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Mechanisms of Soil Carbon Sequestration

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Carbon (C) sequestration in soil is one of the several strategies of reducing the net emission of CO_2 into the atmosphere. Of the two components, soil organic C (SOC) and soil inorganic C (SIC), SOC is an important control of edaphic properties and processes. In addition to off-setting part of the anthropogenic emissions, enhancing SOC concentration to above the threshold level (∼1.5-2.0%) in the root zone has numerous ancillary benefits including food and nutritional security, biodiversity, water quality, among others. Because of its critical importance in human wellbeing and nature conservancy, scientific processes must be sufficiently understood with regards to: i) the potential attainable, and actual sink capacity of SOC and SIC, ii) permanence of the C sequestered its turnover and mean residence time, iii) the amount of biomass C needed (Mg/ha/yr) to maintain and enhance SOC pool, and to create a positive C budget, iv) factors governing the depth distribution of SOC, v) physical, chemical and biological mechanisms affecting the rate of decomposition by biotic and abiotic processes, vi) role of soil aggregation in sequestration and protection of SOC and SIC pool, vii) the importance of root system and its exudates in transfer of biomass-C into the SOC pools, viii) significance of biogenic processes in formation of secondary carbonates, ix) the role of dissolved organic C (DOC) in sequestration of SOC and SIC, and x) importance of weathering of alumino-silicates (e.g., powered olivine) in SIC sequestration. Lack of understanding of these and other basic processes leads to misunderstanding, inconsistencies in interpretation of empirical data, and futile debates. Identification of site-specific management practices is also facilitated by understanding of the basic processes of sequestration of SOC and SIC. Sustainable intensification of agroecosystems—producing more from less by enhancing the use efficiency and reducing losses of inputs, necessitates thorough understanding of the processes, factors and causes of SOC and SIC dynamics in soils of natural and managed ecosystems.