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Dynamics of soil organic carbon, nitrogen, phosphorus, and aggregates stability under different grassland management types in the central rift valley, Ethiopia

Wakshuma Mergo[1], Gianni Bellocchi[2]

[1] *Dilla University, Environmental Science , Ethiopia*
[2] *French National Research Institute for Agriculture, Food and Environment (INRAE), Grassland Ecosystem Research Unit (UREP),*

Abstract

Grassland management significantly influences soil organic carbon (SOC) and nutrient fluxes. This study investigated the effects of five distinct grassland management types on SOC, nitrogen (N), and phosphorus (P) in Ethiopia's Central Rift Valley. We collected soil samples from random grazing natural grasslands (random grazed); periodically mowed and grazed natural grasslands (mowed-grazed); cultivated, fertilised, and mowed grasslands (cultivated-mowed); periodically mowed area closure natural grasslands (mowed-closed); and protected native forest grasslands (protected forest). We analysed SOC, labile and stable C fractions, total N, total P, and soil aggregate indices using standard methods, also calculating the C management index and stability ratio. Our findings reveal significant variations ($p < 0.01$) in SOC fractions across management types. Protected forest grasslands exhibited the highest labile C (1.41 %), while random grazed grasslands showed the lowest (0.39 %). For stable C, mowedclosed grasslands had the highest (0.92 %) and random grazed the lowest (0.23 %). Total N ranged from 1.18 % in protected forest and cultivated-mowed to 0.04 % in random grazed, with total P highest in cultivated-mowed soils. SOC, total N, and total P levels also varied significantly ($p < 0.05$) with soil depth. The highest total SOC was observed in protected forest, followed by mowed-closed, cultivated-mowed, mowed-grazed, and random grazed. Overall, grassland management practices that minimise soil disturbance, such as protected forest and mowed-closed, proved most effective in enhancing SOC storage and total N content and the decreasing order of the five grassland management types is protected forest > mowed-closed > cultivated-mowed > mowed-grazed > random grazed. This study underscores the critical importance of implementing sustainable grassland management to maximise C sequestration in the region.

Keywords: Carbon sequestration, grassland management, nutrient dynamics, soil aggregate stability , soil organic carbon

Contact Address: Wakshuma Mergo, Dilla University, Environmental Science , Dilla wallame, 419 Dilla, Ethiopia, e-mail: wakyadm@gmail.com