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Soil carbon sequestration in rainfed production systems in the semiarid tropics of India

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HIGHLIGHTS

- Soil organic carbon (SOC) is a strong determinant of soil quality and productivity.
- High temperatures and low soil moisture are causes of SOC depletion in the tropics.
- Application of chemical fertilizer and organic amendments improve the SOC stock.
- Improvement of SOC stock increase the crop yields even in rainfed conditions.
- National level policy interventions needed to promote measures for C sequestration.

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ABSTRACT

Severe soil organic carbon (SOC) depletion is a major constraint in rainfed agroecosystems in India because it directly influences soil quality, crop productivity and sustainability. The magnitude of soil organic, inorganic and total carbon stocks in the semi-arid bioclimate is estimated at 2.9, 1.9 and 4.8 Pg respectively. Sorghum, finger millet, pearl millet, maize, rice, groundnut, soybean, cotton, food legumes etc. are predominant crop production systems with a little, if any, recycling of organic matter. Data from the long term experiments on major rainfed production systems in India show that higher amount of crop residue C input (Mg/ha/y) return back to soil in soybean–safflower (3.37) system practiced in Vertisol region of central India. Long term addition of chemical fertilizer and organic amendments improved the SOC stock. For every Mg/ha increase in SOC stock in the root zone, there occurs an increase in grain yield (kg/ha) of 13, 101, 90, 170, 145, 18 and 160 for groundnut, finger millet, sorghum, pearl millet, soybean and rice, respectively. Long-term cropping without using any organic amendment and/or mineral fertilizers can severely deplete the SOC stock which is the highest in groundnut–finger millet system (0.92 Mg C/ha/y) in Alfisols. Some agroforestry systems also have a huge potential of C sequestration to the extent of 10 Mg/ha/y in short rotation eucalyptus and *Leucaena* plantations. The critical level of C input requirements for maintaining SOC at the antecedent level ranges from 1.1 to 3.5 Mg C/ha/y and differs among soil type and production systems. National level policy interventions needed to promote sustainable use of soil and water resources include prohibiting residue burning, reducing deforestation, promoting integrated farming systems and facilitating payments for ecosystem services. A wide spread adoption of these measures can improve soil quality through increase in SOC sequestration and improvement in agronomic productivity of rainfed agroecosystems.

1. Introduction

India is still a predominantly agrarian economy. Of the total geographical area of 328.7 million ha (Mha), 141 Mha is the net cultivated area devoted to agriculture, of which only 63 Mha or 44% is the net irrigated area producing more than 56% of the total food grains (FAI, 2011). While generating only 44% of the total food, rainfed agriculture is critical as it contributes significantly to the production of coarse cereals (90%), pulses (87%), and oil seeds (74%). These commodities, produced under rainfed agro-ecosystems, are vital for ensuring food and nutrition security for the ever-growing population. Because of the large diversity in rainfall patterns, temperature regimes, parent materials, vegetation and relief or topography, India is endowed with a wide range of soil types. Inceptisols (95.8 Mha) are the predominant soil types in India followed by

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