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Long term impact of different tillage practices on soil C sequestration potential

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Long-term experiments provide important information on the impact of agricultural management practices on soil quality. In 1994, a trial was started to investigate the effects of four different tillage systems on organic carbon and physical properties of a Calcari Fluvic Cambisol loam soil under continuous maize. The tillage practices compared were: conventional tillage by mould-board ploughing to 40 cm depth (DP); ripper sub-soiling to 40-45 cm (RS); shallow tillage by mould-board ploughing to 20 cm depth (SP); minimum tillage by disk harrowing to 10-15 cm (DH).
Soil carbon pool, bulk density, macroporosity and aggregate stability were studied at different depth increments (0-10, 10-20, 20-30 and 30-40 cm) and by two repeated samplings (in 1999 and 2011), in order to evaluate their temporal evolution under the different tillage systems.
For a better understanding of mechanisms leading to C sequestration, a qualitative characterization of soil organic matter (OM) was performed by acid hydrolysis (HCl 6N), in order to separate the labile and the recalcitrant fractions.
After 18 years of treatments we hypothesized changes in OM content and quality, as well as in its vertical distribution, due to tillage practices.
At the end of the trial, soil total organic carbon (TOC) stock increased in the surface layers under DH (to 10 cm depth), RS (to 20 cm depth) and SP (to 10 cm depth), while it was unchanged under DP. When considering the whole 0-40 cm layer, all tillage treatments resulted in no significant variation in TOC stock. OM quality and its evolution over time showed well defined differences among treatments: the OM recalcitrant fraction increased under RS (up to 30 cm depth), decreased under DP (up to 40 cm depth) and showed no significant changes under DH and SP. The negative impact of DP on C stabilization was confirmed by a significant decrease of the recalcitrant to TOC ratio in the whole sampled layer.
In conclusion, DP showed the worst impact on C storage and soil physical properties, while RS proved to be a more stable system, stimulating an increase of recalcitrant C in the surface layers and overall good soil physical conditions.