Influence of Soil Texture and Management Practices on Soil Organic Carbon Stocks

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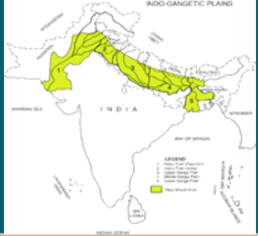


Introduction

It is well known that substantial soil organic carbon (SOC) losses occur from cultivated agricultural soils and that SOC levels are controlled by soil aggregation and texture. In general, levels of SOC increase as soil texture becomes finer. The rice (*Oryza sativa* L.) - wheat (*Triticum aestivum* L.) rotation has emerged as a major production system in the Indo-Gangetic Plains (IGP) of South Asia. Under this system, wetland rice culture destroys soil aggregates and released organic matter mineralizes readily in the aerobic phase of the rotation leading to severely depleted soil carbon contents. The goal of this study was to assess the influence of soil texture on carbon stocks of IGP soils under native forests and rice-wheat cropping to provide a perspective on the potential for carbon sequestration in agricultural soils. Long-term soil fertility experiments (LTFEs) were sampled to understand the effects of nutrient and organic inputs on soil organic carbon (SOC) stocks under conventional tillage.

Materials and Methods

Soil cores (2.15 or 5 cm diameter) collected by hand or using a Giddings hydraulic sampler from forestland sites (99) and cultivated rice-wheat fields (22) in Nepal and Bangladesh were sectioned into 15 cm depth increments to a depth of 60 cm. Surface layer (0-15 cm) samples were collected from an additional 266 cultivated sites. Quantitative relationships between SOC content and texture expressed as silt + clay (S+C) were established for each depth increment.

Three LTFE's (23-25 yr old) located at Bhairahawa (S+C=93%), Parwanipur (S+C=59%), and Tarhara (S+C=68%) in the Nepal terai were similarly sampled. The annual cropping system was rice-rice-wheat (RRW) at Bhairahawa and rice-wheat (RW) at the other two sites. Three core treatments:

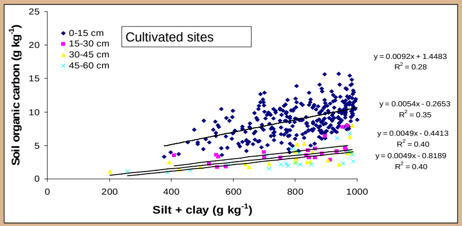
- control (unfertilized)
- recommended NPK, and
- farm yard manure (FYM; 4 Mg ha^{-1}dry wt./crop)

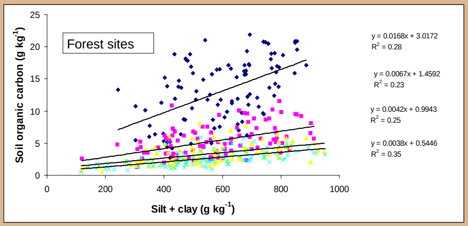
were sampled at all sites. Two additional treatments with NPK to wheat and either FYM + 50 kg N ha^{-1} or 5 Mg ha^{-1} dry chopped wheat straw (CWS) + 50 kg N ha^{-1} to rice were also included at Parwanipur. An unfertilized, harvested grassland adjacent to 2 of the LTFEs was also sampled; this was established from the same field at the initiation of the LTFEs.

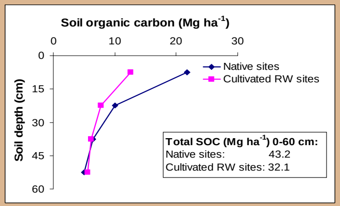
For each soil sample, sand content was determined by sieving Calgon treated soils, OC by dry combustion after removing carbonates as necessary and bulk density from the core mass and volume.

Results

SOC-Texture Relationships and C Stocks in Forest and Cultivated Sites

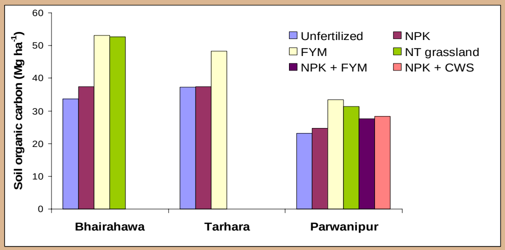


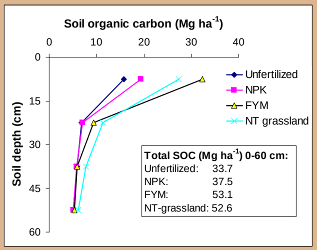




- Regression analyses showed linear increases, but wide variability, in SOC with increasing silt+clay content at all depths for both forest and cultivated soils.
- Conversion of forests to cropland resulted in a 42% and 23% reduction in SOC stocks in the 0-15 and 15-30 cm depths, respectively.
- The top soil layer (0-15 cm) contributed 50% and 39% of total SOC under forest and cultivated RW sites, respectively.

SOC Stocks in Long-Term Soil Fertility Experiments





- In general, SOC stocks were highest in the FYM treatment and the grassland and lowest in the cultivated control and NPK treatments; residue return and reduced FYM inputs gave intermediate SOC stocks.
- The SOC stock in the grass control at Bhairahawa was similar to that in the FYM treatment, suggesting that a change to no tillage would provide a SOC benefit equivalent to adding 4 Mg ha^{-1} dry wt of FYM/crop.
- There was little or no impact of NPK fertilization on SOC stocks with crop residue removal.
- Differences in SOC stocks were limited to the top 30 cm for cultivated soil treatments at Bhairahawa, whereas the SOC depth profile suggests deeper rooting in the grassland.

Conclusion

- Trends in animal populations and FYM availability in the study areas and throughout the Indo-Gangetic Plains make it impractical to consider using FYM to increase SOC stocks.
- Shifting to no-tillage agriculture presents the best option for increasing SOC stocks; carbon sequestration potential is estimated to be 30 Mg ha^{-1} for the NPK treatment at the Bhairahawa site.

Acknowledgement

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