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Permaculture practices favor organic matter storage in labile form in the macroaggregate pool

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The agricultural transition must address the need for a sustainable agricultural productivity. In this regard, the role played by soil organic matter (SOM) dynamics in aggregates is key. Here we aimed to study the impact of permaculture and biointensive micro-gardening practices on soil fertility parameters and SOM distribution in aggregate fractions. In identical geopedoclimatic conditions, we compared SOM dynamics in a pasture that evolved towards cultivation under permaculture practices for twelve years and with a soil under conventional agriculture practices. For this purpose, soils were separated into three aggregate-size fractions (2000-500, 250-50 and <50 μm) by wet sieving. Macroaggregates (2000-250 μm) were separated into coarse particulate organic matter (POM), microaggregates within macroaggregates (250-50μm) and silt and clay (<50μm). Organic carbon (OC) concentrations were measured in each fraction and soil fertility parameters on the bulk soils. Our dataset shows that permaculture practices increased the concentrations of bioavailable nutrients Ca, Mg, K and P extracted with EDTA-ammonium and OC stocks in bulk soils, which was explained by the very large organic inputs characteristics of this practice. The percentage of stable macroaggregates in the permaculture plots was 5 times higher than in the conventional system and 1.5 times higher than in the reference soil under pasture. Furthermore, OC concentrations in macroaggregates and in microaggregates within macroaggregates increased after cultivation with permaculture practices but remained identical for the free microaggregates and silt & clay pools, compared to the pasture reference plot. Despite higher OC concentrations in the protected microaggregates fraction, its contribution to the increase of OC stocks was significant only for one of the three permaculture plots compared to the control pasture soil. The increase of OC stocks was mainly attributable to coarse POM contained in the macroaggregates. As C inputs to soil were considerably increased under permaculture practices, we hypothesized that (1) mineral associated fractions become C-saturated and that additional inputs result only in an increase of labile soil C fractions such as coarse POM occluded in the macroaggregates or (2) time since cultivation is not sufficient to allow the complete decomposition of coarse POM in fine inter-POM, more associated with mineral particles. We can argue that permaculture/biointensive micro-gardening practices could enhance soil fertility parameters and SOM storage. However, the results are predominantly driven by important organic inputs in the permaculture soils and we showed that a large proportion is probably rapidly mineralized. Hence, further research is needed to optimize the amount of organic inputs required to provide high fertility parameters and SOM storage under persistent forms. Furthermore, as OM inputs to soil come from other plots of the farm, a C balance should be performed at this scale, in order to determine if OC storage in cultivated plots corresponds to a net sink of CO_2 at the farm scale.