Carbon and Nitrogen Stock Distribution in Unburned Ratoon Sugarcane Chronosequence

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INTRODUCTION

Investments in sustainable energy worldwide are rapidly increasing to meet the need for low-carbon agriculture. In Brazil, the further sustainable development of renewable energy from sugarcane biomass requires a rationalized use of inputs and an improvement in nutrient cycling. These actions aim at the reduction and mitigation of environmental impacts and greenhouse gases (GHG) emission (Goldemberg, 2007).

Biogeochemistry cycles of carbon (C) and nitrogen (N) show that these elements are distributed through the atmosphere, terrestrial ecosystems and oceans. It is well known that the total amount of C stocked in the soil is a result of the balance of carbon inputs and outputs, influencing the amount stored and released from the soil (Batjes & Sombroek, 1997; Lal 2004; Cerri *et al.*, 2011).

As described, soils are fragile ecosystems influenced by the management system used in the crop production. Inadequate management of agricultural soils can lead to increase in the emission rates of GHG from the soil to the atmosphere. However, suitable crop production as no-tillage systems associated with high input of crop residues rich in C and N, can sequestrate C from the atmosphere, decrease erosion and loss of organic matter, and provide a positive balance of these elements in the soil (Cerri *et al.*, 2010).

Although agricultural management in sugarcane production is essential for reducing GHG emissions, improving C and N stocks and the resilience of the system, the recovery potential also depends on the soil characteristics (Cerri *et al.*, 2011). An estimation system that can account for more of the local variability in soil responses to a particular management practice will increase the economic efficiency of the mitigation policy, and provide a better estimate of the actual mitigation benefits achieved. Therefore, quantifying changes in C and N stocks over time in different sugarcane production scenarios are essential to understand these elements of the cycle.

This study aims to determine the C and N stocks in unburned sugarcane cultivated in two soils down to 1 m (vertical dimension), in a chronosequence of 8 and 12 years after sugarcane renovation (temporal dimension), with the same variety of sugarcane and under similar conditions of topography and climate.

METHODS

This studied was conducted in commercial sugarcane areas located in the north of São Paulo state, producing sugar and ethanol in a raw sugarcane harvesting system. Two trials were conducted in different Oxisols. The two chronosequences evaluated were classified as production environment B and C both cultivated with the sugarcane variety RB855453. Chronosequence strategies are used to evaluate the temporal dynamics of C and N in a sequence of soil in homogeny and similar areas, with equivalent soil conditions, climate, and topography. In this study, six unburned sugarcane areas corresponding to different periods of harvesting were evaluated.

Soil samples were collected in the four walls of each trench, and at until 100 cm. Stocks were calculated for each layer and compared within the chronosequence of each ratoon sequence of the experimental areas included in the project (Ellert & Bettany, 1995).

RESULTS AND DISCUSSION

The soil chronosequence approach was adopted in order to enable this study, without the necessity of having to wait extended periods of time until changes in soil C and N occurs. An analysis of the potential effects of vegetation change on the temporal and vertical dynamics of C and N, in a sugarcane chronosequence for production environments A and B, are presented in Fig. 1 and 2. For production environment C, Fig. 1, comparison of the C and N concentrations show a gradual increase of these elements' concentration over the course of time. This indicates that the sugarcane residues left on the soil surface during harvesting improved organic matter content, as the degradation of the mulch provided an increase of C and N concentrations over time, especially in the first layers. The chronosequence of production environment B, however, did not follow the tendency of the production environment C, as the highest concentration in first layers of the area over 5 years indicates that the soil has different characteristics. Additionally, the experiments were conducted in commercial areas and some inputs were not fully controlled.

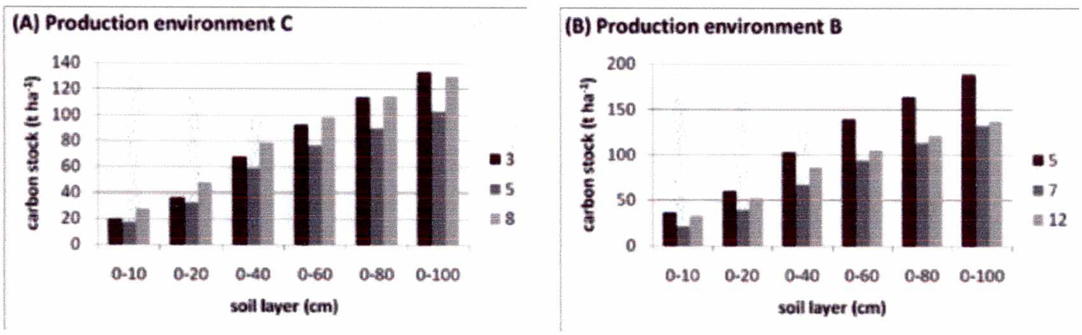

Fig. 1. Accumulated soil C stock (t ha-1) in production environment C (A) and B (B).

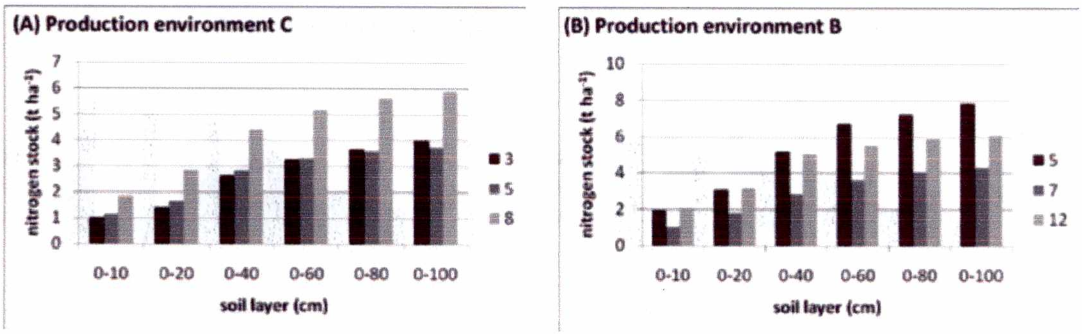

Fig. 2. Accumulated soil N stock (t ha-1) in production environment C (A) and B (B).

CONCLUSIONS

Areas that use sugarcane management without burning cane straw accumulate carbon and nitrogen over time. The use of sugarcane residues can lead to an increased concentration of C and N stored in the soil. This study shows the potential of carbon sequestration of plantations over time.

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