Assessment of Baseline Soil Carbon Stock on Subsistence Farming Systems in Tigray: The Case of Mount Alaje, Northern Ethiopian Highlands

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Abstract

While declining soil organic matter has negative effects on crop productivity, improving its level helps improve desirable soil health and crop productivity. Soils on the mountainous terrains of northern Ethiopia are exhausted of overcultivation, and sustaining agricultural livelihoods faces difficulties. A soil carbon stock survey was carried out on altitudes ranging from ca. 2000 to 3400 meters amsl for planning soil organic matter improvement programs. The survey estimated 29% of land falls in the gentle slopes category while the moderate slopes category covers 18%, and the steep slopes category accounts for about 53% of the land. The two farming practices (cropping and grazing) on three slope indices (i.e. $ln(\alpha/tan\beta)$, α & β *are slope length & angle*) ranging from 6.07 to 3.85 for gentle, 3.85 to 3.35 for moderate, and 3.35 to 2.15 for steep slopes, induced significant variations in soil properties and soil erosion risk. Total organic carbon ranged from 2.48% on topsoil (0-10cm) to 1.88% in lower depth (20-30cm) on grazing soils while it ranged 1.87 to 1.60% on croplands. Bulk density, C:N ratio, available phosphorus and exchangeable cations significantly ($P \leq 0.05$) increased with decreasing slope gradient and were higher on grazing than cropping soils. While it did not vary on croplands, C:N ratio was higher in subsoil (10-20cm) and lower soil depth than topsoil on grazing lands. Soil erodibility ranged from 0.25 to 34, highest being on steep slopes leading to estimations of soil loss up to ca. 98Mt $ha^{-1}yr^{-1}$. The results confirmed that the mountainous areas under hillside farming practices are threatened by soil organic matter depletion, and accelerated soil erosion. Thus, planning soil health improvement programs should give attention to establishing indicators such as soil carbon versus surface slope angle and length as correlated with soil water balance.

Keywords: Hillside farming, Slope indices, Organic carbon, Total nitrogen, Erosion risk