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Soil organic carbon storage following conversion from arable to grassland use on sites with different soil drainage and erosion histories

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Changing soil use from arable to grassland influences organic carbon storage in a highly complex way. This includes the root/shoot allocation, the root depth distribution, the mode of incorporation of shoot biomass and lateral organic carbon fluxes, by erosion and removal of harvested carbon, and finally the aeration by tillage. An experiment was designed allowing to resample a number of arable fields 18 yr after conversion to grassland. Before conversion to grassland the arable fields where prone to erosion, with a mean lateral carbon fluxes during 20 yr prior to conversion of 13 t ha-1. Harvest had removed another 29 t ha-1 at eroding sites. Colluvial carbon inputs had been up to 18 t ha-1 while harvest had removed 38 t ha-1. The carbon fluxes by erosion became negligible during the 18 yr period after conversion. Carbon losses by harvest also ceased at set-aside grassland and pastures while the net losses on meadows were 45 t ha-1. Conversion to grassland lead to fast processes, which caused displacement of the organic, mineral and gas phases within the soils. The depth functions of carbon and stones, carbon concentration, bulk density and porosity changed significantly. Despite the large changes in carbon balance, carbon gains or losses were too slow to cause a significant change of carbon stocks within 18 yr. Poorly drained, gleyic soils differed from well-aerated soils in carbon storage independent of soil use with differences up to one order of magnitude. The widespread drainage of wet grassland soils prior to conversion to arable thus can cause a large release of carbon, while an influence of tillage by either increasing aeration or erosion could not be detected in this study. Therefore, fostering carbon sequestration by conversion of arable to grassland requires restoring former draining conditions.