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The effects of Soil-Improving-Cropping-Systems (SICS) across Europe: a simulation study

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One of the strongest challenges for European agriculture is to simultaneously reduce its negative environmental impact and at the same time, remain competitive. A key aspect of the environmental impact is the ongoing soil degradation. Within the Soil Care project, sustainable agricultural practices were investigated that could improve soil quality, termed soil improving cropping systems (SICS); four plausible scenarios were developed with different levels of SICS uptake. In this study we aimed to evaluate how such SICS, through the different scenarios, impact crop yield, soil organic carbon content and land degradation (specifically erosion and soil water dynamics) across Europe, through the application of the PESERA and dyna-QUEFTS models. The Pan-European Soil Erosion Risk Assessment (PESERA) model simulates biophysical processes including above-ground biomass production, soil erosion risk, soil water deficit and soil humus content and was adapted and calibrated for Europe. The dyna-QUEFTS model calculates nutrient limitations and was used to calculate crop yields using PESERA output information. All four scenarios were run from current (2020) until 2050 and for two climate trajectories. Results indicate that the 'Caring and Sharing' scenario likely provides the best sustainability impacts (i.e. stable or increased SOC contents and reduced erosion) due to widespread uptake of SICS, compared to the 'Race to the Bottom' scenario, in which no SICS were taken up, although regional differences can be seen from the spatially explicit maps that the modelling produces. While, by necessity, the models are a simplification of the reality and assumptions and input data quality affect the results, a comparative analysis of the scenarios and their likely effect can still be made and will be helpful for agricultural policy development across Europe. In addition, the modelling tool provides the opportunity to further analyze which SICS are effective where and to explore the impacts of SICS implementation.