# Soil aggregation and recalcitrant carbon pools in silvopasture systems in Florida

**J.M. Showalter, V.D. Nair and P.K. Ramachandran Nair**

UF UNIVERSITY of FLORIDA IFAS Soil and Water Science

## Introduction

- The focus on carbon (C) sequestration in soils has led to an increased interest in agroforestry systems based on their perceived ability to enhance the process.
- The extent and mechanisms of C incorporation into recalcitrant soil pools in these systems are, however, not adequately understood.
- Separating the organic matter in the soil into aggregate organic matter (AOM) that holds the majority of recalcitrant C and free particulate organic matter (POM) that breaks down more quickly can give a better indication of long term C storage in the soil.
- This study compared soil C pools and aggregation in silvopasture and adjacent open pasture fields on Spodosols in Florida.

## Hypothesis

- Systems that include woody perennials will have higher % AOM while systems without will have lower % AOM.
- AOM will be higher deeper in the soil profile than POM.

## Objectives

- To compare C in AOM and POM in soils on silvopasture near trees and in alleys and on open pasture.

## Methods

### Site description

- Soil samples were taken from a silvopasture of slash pine (*Pinus elliottii* Engelm.) and bahiagrass (*Paspalum notatum*) and adjacent bahiagrass pasture occurring on Spodosols at the Ona research station in south central Florida (Figure 1).

### Sampling

- 3 composite subsamples were taken at 6 depths (0-5, 5-15, 15-30, 30-50, 50-75, and 75-125 cm) on silvopasture near the tree and in the alley, and on open pasture (Figure 1).

### Lab analyses

- Samples were fractionated into macroaggregates (>250µm), microaggregates (250-53µm) and silt+clay (<53µm) sized fractions using a procedure adapted from Elliot (1986).
- Macroaggregates were sonicated with a dispersion energy 92.2J mL$^{-1}$ (Figure 2) and the POM and AOM separated and analyzed for total carbon (Figure 3).

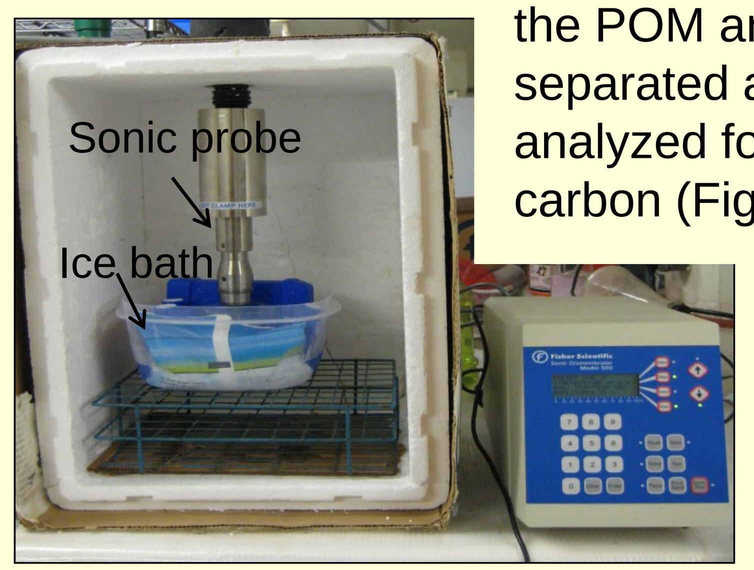


**Figure 2**: Sonicator setup

- Sonication was carried out to separate the particulate organic matter (POM) from the aggregate organic matter (AOM). Upon sonication, the macroaggregates break up and AOM passes through the sieve while the POM does not break up (Figure 3).

