FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: CARBON SEQUESTRATION

Reference 16

Bai, XX; Huang, YW; Ren, W; Coyne, M; Jacinthe, PA; Tao, B; Hui, DF; Yang, J; Matocha, C 2019 Responses of soil carbon sequestration to climate-smart agriculture practices: A meta-analysis Global Change Biology, 25, 2591-2606 10.1111/gcb.14658

Background and objective

Climate-smart agriculture (CSA) management practices (e.g., conservation tillage, cover crops, and biochar applications) have been widely adopted to enhance soil organic carbon (SOC) sequestration and to reduce greenhouse gas emissions while ensuring crop productivity. However, current measurements regarding the influences of CSA management practices on SOC sequestration diverge widely, making it difficult to derive conclusions about individual and combined CSA management effects and bringing large uncertainties in quantifying the potential of the agricultural sector to mitigate climate change. Simultaneously examine the effects of three widely used CSA management practices (i.e., conservation tillage [no-till, NT; and reduced tillage, RT], cover crops, and biochar) on SOC sequestration. Scientific objectives were to: (a) evaluate and compare the effects of conservation tillage, cover crops, and biochar use on SOC; (b) examine how environmental factors (e.g., soil properties and climate) and other agronomic practices (e.g., nitrogen fertilization, residue management, irrigation, and crop rotation) influence SOC in these CSA management environments. Here, we report only results regarding biochar amendment.

Search strategy and selection criteria

The search keywords were "soil organic carbon" and "tillage" for conservation tillage treatments; "soil organic carbon" and "cover crop" for cover crop treatments; and "soil organic carbon" and "biochar" for biochar treatments. 1) SOC was measured in field experiments (to estimate the potential of biochar to increase soil carbon, we also included soil incubation and pot experiments with regard to biochar use); 2) observations were conducted on croplands excluding orchards and pastures; 3) ancillary information was provided, such as experiment duration, replication, and sampling depth; and 4) other agronomic management practices were included besides the three target management practices in this study.

Data and analysis

A random-effect model of meta-analysis was used to explore environmental and management variables that might explain the response of SOC to CSA management practices. The data analysis was performed in R (R Development Core Team, 2009).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
64	Croplands excluding orchards and pastures	Cover crops	no cover crop (fallow) . all other aspects of management held constant like in the intervention.	Metric: Soil organic carbon stock; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.75

Results

- Cover crops enhanced SOC storage by 6%
- NULL
- NULL
- NULL
- NULL

Factors influencing effect sizes

- Climatic conditions : Cover crops increased SOC by 15% in warm areas, three times larger than that in cool areas
- Soil depth : Cover crops significantly increased SOC by 9%, 3%, and 9% in the 0–10 cm, 10–20 cm, and 20–50 cm depth ranges, respectively, but not in the 50-100 cm depth range. Further analysis showed that cover crops could increase SOC (5%) in the entire 0–70 cm soil profile.
- Soil pH : Cover crops increased SOC by 15% in neutral soils, followed by alkaline (9%) and acid soils (6%).
- Time scale : Cover crops significantly increased SOC by 5%, 11%, and 20% in the short-term, medium-term, and long-term experiments, respectively
- Crop residue retention : When crop residues were returned, cover crops significantly increased SOC by 6%. However, if crop residues were removed, cover crops had no significant effect on SOC.

Conclusion

On average, cover crops represented an effective approach for significantly increasing SOC content (6%).