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Soil organic carbon dynamics and sequestration potential in cropland-grassland agro-ecosystems

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Increasing soil organic carbon (SOC) in agro-ecosystems enables to address simultaneously food security as well as climate change adaptation and mitigation. Croplands represent a great potential to sequester atmospheric C because they are depleted in SOC. Hence, reliable estimations of SOC deficits in agro-ecosystems are crucial to evaluate the C sequestration potential of agricultural soils and support management practices. Using a 30-year old soil monitoring networks with 250 sites established in western Switzerland, we identified factors driving the long-term SOC dynamics in croplands (CR) and permanent grasslands (PG) and quantified SOC deficit. A new relationship between the silt + clay (SC) soil particles and the C stored in the mineral-associated fraction (MAOMC) was established. We also tested the assumption about whether or not PG can be used as carbon-saturated reference sites. The C-deficit in CR constituted about a third of their potential SOC content and was mainly affected by the proportion of temporary grassland in the crop rotation. SOC accrual or loss were the highest in sites that experienced land-use change. The MAOMC level in PG depended on the C accrual history, indicating that C-saturation level was not coincidental. Accordingly, the relationship between MAOMC and SC to determine soil C-saturation should be estimated by boundary line analysis instead of least squares regressions. In conclusion, PG do provide an additional SOC storage capacity under optimal management, though the storage capacity is greater for CR.