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Impact of conservation agriculture on harnessing sustainability and building resilience against land degradation in the northern Ethiopian highlands

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Conservation Agriculture (CA) aims at improving soil quality and crop yield whilst reducing runoff and topsoil erosion which raises the soil resilience to combat soil degradation. Different chemical, physical, and biological properties of a soil interact in complex ways that determine the crop productivity potential of the soil. Hence, a medium-term tillage experiment was carried out (2005 to 2011) on a Vertisol to evaluate changes in soil quality, runoff and soil loss due to CA-based field conservation practices in northern Ethiopia. The experimental layout was implemented in a randomized complete block design with three replications on permanent plots of 5 m by 19 m. The tillage treatments were derdero+ (DER+) with a furrow and permanent raised bed planting system, plowed once at planting by refreshing the furrow and with 30% standing crop residue retention, terwah+ (TER+) with plowing once at planting with 30% standing crop residue retention and contour furrows made at 1.5 m distance interval, and conventional tillage (CT) with a minimum of three tillage operations and removal of crop residues. All the plowing and reshaping of the furrows was done using the local ard plow mahresha. Local crop rotation practices followed during the seven years sequentially from the first to the seventh year included wheat-teff-wheat-barley-wheat-teff-grass pea. Glyphosate was sprayed starting from the third year (2007) at 2 l ha-1 before planting to control pre-emergent weed in DER+ and TER+. Significantly different ($p<0.05$) mean runoff coefficients (%) in 7-yrs of 13, 20 and 27 were recorded for DER+, TER+ and CT, respectively. Mean soil losses of 7-yrs were 4.4, 12.5 and 18 t ha-1 y-1 in DER+, TER+ and CT, respectively. Among the several assessed soil properties, SOM, N, P, soil microbial biomass carbon, aggregate stability index, consistency index, cone index, air capacity and macroporosity were shown to significantly increase in soils subjected to DER+ planting system compared to CT, specifically at 0-10 cm depth. Aggregate instability index, crack size at harvest, relative water capacity and plastic limit were significantly larger in CT compared to CA treatments. Adoption of improved local practices of DER+ and TER+ planting systems that employ conservation agriculture principles can reduce runoff, soil loss and improve crop yield and soil quality and thus, sustainability in Vertisols.

Keywords: Soil resilience, Vertisol, conservation agriculture, field conservation practices, soil quality