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Organic carbon sequestration potential, rate and associated practices, as observed in Swiss arable land

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Since 1993, analysing the soil of any cropped field at least every ten years is required to receive subsidies associated with ecological services in Switzerland. After data quality control, we used 3'000 repeated analyses available from the cantons of Vaud and Geneva to quantify the deficit in Soil Organic Carbon (SOC), the SOC content change rate per year and its time evolution along the past 25 years. We then interviewed 120 farmers on a sample representative of the overall range of SOC change rates to analyse the relationships between their practices in the past ten years and the resulting rate.

The SOC deficit was quantified based on the soil vulnerability index, namely SOC to clay ratio (Fell et al., 2018; Johannes et al., 2017), with the 10% SOC:clay ratio as minimum desired SOC level. This yielded different deficits ranging from 20% to 70 % of the average SOC content in the Swiss cantons depending on the cropping systems and the soil types.

Though the SOC deficit was different between the cantons, the distribution of SOC change rates was very similar, ranging from -50‰ to +50‰ with a median value close to 0. The average change rate, however, was significantly and linearly changing with time, from -4‰ in the 1995-2000 period to 9‰ in the present. This pattern was identical on both cantons and can be related to the introduction of different mandatory measures in 1993-1998 such as cover crops in fall, and a minimum of 4 crops in the rotation, and the development of conservation agriculture practices.

The detailed analysis of cropping practices and related SOC change rates allowed revealing the major options allowing for rapid sequestration and conversely. Moreover, exceptions to the general trends, allowing either to compensate SOC losses practices or jeopardizing sequestration efforts, were also highlighted. Two performing cropping systems were emerging: polyculture with breeding and conservation agriculture. Farmers' income per ha of these systems were equal to or larger than the conventional models. Interestingly, the first factor for high sequestration performance was diversified rotation and intensive cover crops, regardless of the manuring level. These results were used to define the agricultural sections of the climate plan of the cantons.

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