Soil Organic Matter Accumulation under Tilled and Non-Tilled Rice Cropland

ABSTRACT

Soil organic matter is an indicator of fertility in prime agricultural lands greatly affecting productivity. Assessment of SOM must include both Fn-fraction (<0.05mm) and Lf-fraction (<2mm). This study investigated the dynamics of both SOM fractions through field experimentation and modelling. Model simulations were generated using the Stella platform as software. Results from the in-situ assessment were used to determine the functionality of known components, such as temperature, moisture, soil nutrients and the biological composition in the decomposition process of both SOM fractions. The long-term effect of SOM management through farming practices such as soil tillage and soil incorporation of crop residues were simulated using a mechanistic modeling approach. Results from field experimentation showed that Fn in intensively tilled soil was significantly reduced by 7% ($P=0.006$ at 0.05α) while the Lf increased by 27% ($P<0.001$ at 0.05α). The average rate of change in every 14-day interval for the duration of three months revealed that higher accruals of Lf and Fn occur in non-tilled and tilled soils, respectively. Reduction rates in both Lf and Fn increased whenever accruals were high. These in-situ results served as the basis of parametrization for the SOM model. Simulation output of the SOM model was both calibrated and validated using observed data from both tilled and non-tilled soil for wet and dry seasons; with $P= 0.3987$ and 0.1289 (0.05α) in ANOVA, R^2 of 0.83 and 0.78 with $p<0.001$ in regression analysis and RMSE of 0.016 and 0.059, respectively, the projected SOM values were closely related to the observed SOM values with minimal errors. Based on the model output, the accumulation of SOM both for tilled and non-tilled soil in rice cropland was highly dependent ($R^2 = 0.98$ and 0.97) on the increasing pool of Fn-fraction caused by the continuous additions of particulate organic matter from the pool of Lf-fraction. The model predicts that 5 years of continuously incorporation of rice crop residues through soil tillage in prime agricultural cropland increases the SOM from 2.30% to 2.68% which is about 253.33g/m^2 of particulate soil organic material accumulation at a soil depth of 5cm.