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Agricultural Management and Soil Carbon Sequestration: the potential of APSIM model to support climate change mitigation

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Leveraging soil carbon sequestration in croplands can support climate change mitigation; however, it is challenging to develop optimal management practices to maximize both sequestered carbon and crop yield. In intelligent agricultural management systems, large-scale crop models can provide an understanding of the complex soil-water-plant-atmosphere interactions and allow the evaluation of the effects of various management practices on carbon sequestration. This study aims to investigate soil carbon dynamics in maize cropland under different management practices, and discuss their potential to leverage the carbon sink capacity of agricultural soils. The Agricultural Production Systems sIMulator (APSIM) is used to investigate soil carbon dynamics in maize cropland of Baixo Mondego, an agricultural region in central mainland Portugal, under Mediterranean climate. The model was set up using soil properties retrieved from the INFOSOIL national database and run with daily climate data from 2001 to 2020 provided by local weather stations (i.e., solar radiation, maximum and minimum temperature, and rainfall). The maize yields' records from an agricultural farm were used for model calibration (2017 - 2019) and validation (2020 - 2021). The model was then used to investigate the impact of different scenarios focusing on distinct fertilization management practices (i.e. fertilization rates, timing, and type of fertilizer) on soil carbon and crop yields. This study is part of a larger research project funded by C3.AI Digital Transformation Institute to develop an intelligent agricultural management system using deep reinforcement learning (RL) for agriculture sustainability and climate change mitigation. This project has great potential for impact on climate change and food security, two of the most significant challenges currently facing humanity.