Management of soil organic matter in small-scale farmers cropping systems: Possibilities and limitations

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Management of organic matter is of primary importance in maintaining soil fertility and productivity and in minimizing agricultural impact on the environment. The level of soil organic matter (SOM) is determined by the equilibrium between the factors which determine its formation and those which promote its breakdown (Greenland and Nye 1959). More than a century ago the Northeast of the state of Pará, Brazil, the "Bragantina" region, gradually underwent a systematic colonization process, turning the primary forest completely into an anthropogenic landscape. As in most parts of the tropics this conversion resulted in a decline of the SOM content to a new equilibrium, which nowadays rarely passes 1.5% OM in the topsoil (0-10 cm). Apart from rarely occurring erosion processes, this is basically caused by a reduction in the quantity and the quality of OM input (short fallow periods) and an increase in the rate of oxidation (slash-and-burn and in cash crops microbial respiration fueled by fertilization). On the other hand, the prevailing Ultisols (U.S. Soil Taxonomy) with low contents of low-activity clays (<15%) highly depend on SOM to ensure favorable physical and chemical characteristics such as soil structure and ion exchange capacity. For the nutritional elements of crops the latter is of essential importance, because it allows higher persistence rates of plant available nutrients, even the ones originating from mineral fertilizers. But SOM also acts as a direct source and sink for mineral nutrients part of which are taken up by deep reaching roots of the fallow vegetation and part of which are incorporated by biological nitrogen fixation. Later on, they are mineralized as a consequence of litter- or mulch decomposition or of burning. Taking into account that SOM is a renewable source, the antagonistic factors can be manipulated in order to stop or reverse its continued decline. Previous works (Brasil et al. 1991) within the study region have shown to which extent slash-and-burn reduces SOM (from 2.15% to 1.56% in 0-10 cm) and how fire-free land preparation can increase these values (from 1.69% to 2.66% in 0–10 cm). Consequently, the project SHIFT-*Capoeira* paid special attention to manipulate: 1) the adverse oxidation process responsible for the OM losses by substituting slash-and-burn with a newly developed slash-and-mulch technology, 2) the quantity and the quality of the OM input by overcoming the short fallow periods with enrichment plantings with fast growing leguminous trees in order to accelerate biomass accumulation, recycle nutrients, and enhance biological nitrogen fixation. Apart from a gradual improvement of SOM status and soil fertility, the improvement of crop productivity and the maintenance of a high functional biodiversity are focussed at. In the experiments conducted to develop the slash-and-mulch technology the following studies are conducted: soil nutrient and water dynamics, litter and mulch decomposition, soil nutritional status and mineralization processes. Since temporary immobilization of nutrients by the decomposition process has to be overcome, fertilizer response studies are conducted, aiming at new fertilizer recommendations. The fallow enrichment experiments comprise analyses and measurements of total biomass accumulation of the introduced trees and the spontaneous undergrowth, growth rates of the utilized species, net nitrogen input by BNF, rooting depth and root distribution, impact on diversity of floral species. Interactions of the two technologies, are starting to be considered, as well.