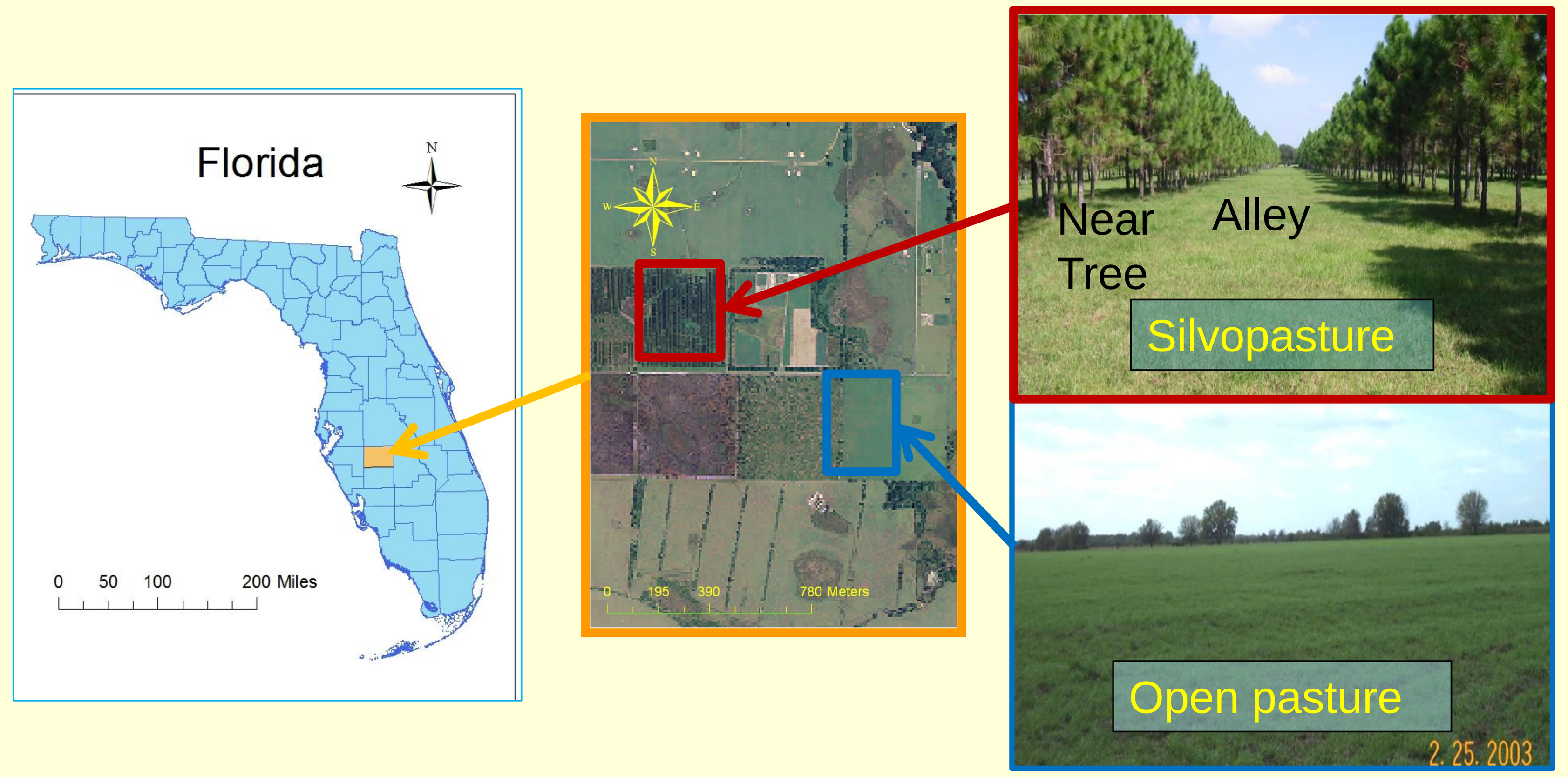


**Figure 1**: Location of the silvopasture and open pasture on Spodosols in Ona, FL.

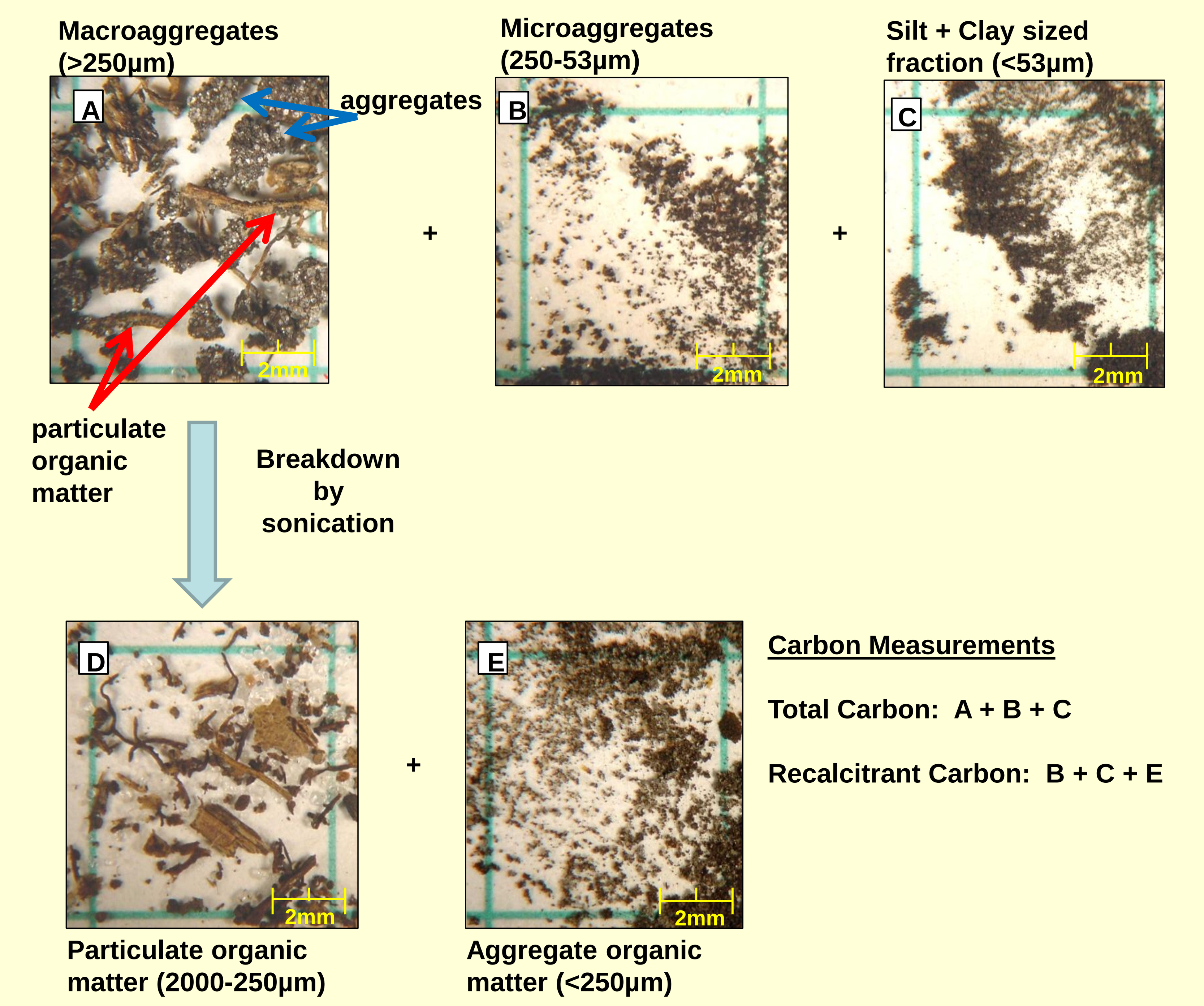


**Figure 3**: AOM and POM of soils before and after sonication.

## Results and Discussion

- POM was much higher in the surface horizon (>40%), but maintained a low constant fraction of around 15% throughout the rest of the soil profile (Table 1).
- Silvopasture soils near trees had significantly higher AOM in the surface horizons than open pasture (Table 2).
- Decrease in AOM with depth was more gradual in silvopasture soils than open pasture (Figure 4).

