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Soil carbon content and stock in tropical pastures in a milk production system

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Introduction

In the context of global climate change, soil and its forms of use are in focus, especially with regard to agriculture and livestock production. Agricultural soils can act as a source or as a sink of greenhouse gases (GHG), depending on the management system that are submitted (IPCC, 2001). Management systems that increase the addition of vegetable wastes and retention of soil C constitute important alternatives to increase the drain capacity C-CO_2 atmospheric and GHG mitigation, contributing to the efforts to avoid global warming (Bayer et al., 2006).

The aim of this study was to evaluate the impact of pasture management on the soil C stocks, focusing on the sustainability of livestock farming in Brazil. Carbon stocks and C accumulation rates were compared in the surface (0-30 cm) and in deeper layers (30-100 cm) of soil, having a native forest as reference.

Material and Methods

The study was carried out at Embrapa Pecuária Sudeste, São Paulo state, Brazil. Soil C was evaluated in pastures under two types of management in a milk production sytem in a dystrophic Red yellow Latossol (Oxisol): EXT - extensive with low stocking rate; IIR - intensively managed and irrigated with high stocking rate. The EXT pasture was composed of two paddocks (bloks), 3.0 ha each, containing *Brachiaria spp*. and *Cynodon nlemfuensis* Vanderyst, managed as continuous grazing systems, without fertilization. Pastures in IIR system were stablished with *Panicum maximum* Jacq cv. Tanzânia and overseeded with *Avena byzantina* cv. São Carlos and *Loliun multifloram* Lan. cv. BRS Ponteio, in autumn. The IIR system consisted of two similar 1.6 ha rotational systems, divided in 27 paddocks with 600 m^2 each, intermittently grazed, with a day of occupation and 26 days of rest. The intensive managed pastures were limed and fertilized with superphosphate and potassium chloride to achieve respectively, 20 mg $P.dm^{-3}$ and 4% K in soil CTC - cation exchange capacity. Nitrogen was applied at the rate of 600 kg $ha^{-1}year^{-1}$. Cows grazing all pastures received a dietary supplement (concentrate) formulated according to the NRC (2001) in the rate of 1 kg of concentrate per 3 kg of milk produced. All grazing systems were submitted to stocking rate adjustments using the "put and take" technique (Mott and Lucas, 1952) and visual evaluation of forage availability.

Soil samples were collected in different depths: 0-5, 5-10, 10-20, 20-30, 30-40, 40-60, 60-80 and 80-100 cm; with six replicates (three replicates/block) and two cores from each field replicate. Samples from each depth interval were collected using an aluminum ring of known volume and pooled for the subsequent evaluation of dry soil weight (105 ºC). Individual soil samples were air-dried and ground in a mortar to pass a 0.150 mm sieve. Carbon concentration was analyzed using CHN equipment. Carbon stock (Mg ha^{-1}) of each sample was calculated and corrected to an equivalent mass depth (Ellert

and Bettany, 1996), using the native forest (Atlantic Forest) soil as reference. In addition, C accumulation rates in the 0-30 and 0-100 cm soil layers of each pasture were calculated. Data were analyzed by the SAS® (SAS Institute, 2002) program, using the Mixed Procedure.

Results

The type of pasture and the soil layer affected the C concentration (%) in the soils (Table 1). The concentration of soil carbon was higher in EXT, compared to IIR and the forest (FOR) which had similar concentrations. Carbon concentration was higher in the first layer (0-5 cm) of soil, decreasing as the depth increased. There was a pasture/soil layer interaction only for the depth of 0-5 cm, in which soil C concentration was higher in EXT (4.47%) than in IRR and FOR pastures (2.37 and 2.24%, respectively).

The type of grazing system did not affect the C stock variable. The soil layer influenced that variable. Carbon stock in the 0-100 cm layer was 121% higher than in the 0-30 cm layer, Sthal, et al. (2016) indicating that carbon stocks should be considered in layers as deep as 100 cm.

Table1. Soil carbon concentration (%) and stock (t ha^{-1}) in pastures under intensive and extensive managements, and in the native forest.

	Grazing System			Soil Layers (cm)								SEM	*P Level*		
Item	EXT	IIR	FOR	0-5	5-10	10- 20	20-30	30-40	40-60	60-80	80-100		Tre	Layers	TrexLayers
C (%)	1.6^{a}	1.3^{b}	1.3^{b}	3.1^{a}	1.9^{b}	1.4^{c}	1.3^{d}	1.1^{e}	1.0^{f}	0.8^{g}	0.8^{g}	0.06	0.0046	<0.0001	<0.0001
							0-30				0-100				
C (t ha^{-1})*	107.54	95.29	94.94	-	-		61.7^{b}	-	-	-	136.7^{a}	6.73	NS	<0.0001	NS

$^{a-g}$ means followed by different letters within a line are different ($p \leq 0.05$)SEM: standard error of the means; Tre: treatments; NS: non-significant ($P>0.05$); *Corrected stocks of carbon . EXT: extensive with low stocking rate; IIR: intensively managed and irrigated with high stocking rate; FOR: Atlantic Forest

Conclusions

Soil in pastures under extensive management may have higher C concentration than soils in intensively managed pastures and in tropical forests but C stocks may not differ between these areas. For pastures,

it is important to consider the C stock as deep as 100 cm, in view of the large amounts of C that may be stored in depths below 30 cm in the soil.

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