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Does management intensity control soil carbon storage in perennial meadows? - Results from three controlled long-term field experiments

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Managed grasslands are supposed to be relevant sinks for atmospheric CO_2. Grasslands differ widely in their productivity, depending on site and management conditions, and their intensity of use might affect soil organic carbon (SOC) storage. Whereas grazing effects on soil carbon have been widely studied, the relationship between management intensity and SOC storage is less known for meadows. Because SOC is a slow response variable, long-term evaluations are needed to infer whether management intensity effectively controls grassland SOC storage. Here, we report on three long-term temperate meadow experiments in Switzerland, spanning durations of between 21 and 42 years. They differ in site conditions, and mineral fertilization and cutting regime were applied as experimental factors at the respective sites. Yields were significantly stimulated by long-term fertilization but not cutting regime and were also site dependent. Root biomass was the same among treatments of each of the experiments as were estimated carbon inputs to soil (overall range 0.25-0.53 kg C m-2a-1, 0-0.2 m). We derived corresponding SOC turnover times of 9-31 years (0-0.2 m); these differed between sites but not among experimental treatments. Uncertainties in input and turnover were quantified using Monte Carlo Simulations. Most importantly, at each site, SOC stocks were not modified by treatment. Grassland abandonment at one site resulted in higher SOC content that may, beyond the studied time frame of 21 years, result in higher SOC stocks in the future. Our research provides evidence that grassland productivity, as controlled by mineral fertilization and cutting regime, is no major driver for carbon storage in the upper 0.2 m soil layer of temperate perennial meadows over decadal timescales.