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Increased soil organic carbon stocks under agroforestry: A survey of six different sites in France

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Introduction: Agroforestry systems are land use management systems in which trees are grown in combination with crops or pasture in the same field. In silvoarable systems, trees are intercropped with arable crops, and in silvopastoral systems trees are combined with pasture for livestock. These systems may produce forage and timber as well as providing ecosystem services such as climate change mitigation. Carbon (C) is stored in the aboveground and belowground biomass of the trees, and the transfer of organic matter from the trees to the soil can increase soil organic carbon (SOC) stocks. Few studies have assessed the impact of agroforestry systems on carbon storage in soils in temperate climates, as most have been undertaken in tropical regions.

Methods: This study assessed five silvoarable systems and one silvopastoral system in France. All sites had an agroforestry system with an adjacent, purely agricultural control plot. The land use management in the inter-rows in the agroforestry systems and in the control plots were identical. The age of the study sites ranged from 6 to 41 years after tree planting. Depending on the type of soil, the sampling depth ranged from 20 to 100 cm and SOC stocks were assessed using equivalent soil masses. The aboveground biomass of the trees was also measured at all sites.

Results: In the silvoarable systems, the mean organic carbon stock accumulation rate in the soil was 0.24 (0.09–0.46) Mg C ha⁻¹ yr⁻¹ at a depth of 30 cm and 0.65 (0.004–1.85) Mg C ha⁻¹ yr⁻¹ in the tree biomass. Increased SOC stocks were also found in deeper soil layers at two silvoarable sites. Young plantations stored additional SOC but mainly in the soil under the rows of trees, possibly as a result of the herbaceous vegetation growing in the rows. At the silvopastoral site, the SOC stock was significantly greater at a depth of 30–50 cm than in the control. Overall, this study showed the potential of agroforestry systems to store C in both soil and biomass in temperate regions.