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Effects of conservation agriculture on soil physical, chemical and biological properties and maize yields in the mid altitude agro-ecological zones of Malawi

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Conservation agriculture (CA) is increasingly being promoted as one way of improving soil organic carbon in the highly degraded fields of smallholders in southern Africa. Long term CA field experiment was established in the 2007-2008 season at Chitedze Agricultural Research Station to elucidate the effects of CA systems and conventional tillage (CT) on soil fertility and maize grain yield under medium altitude agro-ecological zone of Malawi on Ferric Luvisol. The experiment compares continuous monocropped maize (Zea mays) under CT with different CA systems in continuous monocropped maize; intercropping and rotating with grain legumes. The study revealed that the CA maize-cowpea rotation increased soil organic carbon (SOC) by 41% than CT with continuous maize, but all other CA treatments did not exhibit any significant differences compared with CT. In the seventh, eighth and ninth seasons, maize in CA maize-cowpea rotation gave 0.5 Mg ha-1, 0.4 Mg ha-1, and 0.8 Mg ha-1 respectively greater maize grain yields than CT. Furthermore, CA maize-cowpea rotation was characterized by better potassium (K), SOC and earthworm population while CT was characterized by less K, SOC, earthworm, infiltration and poor aggregate stability. Partial least squares showed that most of the variation in yield (87.6%) was explained by soil aggregate stability, earthworm and SOC.

Simulating long-term soil carbon dynamics in temperate and subtropical agroecosystems with DSSAT-CENTURY model

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No-tillage (NT) experiments are relatively recent (<50 yr) and little is known about long-term soil organic carbon (SOC) storage and permanence in NT soils. We used the DSSAT-CENTURY model to simulate SOC (0-30 cm) with datasets from two long-term experiments assessing tillage and N sources in a Mollisol from Kansas (28 yr) and tillage and crop rotations in a Oxisol from Southern Brazil (33 yr). SOC accrual in NT soils was >0.5 Mg C ha-1 yr-1 with medium-low yield maize in the Mollisol, and negligible in the Oxisol with soybean/wheat succession. Organic fertilization and crop rotation increased SOC accrual in both sites, respectively. SOC simulated by DSSAT-CENTURY model had good agreement with observations for NT soils but overestimated SOC in tilled soils. Model's parameters (litter C respiration losses) were then modified for tilled soils. Long-term simulations (100 yr) revealed that SOC accrual (0-15 cm) could be partially offset by losses at 15-30 cm under low C inputs. Simulations with best management practices (BMP), cover crops (Mollisol), and organic fertilization (Oxisol) augmented SOC recovery, especially in the Mollisol under NT. Nonetheless, modelled SOC accrual occurred mostly within labile SOC pool. Simulations with disruption of NT soils decreased SOC to the levels of soils under continuous tillage with faster decline under low C input and warmer climate. Our results suggest that SOC stabilization and permanence in NT soils depends on the maintenance of continuous NT and intensification of agricultural systems.