FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: CARBON SEQUESTRATION

Reference 11

Jian, Jinshi; Du, Xuan; Reiter, Mark S.; Stewart, Ryan D. 2020 A meta-analysis of global cropland soil carbon changes due to cover cropping Soil Biol. Biochem. 143, 107735 10.1016/j.soilbio.2020.107735

Background and objective

Including cover crops within agricultural rotations may increase soil organic carbon (SOC). However, contradictory findings generated by on-site experiments make it necessary to perform a comprehensive assessment of interactions between cover crops, environmental and management factors, and changes in SOC. 1) quantify CC usage effects on SOC concentrations; 2) evaluate how climate type, CC species, and cash crop rotation affected SOC dynamics using meta-analysis; 3) identify possible mechanisms for SOC changes via correlation with other soil/agronomic variables; and 4) estimate carbon sequestration potential as CCs become applied to various extents within cropland across the globe.

Search strategy and selection criteria

To gather data for analysis, we collected publications from three sources: (1) the "Research Landscape Tool" that compiled soil health-related publications and research projects into a searchable database (http://www.soilhealthinstituteresearch.org/); (2) cited papers from previous meta-analyses and review papers, specifically Poeplau and Don (2015), Alvarez et al. (2017), Sileshi (2009), and Gattinger et al. (2012); and (3) scholarship-focused search engines, including ISI Web of Science, Google Scholar, and the China National Knowledge Infrastructure (CNKI). We accessed the Research Landscape Tool (http://www.soilhealthinstituteresearch.org/Home/Search/Cover-Crop) on April 25, 2018, and found all peer-reviewed journal articles listed there under "cover crops". For search engines, we used the keywords "soil health" or "soil quality" and "cover crop" or "green manure" or "organic farm" to find relevant publications. (1) experiments were conducted in the field or at a research station; (2) the publications reported comparisons between controls (e.g., NC control plots; baseline SOC) and treatments (i.e., with CCs); (3) the publications were either peer-reviewed journal articles, conference collections, theses, or dissertations; and (4) the publications were written in English or Chinese.

Data and analysis

Simple linear regression was used to analyze the relationship between RRSOC and RRx (other variables) for the 32 different soil/agronomic variables recorded from the studies. Simple linear regression was also applied to explore the relationship between RRSOC and many other environmental conditions. All statistics were conducted using R (version 3.5.1, R Core Team, 2014). The meta-analysis was applied using 'metafor' package, and the simple linear regressions were applied under R using the linear model (lm) function. We used 'ggmap' to generate site spatial distribution.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
131	Arable fields cultivated with corn, soybean, wheat, other monoculture, corn-soybean rotation, corn-wheat-soybean rotation, and other rotations of more than two cash crops	Cover crops	No cover crop	Metric: Soil organic carbon stocks to a depth of 0.3 m; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	75

Results

- When cover crops were included in rotations, SOC increased by an average of 15.5% across all experiments. Including only those experiments that reported SD in the original publication showed a 30% increase in SOC under cover crops.
- Legume cover crops, mixtures of two legumes, and mixtures of more than two other cover crops showed significant increases in SOC relative to controls, while grass cover crops or grass-legume mixtures did not show significant changes.
- The areal extent of global cropland was constrained from six different studies as A = 1960 ± 680 Mha. Using the overall mean C-rate value of 0.56 Mg ha−1 yr−1, average global Csequestration values ranged from 0.09 ± 0.03 Pg yr−1 (for f = 0.08, which represented the current proportion of acreage managed using CCs in the United States) to 0.16 ± 0.06 Pg yr−1 (for f = 0.15) to 1.1 ± 0.4 Pg yr−1 (for f = 1.0, which represented all cropland being managed using CCs). Carbon sequestration values thus represented 0.5% on the low end to 16% on the high end of current fossil fuel emissions.
- NULL
- NULL

Factors influencing effect sizes

- Soil texture : Soil carbon stocks were significantly greater in CC treatments versus NC controls for all soil texture groups, but fine-textured soils showed larger increases than medium- and coarse-textured soils.
- Cash crop : Corn, wheat, and vegetables all showed significant carbon increases while soybeans, corn-soybean rotations, and corn-wheat-soybean rotations did not. Other rotations of two or more crops (i.e., those that did not include corn and soybeans) also showed significant SOC increases when using CCs.
- Soil depth : When separated into different soil sampling depths, surface soils showed significant carbon increases when CCs were used, whereas subsurface soils did not.

Conclusion

Cover cropping caused a 15.5% increase in SOC (95% confidence interval of 13.8%–17.3%) in near-surface soils (i.e., ≤30 cm depth).