



Tropentag, September 20-22, 2023, hybrid conference
“Competing pathways for equitable food systems transformation:
Trade-offs and synergies”

Storage and distribution of soil organic carbon, total nitrogen and CO₂ emissions in semi-arid soils

CHUKWUEBUKA CHRISTOPHER OKOLO¹, GIRMAY GEBRESAMUEL², AMANUEL ZENEBE², MITIKU HAILE², JEPHTER EBUKA ORJI³, CHINYERE BLESSING OKEBALAMA⁴, CHINEDU EMMANUEL EZE⁵, EMMANUEL EZE⁶, PETER NDUBUISI EZE⁷

¹*Jimma University, Natural Resources Management, Ethiopia*

²*Mekelle University, Dept. of Land Res. Manag. and Environ. Protection, Ethiopia*

³*Alex Ekwueme Federal University Ndufu-Alike, Dept. of Agriculture, Nigeria*

⁴*University of Nigeria, Dept. of Soil Science, Nigeria*

⁵*Michael Okpara University of Agriculture, Dept. of Agronomy, Nigeria*

⁶*University of Education Heidelberg, Dept. of Geography - Research Group for Earth Observation (rgeo), UNESCO Chair On World Heritage & Biosphere Reserve Observation and Education, Germany*

⁷*Botswana International University of Science & Technology, Dept. of Earth & Environmental Science, Botswana*

Abstract

This study aims to investigate soil organic carbon (SOC) and total nitrogen (TN) contents and stocks, and CO₂ emissions in croplands, grazing lands, exclosures and forest lands of semi-arid Ethiopia. Sampling was done at 0–30, 30–60 and 60–90 cm soil depth and concentration and stocks of SOC, TN and selected soil properties were determined using routine laboratory procedures. There were variations in distribution of SOC and TN stock over 90 cm depth across land use types and locations, decreasing from topsoils to subsoil, with average values ranging from 48.68 Mg C ha⁻¹ and 4.80 Mg N ha⁻¹ in Hugumburda cropland to 303.53 Mg C ha⁻¹ and 24.99 Mg N ha⁻¹ in Desa'a forest respectively. Forest sequestered significant higher SOC and TN stock, decreasing with depth, compared with other land uses. In Desa'a and Hugumburda, the conversion of forest to cropland resulted in a total loss of SOC stock of 9.04 Mg C ha⁻¹ and 2.05 Mg C ha⁻¹, respectively, and an increase in CO₂ emission of 33.16 Mg C ha⁻¹ and 7.52 Mg C ha⁻¹ yr⁻¹, respectively. The establishment of 10-year (Geregera) and 6-year (Haikihelet) exclosures on degraded grazing land increased SOC stock by 13% and 37% respectively. Clay content and precipitation partly modulated SOC distribution, with high SOC content recorded in soils with high clay content and precipitation. Exclosure establishment on degraded ecosystem has shown to be a sustainable restoration pathway with significant improvement in soil properties and C sequestration. Loss of SOC stocks associated with land use conversion can be reversed in degraded croplands with the introduction of sustainable soil management practices (residue retention, integrated soil nutrient management, reduced tillage impact) in view of mitigating climate change impact.

Keywords: Cambisols, land use change, soil organic carbon sequestration, soil processes, vertisols