Does conversion to reduced tillage really increase soil organic carbon stocks in organic arable farming?

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Aggravation of weather extremes increases awareness of climate change consequences. Mitigation options are in demand that aim to reduce the atmospheric concentration of greenhouse gases. Amongst others, the conversion from ploughing to reduced tillage is argued to increase soil organic carbon (SOC) stocks as an accumulation of SOC in topsoil layers is commonly reported. Yet, reviews and meta-analyses describe various results from significant increases to just a redistribution of SOC in the soil profile. Reasons can be found in different sampling depths, SOC and bulk density measurement procedure, and stock calculation (equivalent soil mass vs. equal sampling depth). Furthermore, few studies evaluated the impact of organic farming systems.

In nine long-term experiments on tillage systems in temperate Europe (France, Germany, Netherlands, and Switzerland), a common soil sampling campaign took place in spring and autumn 2017, and spring 2018. All trials represent common mixed organic farming systems of the respective region and contain plots with conventional and reduced tillage practices. While climatic conditions are similar, soil types vary from sandy to clayey soils. We took three undisturbed soil cores with driving hammer probes (8 cm in diameter) in each plot (minimum 3 plots per treatment) to a maximum depth of 100 cm and divided the cores in the increments 0-30, 30-50, 50-70, and 70-100 cm. The topsoil (0-30 cm) was further divided into the different tillage depths of the respective trial. We determined bulk density and organic carbon concentration as main variables and soil texture and pH as co-variates for each sample and collected C-inputs for each plot in all trails on a yearly basis.

Multivariate statistics will enable the comprehensive evaluation of tillage effects on SOC stocks up to a depth of 100 cm in organic long-term trials. Texture, trial age, and the co-variate C-input will be decisive for the development of SOC stocks and enable the evaluation of carbon sequestration potentials of agricultural soils through improved tillage practices.