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Long-Term Carbon Input-Output Budget from Organic Fertilisers in Temperate and Tropical Regions

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Abstract

Soil organic matter (SOM) enrichment by organic fertiliser application is more essential for chemical soil fertility factors in soils of the tropics and for physical soil fertility factors in soils of temperate climates. Even with adequate mineral fertiliser inputs according to crop demand, organic amendments may further enhance the nutrient availability for crops by increasing the cation exchange capacity (CEC) and counteracting P-fixation. The benefit of organic matter on soil physics is related to the formation of organo-mineral complexes that improve aggregate stability. However, SOM enrichment is an investment into a living system that is associated with carbon (C) losses due to respiration of soil microbes. Therefore, the objective of this review was to compare crop yield benefits from organic amendments by quantifying C input-output budgets. Carbon balances were estimated with literature data of farmyard manure (FYM) and pooled data of crop residue and green manure (straw-GM) fertilisation studies from tropical and temperate climates. A direct input-output assessment in five long-term field experiments (40 to 152 years) resulted in an average FYM-C recovery of 33±7 % (±s.e.) in temperate climates. Based on 171 experiments, additional indirect C budgets were calculated by multiplying fertiliser C accumulation factors (SOC increase / annual C input increase) in soils by relative crop yield responses to increasing SOC levels: In the tropics, 28±6 % FYM-C and 13±3 % straw-GM-C were recovered in crop yields, which was nearly equal to recoveries of 29±7 % FYM-C and 16±4 % straw-GM C in temperate climates. These clearly negative C balances of organic fertilisation on cropland have two major practical implications: **(i)** If organic fertilisers are produced in competition with food crops they will reduce the total biomass yield, which is one explanation for frequent crop yield losses in "alley cropping" systems and for lower crop yields in "organic" as compared to "conventional" farming. **(ii)** The atmospheric C mitigation effect is higher by an energetic use of crop residues that replaces fossil fuels than by SOC accumulation on cropland.

Keywords: Alley cropping, carbon sequestration, organic farming, soil organic matter

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