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Soil carbon balance in Hungarian crop rotation systems

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Although characteristics of the carbon balance and the organic carbon stock changes of arable lands have been the primary research focus of numerous studies, uncertainity is still a major factor in this area of research. Our aim is to determine the dynamics of carbon cycling in croplands in regards to a crop rotation consisting of different crop types and to clarify the factors driving the carbon fluxes between its main components.

A field-scale eddy covariance (EC) station was established in 2017 at a cropland site in Central Hungary in order to obtain the cropland's annual net ecosystem exchange of CO_2 (NEE). Net ecosystem carbon budget (NECB) was calculated considering vertical and lateral C fluxes as well. Soil management is a conventional management with yearly deep ploughing and mineral fertilizer application.

During the three years of our experiment the crop rotation included winter wheat, winter rapeseed, sorghum and winter wheat. The largest net CO_2 uptake was observed during the sorghum season (from sowing to harvest, -309 g C m^{-2} yr^{-1}). However, extreme autumnal drought resulted in the incomplete germination of rapeseed in 2018, which led to carbon loss (108 g C m^{-2} yr^{-1}) during this vegetation period. Results show a significant difference between the two winter wheat seasons – sown in 2017 and 2019 – which can be explained by the differing precipitation of the two periods. Despite the strong CO_2 uptake of winter wheat and sorghum, NECB ranged between negligible C gain (-18.26 g C m^{-2} $year^{-1}$, sorghum) to C losses of up to 108 g C m^{-2} $year^{-1}$ (rapeseed). During three years the C loss was 420 g C m^{-2} as C export through harvest and fallow periods counterbalanced the crops' CO_2 uptake.

As a conclusion we can state this cropland could not sequester enough carbon to maintain the soil organic carbon pool and in order to reduce the risk of the depletion of soil carbon stock further efforts are needed in the field of soil management practices.