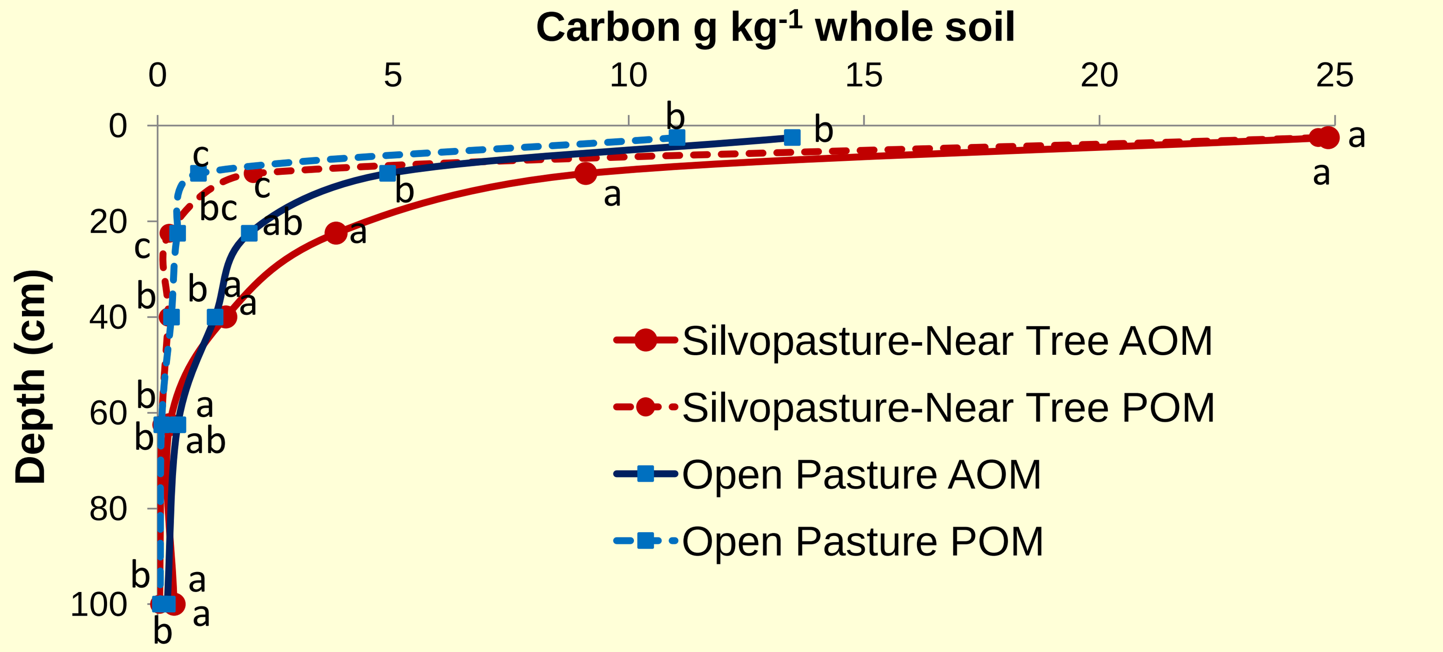


**Figure 4**: AOM and POM C concentrations (g kg$^{-1}$ soil) by depth on silvopasture near the tree, and open pasture. Statistics were carried out separately for each depth. Different letters signify significantly different means based on Tukey's HSD.

**Table 1**: %AOM within the macroaggregates for each depth across management practices.

| Depth (cm) | % AOM |
|---|---|
| 0-5 | 58.60b† |
| 5-15 | 86.47a |
| 15-30 | 88.76a |
| 30-50 | 83.03a |
| 50-75 | 80.33a |
| 75-125 | 83.11a |

†Different letters signify significantly different means of %AOM across depths based on Tukey's HSD.

**Table 2**: AOM Carbon (g 100g$^{-1}$ whole soil) for each management practice and depth.

| Depth (cm) | Management: Silvopasture-Tree | Silvopasture-Alley | Open Pasture |
|---|---|---|---|
| 0-5 | 2.501a† | 1.475ab | 1.338b |
| 5-15 | 0.907a | 0.424b | 0.488b |
| 15-30 | 0.377a | 0.206a | 0.202a |
| 30-50 | 0.134a | 0.062a | 0.120a |
| 50-75 | 0.024a | 0.033a | 0.043a |
| 75-125 | 0.032a | 0.022a | 0.022a |

†Statistics were carried out separately for each depth. Different letters signify significantly different means based on Tukey's HSD.

## Conclusions

- Soils near trees in this silvopasture had higher concentrations of recalcitrant C (AOM) than in open pasture.
- The higher fraction of POM in the surface horizon suggests that estimates of C sequestration relying on surface measurements of total C are skewed by this less recalcitrant form of C.
- Separating AOM from POM using sonication can give a better estimate of recalcitrant C in soils for different management practices.

## Acknowledgments

We would like to thank Willie Harris for ideas and help with the dissecting microscope and Solomon Haile for soil sampling for this project.

## References

Elliott, E.T. 1986. Aggregate structure and carbon, nitrogen and phosphorus in native and cultivated soils. *Soil Sci. Soc. Am. J.* 50:627–633.
Haile, S.G., V.D. Nair, and P.K.R. Nair. 2010. Contribution of trees to carbon storage in soils of silvopastoral systems in Florida. *Global Change Biol.* 16:427–438.
Haile, S.G., P.K.R. Nair, and V.D. Nair. 2008. Carbon storage of different soil sized-fraction in Florida silvopastoral systems. *J. Environ. Qual.* 37:1789–1797.