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Management impacts on soil organic C decomposition and stabilization rates in oil palm plantations

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The large-scale expansion of oil palm plantations in tropical regions is a challenge for maintaining the fertility and the C sequestered in heavily-weathered tropical soils. While soil organic matter (SOM) at the plantation scale decrease following the conversion of natural ecosystems to oil palm plantations, specific zones determined by the management may exhibit an increase in SOM. Plantations management results in four zones with contrasting soil C and fertilizer inputs: 1) the weeded circles around trees with high roots density and fertilization application, 2) the frond piles where all aboveground C inputs are concentrated and fertilization application is low, 3) the interrows with fertilization application similar to frond pile areas and 4) the harvest paths where no fertilization are applied. We took advantage of this well-defined management and a shift from C4 (savanna) to C3 (oil palm) vegetation to assess the impacts of organic matter (from frond piles and roots) and fertilizers addition on savanna-derived SOC decomposition or oil palm-derived SOC stabilization rates. Soils were sampled down to 70 cm depth in a chronosequence of oil palm plantations (up to 27 years old) established on natural grassland savannah in Colombia. Soil organic C (SOC) stocks in the interrows and harvest paths were still decreasing in mature plantations due to higher decomposition rates of savanna-derived SOC than net stabilization rates oil palm-derived SOC. The application of fertilization in interrows increased more the stabilization rate than the decomposition rate leading to slightly higher SOC losses as compared to the harvest paths. SOC increased less rapidly under frond piles than in the weeded circles. Roots density was enhanced by the application of dead fronds but only a small fraction of the large amount of organic matter inputs from the fronds was stabilized in SOC. This suggests that the benefit of frond application was a consequence of improved soil conditions (e.g. humidity and nutrient availability) that attracted palm roots rather than the amount organic matter present in the fronds.