ABSTRACT

Integrating No-Tillage with Agroforestry Augments Soil Quality Indicators in Kenya's Dry-Land Agroecosystems

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Conservation agriculture with trees (CAWT) is one of the best-bet strategies for enhanced soil quality under extensive and intensive smallholder farming. CAWT is an agroforestry system that integrates legume trees and shrubs into cropping fields under minimum soil disturbance and tillage. This study identified principal soil quality indicators (SQI) under CAWT system. The study further assessed the effects of CAWT components; i.e. tillage (convention or no-tillage), leguminous trees/shrubs (Calliandra calothyrsus, Gliricidia sepium and Cajanus cajan), and their inter-row spacing (1.5 m, 3.0 m or 4.5 m) on the SQI in the dry-land agroecosystems of eastern Kenya. We finally reported on the suitability of the SQI under CAWT intervention towards maize production. The experimental trials were both researcher (Mother-trials; MTs) and farmer (Baby-trials; BTs) hosted and managed. Principal Component Analyses (PCAs) identified soil fertility and textural components as the main factors explaining soil quality under the CAWT system. In particular, the exchangeable bases (ExBas) such as ExCa, ExK, and ExMg), Cation-Exchange-Capacity (CEC), total soil nitrogen (TSN), soil organic Carbon (SOC), pH, available Phosphorus(P), electrical conductivity (EC), clay and bulk density (BD) were identified as the principal soil quality indicators under the CAWT system. Tree species and varied inter-row spacing, significantly affected available P, BD, pH, ExBas, CEC, SOC, and TSN. The tillage systems significantly ($P < 0.05$) influenced soil pH, ExBas, CEC, SOC and TSN. A high concentration of TSN was recorded in no-tillage (NT) blocks integrated with C. calothyrsus (41.9 and 41.6 Mg N ha^{-1}) and G. sepium (35.7 and 32.3 Mg N ha^{-1}) both spaced at 1.5 m at the MTs and BTs, respectively. Combining NT with C.calothyrsus spaced at 1.5 m or Pigeon pea at 3.0 m significantly increases available P (from 22.9 to 28.8 mg kg^{-1} and 23.4–26.0 mg kg^{-1}) at the MTs, respectively. Significant rise in ExK (1.91–2.25 cmolc kg^{-1}), ExCa (6.86–8.17 cmolc kg^{-1}), and ExMg (2.35–2.78 cmolc kg^{-1}) were observed in NT block's sub-plots with G. sepium spaced at 3.0 m at the MTs. Conclusively, a shift towards CAWT showed evidence of improving soil quality, nutrient availability and increasing soil nutrient thresholds that can potentially support maize production. By establishing the minimum datasets for soil quality determination through this study, key stakeholders in agroforestry and conservation agriculture (CA) have an efficient costeffective and rapid tool for soil quality assessment, especially in dry-land agro-ecosystems.

Keywords: Agroforestry, CAW, Gliricidia sepium, Luvisols, Minimum-dataset selection, Soil quality indicators, Soil organic carbon