Soil and Water Science
Research Brief

Shifts in Stable Carbon Isotopic Signatures in Soil Fractions following Tree Integration into Pastures

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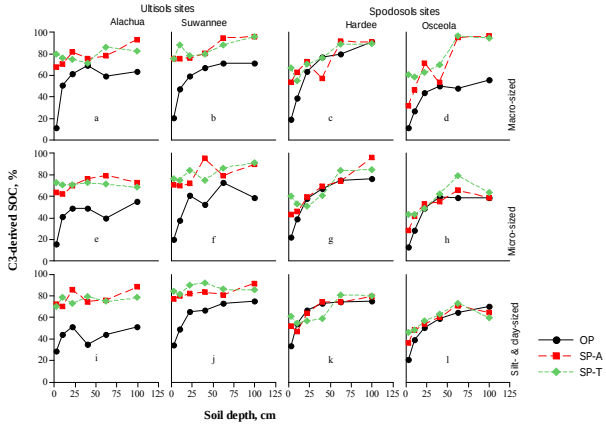
Soil organic matter (SOM) is extremely vulnerable to land-use change, as well as to intensification of agricultural practices. The functional consequences of integration of trees into grass-dominated vegetation include changes of above- and below-ground productivity, modifications to rooting depth and distribution, and changes in the quantity and quality of litter inputs to the soils. These changes in vegetation, litter, and soil characteristics modify SOM dynamics and storage, which in turn may lead to alterations of local and regional climate systems.

In this study, we combine physical soil fractionation and the ^{13}C natural abundance technique to investigate the shifts in soil C following the alteration in vegetation structure due to the integration of trees into open pasture by comparing with an adjacent open pasture with similar background conditions. When one type of vegetation is replaced with another, $\delta^{13}C$ values could be used to identify SOM derived from residues in the native vegetation and the new vegetation, for example, where C_4 plant (with $\delta^{13}C$ values be reported as −19 to −9‰) grows on soil derived from a C_3 plant ($\delta^{13}C$ of − 35 to − 20‰). Soil samples were collected from silvopastures of slash pine (*Pinus elliottii*) + bahiagrass (*Paspalum notatum*), and adjacent open pasture (OP), at six depths down to 125 cm, at four sites representing two major soil orders (Spodosols [Hardee and Osceola sites] and Ultisols [Alachua and Suwannee sites]) of Florida. At the silvopastures, soils were sampled both near the tree (SP-T) and in the middle of the alley (SP-A).

The open pastures on Suwannee, Osceola, Hardee and Alachua farms, were 40, 22, 48, and 55 years old, respectively, since pasture establishment. Florida Flatwoods was the land use prior to the pasture establishment in all the sites except the Alachua site where the land was under agriculture (corn, *Zea mays*). The respective ages of silvopastures since establishment at the four sites were: Suwannee (40 yr), Osceola (14 yr), Hardee (12 yr), and Alachua (8 yr). The plant sources of C in the whole-soil (non-fractionated) and the three soil fraction-sizes, (250 – 2000, 53 – 250 and <53 µm) obtained using a wet-sieving process, were traced using stable C isotope signatures.

The C3-derived soil organic carbon (SOC) in silvopasture in the whole soil (non-fractionated) was double at the surface and was generally higher at the other depths as compared to that in OP sites, particularly at the Ultisol sites. Slash pine trees (C3 plants) seemed to have contributed more C in the silt- + clay- sized (<53 µm; the most stable C fraction) fractions than bahiagrass (C4 plants), particularly deeper in the soil profile. Spodosols sites contained more C in the <53µm fraction at and below the spodic horizon (40 – 50 cm deep) in silvopasture compared to OP.



Changes in percent of C3-derived soil organic carbon (SOC) in macro-sized (250 − 2000 µm; a, b, c, & d), micro-sized (53 − 250 µm; e, f, g, & h), and silt + clay (<53 µm; i, j, k, & l) fractions with mid-points of sampled depths at three pasture locations (silvopasture center of the alley [SP-A] and in-between tree rows [SP-T] and open pasture [OP]) for soils of the Alachua (a, e, & i), Suwannee (b, f, & j), Hardee (c, g, & k), and Osceola (d, h, & l) sites in Florida.

The study showed an increase in total C3-drived SOC pools following tree integration into pasture. Compared to C4-derived SOC, a substantial proportion of C3-derived SOC was C found associated with silt + clay and in the micro-sized fraction. However, the macro-sized fraction had the largest accumulation of C3-derived SOC of all the fractions. The C3 plant had consistently contributed higher proportion of SOC to the silt + clay fraction (<53 µm) than C4 plants, particularly in the greater depths, in all sites, irrespective of the age of the land-use.

Soil type appears to be a major factor in SOC content, with the accumulation being greater in Ultisols and at the Bh horizon of Spodosols where the clay content is greater. In addition, prior land-use history of the sites could have substantial effect on the current status of C storage in soil. In the long term, however, results suggest that tree-based agricultural systems may help sequester more SOC.

For information on total soil carbon storage at these sites, see SWS 09-01. Additional information can be obtained from:

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