Agroforestry and carbon sequestration

Reference 3

De Stefano, A; Jacobson, MG. 2018 Soil carbon sequestration in agroforestry systems: a meta-analysis. Agroforestry Systems, 92, 285-299. doi: 10.1007/s10457-017-0147-9

Background and objective

Within human driven land use change, agricultural and forestry practices have the potential to mitigate CO2 concentration through C sequestration, allowing the land acts as a sink for C. Soil plays an important role in C sequestration, being able to store 1.5–3 times more C than in vegetation. The adoption of specific land management practices, such as the implementation of trees and permanent vegetation, could significantly boost their C sequestration potential. The main objective of this paper was to investigate the effects of agroforestry on soil organic carbon (SOC) stocks by summarizing the data from literature using meta-analytical techniques.

Search strategy and selection criteria

A literature survey of peer-reviewed publications was carried out using ISI-Web of Science, CAB Direct, and Google Scholar (Google Inc., Mountain View, CA, USA). The first step was the identification of the potential studies to be included in the analysis through the examination of the abstract, using agroforestry, C sequestration, soil C sequestration, soil C stock, soil C pool, and their combination their combination, as keywords for the search. To be included, studies had to contain information about soil C concentration or stocks per unit land area (i.e. Mg of C/ha or in other appropriate equivalent), for both non-agroforestry and agroforestry land uses.

Data and analysis

The effect of agroforestry on SOC stock was quantified by calculating the natural log of the response ratio using MetaWin 2.0. A randomeffects model was used for analysis of all data sets, based on the assumption that random variation in SOC stocks occurred between observations. Mean effect size for each observation was calculated with 95% confidence intervals (CIs) generated by a bootstrapping procedures. To facilitate the interpretation of effect size, it was transformed as percentage change.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
52	Different land use systems.	Agrisilviculture, Silvopasture, Agrosilvopasture.	Two datasets were studied, including: 1) Full dataset: Agriculture, pasture/grassland, forest, forest plantation, uncultivated/other land uses; 2) Reduced dataset: Agriculture, pasture/grassland, forest plantation	Logarithm of ratio of SOC stocks (at 0-15, 0-30, 0-60, 0-100, and 0> 100 cm) in agroforestry systems to SOC stocks in non-agroforestry land uses (or before transition to agroforestry), or reverse.	75%

Results

- Full dataset (with forest and uncultivated/other land-uses included): agroforestry revealed a significant and positive effect on SOC stocks at 0–30 and 0–100 cm depths. Reduced dataset (including only agriculture, pasture/grassland, forest plantation): the significant positive effect of agroforestry was observed at all depths, except for 0 ≥ 100 cm.
- The conversion of agricultural land to agroforestry significantly increased SOC stocks at 0–15, 0–30, 0–100, but not at 0–60 and > 100 cm.
- Among agroforestry systems, positive significant increases of SOC stocks were observed in the change from agriculture to agrisilviculture (0–15, 0–30, 0–100 cm), agriculture to agrosilvopastoral systems (0–60, 0–100 cm), and agriculture to silvopasture (0–100 cm).
- No significant differences were observed in the conversion from pasture/grassland to agroforestry (0–15, 0–30, 0–100, 0 ≥ 100 cm), while a significant increase was observed at 0–60 cm. SOC stocks were found significantly reduced when pasture/grassland were converted into agrisilvicultural systems (0–100 cm), probably due to the lack of perennial grasses.
- Land-use conversion from forest to agroforestry decreased the SOC stocks at 0–15 and 0–30 cm depths, while no significant effect was detected at the other investigated depths.

Factors influencing effect sizes

Perennial species, agroforestry type, site, climate, soil type, soil depth, previous land use can affect the results.

Conclusion

The conversion from forest to agroforestry leads to losses in SOC stocks in the top layers, while no significant differences were detected when deeper layers were included. On the other hand, the conversion from agriculture to agroforestry increased SOC stocks in most of the cases. Significant increases were also observed in the transition from pasture/grassland to agroforestry in the top layers, especially with the inclusion perennial in the systems, such as in silvopasture and agrosilvopastoral systems.