate change. An added bonus is having resilient rural communities due to an improved socio economic environment.

## Key Words

Carbon, Soil, advanced farming practices, Transeau's ratio, central west NSW.

## Introduction

To increase soil carbon farmers there are five basic principles that need to be incorporated into existing or new farming practices:

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

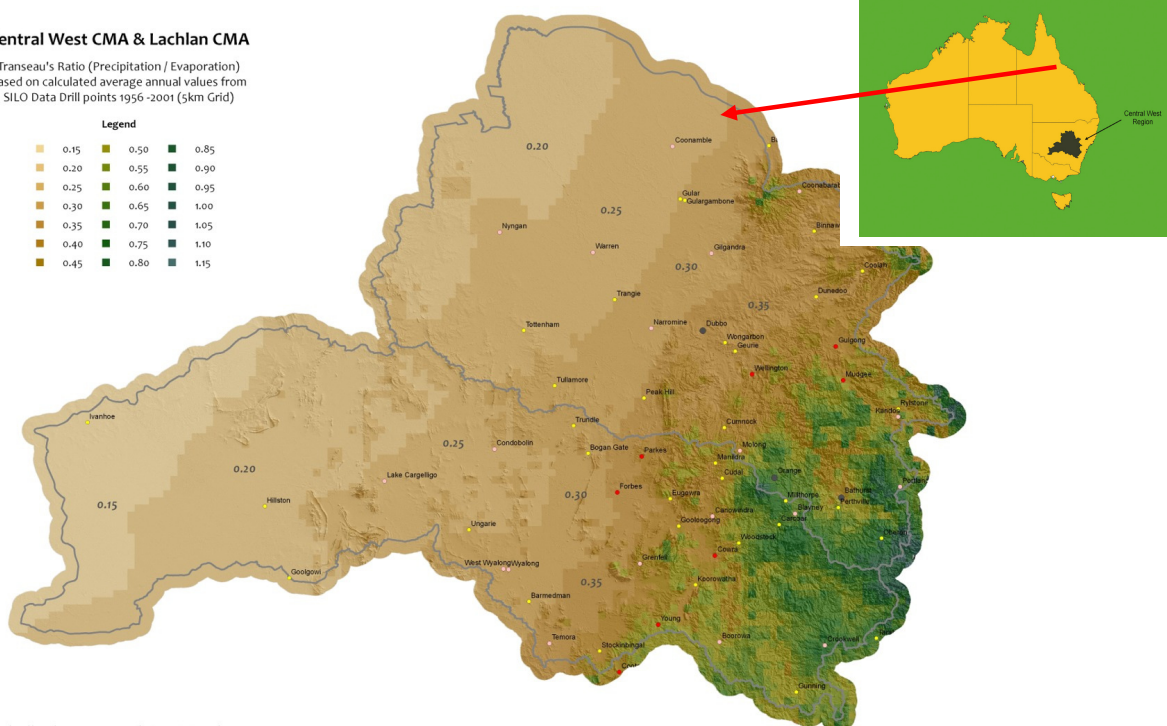
The traditional farming practices which include practices such as overgrazing, hot burning of crop residues and excessive cultivation that do not incorporate these principles and are known to deplete soil carbon. New and more advanced farming practices such as stubble retention and zero tillage, cover cropping, time controlled grazing; pasture cropping, integrated nutrient management and increased use of perennial pasture species have the potential to improve soil carbon. Their impact on the sequestration rate and final level of soil carbon will depend on the level and number of the above principles implemented, climate and soil type. Implementing these principles will improve soil carbon and general soil health which is important for soil biological activity and creating a resilient farming system. There is however a higher order of factors that needs to be considered for soil biological function (Gupta 2009). These are:

1. Moisture
2. Soil pH
3. Temperature
4. Constraints such as pesticides and soil issues.

### Central West CMA & Lachlan CMA

Transeau's Ratio (Precipitation / Evaporation)  
Based on calculated average annual values from  
SILO Data Drill points 1956 -2001 (5km Grid)

Legend		
0.15	0.50	0.85
0.20	0.55	0.90
0.25	0.60	0.95
0.30	0.65	1.00
0.35	0.70	1.05
0.40	0.75	1.10
0.45	0.80	1.15



Map produced by: John Young, DECCW, Soil Science Division 25th Sept 2009

**Figure 1. Transeu Map of Central Western NSW.**

of these moisture and temperature are the main factors to consider in the Central West. The simplest way of delineating the climatic effect is using Transeau's ratio (P/E) for the area.

To calculate the potential of soil carbon levels for 2030, estimates were first calculated for the different Transeau zones (Table 1). These estimates included the broad soil groups of heavy textured and light textured (red soils).

The zones included the following estimated percentage area:

1. Rangelands
  - 1.1. Native vegetation with a good and bad cover – 50%.
  - 1.2. Annual and perennial pasture and bare soil – 50%  
Invasive native scrub was not included in the estimations as there has not been enough data collected on these areas
2. Plains
  - 2.1. Conventional and best cropping practices – 60%
  - 2.2. Annual and perennial pasture- 30%
  - 2.3. Native vegetation- 10%  
Regrowth of native vegetation was not included in the estimations as there has not been enough data collected on these areas
3. Slopes
  - 3.1. Conventional and best cropping practices – 30%
  - 3.2. Annual and perennial pasture – 60%
  - 3.3. Native vegetation – 10%  
Regrowth of native vegetation was not included in the estimations as there has not been enough data collected on these areas
4. Tablelands
  - 4.1. Annual and perennial pasture -70%.
  - 4.2. Native vegetation - 30%  
Regrowth of native vegetation was not included in the estimations as there has not been enough data collected on these areas

