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How does tillage intensity affect soil organic carbon? A systematic review

Neal Robert Haddaway (1), Katarina Hedlund (2), Louise E Jackson (3), Thomas Kätterer (4), Emanuele Lugato (5), Ingrid Thomsen (6), Helene Bracht Jørgensen (2), and Per-Erik Isberg (7)

(1) Mistra Council for Evidence-Based Environmental Management (EviEM), Stockholm Environment Institute, Box 24218, 10451 Stockholm, Sweden. [neal.haddaway@eviem.se, neal_haddaway@hotmail.com, (2) Department of Biology, Lund University, SE-223 62 Lund, Sweden. [katarina.hedlund@biol.lu.se; helene.bracht_jorgensen@biol.lu.se], (3) Department of Land, Air and Water Resources, University of California Davis, One Shields Avenue, Davis, CA 95616, USA. [lejackson@ucdavis.edu], (4) Department of Ecology, SLU, P.O. Box 7044, 750 07 Uppsala, Sweden. [thomas.katterer@slu.se], (5) European Commission, Joint Research Centre (JRC), Directorate for Sustainable Resources, Land Resources Unit, Via E. Fermi, 2749, I-21027, Ispra (VA), Italy [emanuele.lugato@jrc.ec.europa.eu], (6) Department of Agroecology, Aarhus, University, P.O. Box 50, DK-8830 Tjele, Denmark. [Ingrid.Thomsen@agrsci.dk], (7) Department of Statistics, Lund University, SE-220 07 Lund, Sweden. [per-erik.isberg@stat.lu.se]

Background:
The loss of carbon (C) from agricultural soils has been, in part, attributed to tillage, a common agricultural practice that provides a number of benefits to farmers. The promotion of less intensive tillage practices and no tillage (NT) aims to mitigate negative impacts on soil quality and to preserve soil organic carbon (SOC). Several reviews and meta-analyses have shown both beneficial and null effects on SOC due to no tillage relative to conventional tillage, hence there is a need for a comprehensive systematic review of the topic.
Methods:
We systematically review relevant research in warm temperate and boreal regions using, as a basis, evidence identified within a recently completed systematic map on the impacts of farming on SOC. We performed an update of the original systematic map searches to include studies published since the map search. We screened all evidence for relevance according to predetermined inclusion criteria. Studies were coded and subject to meta-data extraction. Quantitative study findings were then extracted and meta-analyses performed to investigate the impact of reducing tillage (from high (HT) to intermediate intensity (IT), HT to NT, and from IT to NT) for SOC concentration and SOC stock in the upper soil and at lower depths.
Results:
A total of 351 studies were included in the systematic review: some 18% coming from an update of research published in the 2 years following searches performed for the systematic map. SOC concentration was found to be significantly higher in NT relative to both IT (1.18 g/kg $\pm$ 0.34 (SE)) and HT (2.09 g/kg $\pm$ 0.34 (SE)) in the upper soil layer (0-15 cm). IT was also found to be significant higher (1.30 g/kg $\pm$ 0.22 (SE)) in SOC concentration than HT for the upper soil layer (0-15 cm). At lower depths, only IT SOC compared with HT at 15-30 cm showed a significant difference; being 0.89 g/kg ($\pm$ 0.20 (SE)) lower in intermediate intensity tillage. For stock data NT had significantly higher SOC stocks down to 30 cm than either HT (4.61 Mg/ha $\pm$1.95 (SE)) or IT (3.85 Mg/ha $\pm$1.64 (SE)). No other comparisons were significant.
Conclusion:
The transition of tilled croplands to NT and conservation tillage has been credited with substantial potential to mitigate climate change via C storage. Changes in C stock due to management via reduced tillage has been estimated to be around 0.4 Mg/ha per year in the US. However, based on our results, the level of C stock increase under NT compared to HT was in the upper soil around 4.6 Mg/ha (0.78-8.43 Mg/ha, 95% CI) during a minimum of 10 years, while no effect was detected in the full horizon. Our results could provide evidence that NT and IT are potential means to promote SOC in the top soil. However, higher SOC stocks or concentrations in the upper soil layers not only promote a more productive soil but also provide resilience to extreme weather conditions. Our findings can hopefully be used to support further work to find solutions to increase and maintain C stocks in agricultural soils.