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Influence of perennial crops in arable systems on soil carbon stocks in Northern Europe

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In the context of climate change it is important to identify management options that can sequester carbon through a sustained increase in soil organic matter, and thereby contribute to the reduction of greenhouse gases in the atmosphere. A perennial crop not only reduces the risk of erosion because of permanent soil cover and the absence of tillage operations, but allocates a greater part of net primary production than annual crops to roots and rhizodeposits.

In particular, ley-arable rotations under Nordic conditions often include several years of perennial leys. Since these systems have components of both grassland and cropland they are expected to have C stocks intermediate between those in continuous grass- and cropland. We quantified the effect of ley-arable rotations versus continuous annual cropping systems on soil carbon stocks by analyzing data from long-term field experiments in Nordic countries. Unpublished data from several sites in Sweden are presented and results from published studies with similar soil and climatic conditions are also summarized. As expected, the positive effects of leys on soil C were declining with length of the experiments. Depending on species composition, management, experimental period and soil depth considered in the different studies, on average 0.5 Mg ha⁻¹ yr⁻¹ (range 0.3 to 1.1; median 0.4 Mg ha⁻¹ yr⁻¹) more carbon was retained in soils in ley-arable compared to exclusive annual systems. These results allow us to have more confidence in predicting soil organic carbon balances for forage-based crop rotations, and they are used to up-date and validate the Swedish national reporting system for changes in soil carbon stocks in arable land.