Soil carbon sequestration potential under perennial pastures in the mid-north coast of New South Wales

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Abstract: *A soil organic carbon survey was carried out under different land uses within a 100 km radius of Taree, New South Wales in 2007. Results highlighted the high soil organic carbon (SOC) sequestration potential of the coastal soils (>70 t C /ha to 20 cm depth) and indicated that introduced perennial pastures can potentially sequester similar amount of soil carbon as native forests. Furthermore results highlighted the importance of management practices on SOC sequestration of pastures.*

Keywords: *pasture management, carbon isotopes, soil carbon sink.*

Introduction

The Mid North Coast region of New South Wales, latitude 30° S to 32° S has an annual rainfall range of 900 mm to 1,600 mm, a subtropical climate, with summer /autumn dominant rainfall and a regular spring drought. Eucalypt forests and open woodlands covered between 85% and 90% of the region before European settlement in the late1820s. Currently, the vast majority of cleared, perennial pasture country would have been disturbed rarely in the last 40 years. This area is dominated by low quality, naturalised and medium quality, introduced subtropical perennial grasses with low management inputs, especially fertiliser.

Contrary to the wheat belt soils (Dalal and Chan 2001; Chan *et al.* 2003), even less information is available on the soil organic carbon (SOC) status under perennial pastures in this coastal region of New South Wales. A preliminary soil carbon assessment project was undertaken in 2007 (i) to compare SOC stocks for paired vegetation types of perennial pastures with adjacent native hardwood forests and (ii) to assess SOC stocks under a range of perennial pasture types within a 100 km radius of Taree, New South Wales.

Methods

Paired sites of adjacent native forests and pastures as well as pasture sites consisting of native, naturalised, introduced summer grasses and lucerne covering different management practices and fertility level were selected. All pasture sites have at least a 15 year pasture history. At each sampling site, ten random cores (19mm i.d.) to 20 cm were taken over a 20 m x 20 m area and bulked to form two composite samples. These soil samples were analysed for total organic carbon, total nitrogen, pH and Bray phosphorus. Bulk density of soil at 0-10 cm and 10-20 cm were also determined. SOC stocks to 20 cm were calculated for all sampling sites.

As the native forest species of the region predominantly comprised C_3 tree species and the tropical pastures were mostly of C_4 origin, the relative contribution of carbon originated from the two different plant communities to the present carbon pool was estimated for two paired sites using isotopic carbon techniques following Skjemstad *et al.* (1990).

Results and discussions

There was no significant difference ($P<0.05$) in SOC stock to 20 cm between paired sites of perennial pastures and native forest, with mean SOC stocks being 72.9 t/ha and 76.5 t/ha respectively. SOC stocks under perennial pastures were significantly higher than those of wheat belt and Tableland soils under lower rainfall (Chan *et al.* in preparation).

The large variation in SOC amongst different pastures highlighted the importance of

Table 1. Soil N and OC levels and properties (0-10 cm layer) and SOC stocks (0-20 cm) at two paired sites with contrasting nutrient history

Pasture Type	Soil P, mg/kg	pH	SOC%	Soil N%	C/N	Carbon† stock
1st paired site						
Kikuyu (fertilised)	37	5.2	5.2	0.53	9.81	67.2
Native grass (*Bothriochloa sp*) not fertilised	9.6	4.8	2.8	0.31	9.03	44.2
2nd paired site						
Pasture irrigated with dairy effluent	220	6.3	4.5	0.18	9.18	75.5
Pasture (adjacent but not irrigated with dairy effluent)	65	6.0	2.3	0.16	10.45	54.8

† soil carbon storage (0-20 cm) in t C/ha

improvement in soil fertility and management practices to sequester more SOC. More than 20 t C/ha of difference in SOC stocks were found between fertilised and unfertilised pastures as well as the effluent applied and the control (Table 1). Therefore, opportunities exist to increase productivity of pasture land and hence sequester more carbon.

For both pasture sites, considerable amounts of the carbon from the original vegetation (C_3 native trees) remained in the total SOC pool. However, contribution of carbon from the two pastures to the total SOC stock was quite different. The contribution from the kikuyu (*Pennisetum clandestinum*) pasture was higher than that from the setaria (*Setaria sphacelata*) pasture in both 0-10 and 10-20 cm layers (Figure 1). In fact, the 70% of the difference in SOC stocks (to 20 cm depth) between the two pastures sites could be attributed to the higher carbon originating from the kikuyu pasture. This is direct evidence of the higher effectiveness of improved pastures in increasing SOC sequestration.

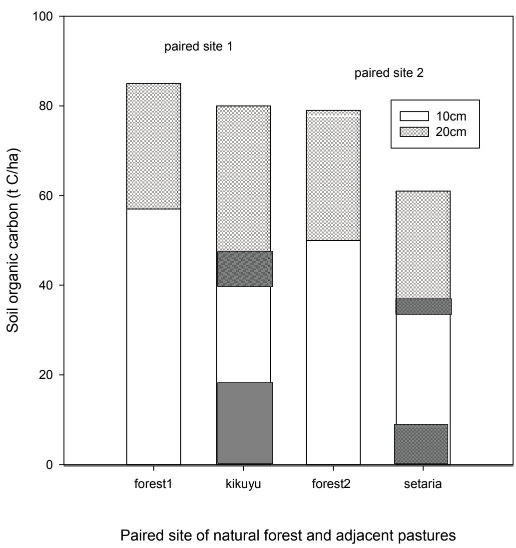

Figure 1. Contribution of SOC from Kikuyu pasture and Setaria pasture (dark grey areas) at 2 paired sites in the 0-10 cm and 10-20 cm layer.

Conclusions

Results of this pilot survey indicated that on the mid-north coast of NSW, introduced perennial pastures can potentially sequester similar amount of soil carbon as native forests. Furthermore results highlighted the importance of management practices on SOC sequestration potential under pastures. Research is needed to more clearly quantify SOC stocks under different pasture management for a range of soil types and climatic conditions in the region.

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References

Chan KY, Heenan DP, & So HB 2003, Sequestration of carbon and changes in soil quality under conservation tillage on lighter- textured soils in Australia, *Aust. J. Exp. Agric.*43, 325-334.

Chan KY, Oates A, Li GD, Conyers MK, Prangnell RJ, Poile G, Liu DL, & Barchia IM (in preparation) Soil carbon stocks under different pastures and pasture management in the higher rainfall areas of south-eastern Australia, *Aust. J. Soil Res.*

Dalal R, & Chan KY 2001, Soil organic matter in rained cropping systems of Australian cereal belt, *Aust J Soil Res*. 39, 435-464.

Skjemstad JO, Le Feuvre RP, & Prebble RE 1990, Turnover of soil organic matter under pasture as determined by 13C natural abundance, *Aust. J. Soil Re.s* 28, 267-76.