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Assessment of Nature-Based Agricultural Practices for Soil and Water Conservation Using SWAT+

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Abstract

Agricultural systems are increasingly vulnerable to the intensifying extremes of water availability brought about by climate change. Addressing these challenges requires the implementation of integrated practices that not only enhance drought resilience and restrain soil erosion but also preserve soil quality and ensure sustainable food production. This research investigates the performance of a range of nature-based small water retention measures and agricultural management practices promoted under the European Union's Common Agricultural Policy (CAP). The evaluation was conducted within the Felső-Válicka catchment area in Hungary, utilizing the Soil Water Assessment Tool (SWAT+) hydrological modelling software for scenario analysis. Each modelled practice was parameterized according to classifications and guidelines of the Hungarian CAP Strategic Plan. For this study, we selected the practices of no-till farming, reduced tillage, the use of cover crops, perennial leguminous forage crops, and green cover, such as the conversion of arable land to grassland, implementation of grass and shrub riparian buffers, and grass and shrub erosion control strips. To assess the hydrological impact of these measures, key environmental indicators were analysed, including streamflow, soil moisture content, and soil loss rates. The analysis also considered potential trade-offs in terms of reducing the availability of arable land for crop production. Our results show

that no-till farming has the most beneficial impact at the study site, with a significant increase in soil moisture content (exceeding 40%) and a significant reduction in erosion (up to -70%) compared to the status quo management, all without reducing the available arable land. Reduced tillage also resulted in a notable increase in soil moisture content (~25%). Where erosion control is a priority, the use of perennial leguminous forage crops (e.g., alfalfa), and cover crops can be an effective solution. Conversely, riparian buffers and erosion control strips showed limited large-scale hydrological benefits, instead providing more localized water and soil conservation benefits.

Keywords: agricultural management practices, soil moisture content, soil erosion, Soil Water Assessment Tool

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