**Table 1. Estimated current and maximum soil carbon storage due to improved practices for different climatic zones.**

Zone (Transeau's Ratio)	Current Practice Soil Carbon Storage – forestry, native vegetation etc  (Mg/ha/30cm)	Soil Carbon Potential with improved practices – forestry, native vegetation etc  (Mg/ha/30cm)	Current Practice Soil Carbon Storage – Pastures  (Mg/ha/30cm)	Soil Carbon Potential with improved practices – Pastures  (Mg/ha/30cm)	Current Practice Soil Carbon Storage – cropping  (Mg/ha/30cm)	Soil Carbon Potential with improved practices – cropping  (Mg/ha/30cm)
Rangelands (<0.2)	13.5	22.5	9	15	N/A	N/A
Plains (0.2-0.25)	25	60	22.5	47.5	17.5	35
Slopes (0.25-0.35)	30	90	25	67.5	21.5	48.5
Tablelands (>0.35)	50	120	37.5	70	N/A	N/A

Using Table 1 and these area estimations, it is possible to further estimate the potential storage of soil carbon if landholders implement advanced agricultural practices.

However for the purposes of this scoping study the forest estimations have not been included as it is assumed there will be little change over the 20 year period. There is however data now emerging that we can improve the management and maybe the carbon levels in our current forests and vegetated areas. If this is the case then forest management can be included for improving soil carbon storage.

Assuming that only 80 percent of farmland will implement advanced farming practices implemented, this reduces the potential extra storage to 666 M Mg of carbon. Therefore the extra carbon stored is 666 M Mg minus 363 M Mg which is approximately 303 M Mg.

To be consistent with carbon discussions this is approximately 1110 M Mg CO<sub>2</sub>-e equivalents (CO<sub>2</sub>-e) of storage possible in the 20 year period between 2010 and 2030. To place this in perspective the following argument is presented:

1. The estimated 2005 NSW greenhouse emissions are 158.25 M Mg CO<sub>2</sub>-e for a population of 9 million people.
2. Concentrating this to Central West NSW with a population of approximately 295,000 people, this represents a proportionate emission of 5.17 M Mg CO<sub>2</sub>-e or 17.5 CO<sub>2</sub>-e per head. This would be an overestimate considering the rural location.
3. Assuming emissions will be static over the next 20 years this is a total emission per head of 350 CO<sub>2</sub>-e or 1.03 M Mg for the Central West.
4. Therefore with the implementation of advanced farming practices on 80 % of farmland in the Central West of NSW would sequester 10 times more carbon into the soil than the population are emitting.

It is again stressed that this is only a scoping investigation and the actual potential most likely will be less as current land use practices do not have such low carbon values and future land management practices cannot be expected to have such high values every where. More work is required to obtain more accurate soil carbon estimates.

These values compare favourably with an estimation by Lawrie et. al (2006) that farmers capable of storing at least 6 times more carbon than they emit. The estimated values in this paper are higher but are more accurate greater due to more data available on both soil carbon storage and emissions.

**Table 2 - Potential to sequester soil carbon in the top 30 cm with advanced farming systems**

Climatic Zone	Area (M has)	Land Use	Percent land use per zone (%)	Current Practice carbon storage (Mg/ha/30 cm)	Storage for each land use (M Mg/30cm)	Total carbon storage (M Mg/30cm)	Estimated Soil Carbon storage with improved practices (Mg/ha/30cm)	Potential soil carbon storage with improved practices (M Mg/30cm)	Total Carbon storage (M Mg/30cm)
Rangelands	1.25	Pastures	50	9	5.63	5.63	15	9.38	9.38
Plains	3.78	Pastures Croppin g	60 30	22.5 17.5	25.52 39.69	65.21	47.5 35	53.87 79.38	133.25
Slopes	9.66	Pastures Croppin g	60 30	25 30	144.90 62.31	207.21	67.5 48.5	391.23 140.55	531.78
Tablelands	3.22	Pastures	70	37.5	84.53	84.53	70	157.78	157.78
					Total	362.58			832.19

### Conclusions

The authors appreciate there is a limitation of soil sequestration in that the soil carbon can only be sequestered once as a one way process. Once the capacity/saturation of the soil to store carbon is reached it cannot store any more carbon. This may be a long time for soils and the 20 years may be a conservative time frame. In the meantime the carbon dioxide emissions are a continuous process occurring every year but hopefully will significantly reduce in the next 20 years, the scope of this paper.

However the following conclusions can be made:

1. The estimations identify the potential for land management change to have a significant impact on storing soil carbon and carbon accounting. Also this soil carbon stored can make a significant contribution in the changeover period to lower emission technologies.
2. The study identifies the potential to use the 158.25 M Mg of CO<sub>2</sub> (NSW annual emissions) as a standard unit to keep things in perspective.
3. There needs to be a refocus on implementing advanced farming practices that increase soil carbon and subsequently soil health rather than just productivity. Improved soil health will in the long term impact on maintained or improved productivity and lower inputs.
4. Future research should continue to benchmark and monitor soil carbon throughout the Central West region to obtain data on the impact of soil types, climatic zones and specific land use on soil carbon for accurate estimations of carbon sequestration for landholders.

### References

- Gupta VVSR (2009) Basic principles for improving biological functions in Australian soils. Lachlan Catchment Management Authority Science Forum, Forbes, August 2009.
- Lawrie J, Murphy B, Packer I (2006) Carbon sequestration with better farming practices – Central West NSW, Australia. International Soil Tillage Research Organisation (ISTRO) 17th Triennial Conference Kiel Germany August 2006.