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## Integrated Crop-Livestock-Forest Systems: Soil Carbon Sequestration and Organic Matter stabilization as detected by laser-based spectroscopies

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The Integrated Crop-Livestock-Forest Systems (CLF) have been able to capture and store the carbon (C) in the form of Soil Organic Matter (SOM), in different regions in Brazil, thereby contributing to mitigate agricultural greenhouse gases emission. This is an eligible practice in Low Carbon Emission Agriculture Plan in Brazil, and currently has around 15 million hectares under use, a very positive and important trend in soil land use in Brazil. SOM is considered a relevant indicator of soil quality due to its direct relationship with biological, chemical, and physical properties, allowing it to evaluate the impacts of agricultural management. Laser-based spectroscopies as Laser-Induced Fluorescence Spectroscopy (LIFS) and Laser-Induced Breakdown Spectroscopy (LIBS) have become promising tools in the evaluation of the SOM in agricultural soils. LIBS can measure soil C, and LIFS can infer about the chemical structure of SOM, mainly aromaticity. The standard protocol for measuring soil C changes involves soil sampling at the field and chemical sample preparation for laboratory analysis. Although this procedure produces precise results, it takes time, generates chemical residues, and the costs restrict its routine for large scale use in agricultural projects. Thus, there is a need to develop clean (green chemistry), rapid, precise, and cost-efficient methods for measuring soil C changes in the field. Also, information about the chemical structure of SOM usually is done through spectroscopic techniques, such as <sup>13</sup>C NMR, EPR, and fluorescence of humic acid, which are not applied for large scale measurement and mapping. LIFS can be applied in whole soil and can be used to evaluate the aromaticity of SOM, and consequently, its chemical stability. The objectives of this study were to evaluate the soil C stock and SOM Stability of some Brazilian soils under different integrated systems, such as, Crop-Livestock-Forest (CLF), Crop-Livestock (CL) and Livestock-Forest (LF). The results showed the combination of soil carbon accumulation, and an increase of SOM aromaticity for CLF, which can be promising for sustainable intensification in agriculture.

**Keywords:** Sustainable Intensification; Soil Organic Matter; Carbon stock; Laser-Induced Fluorescence Spectroscopy; Integrated Crop-Livestock-Forest Systems