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Classification trees for delving into sugarcane production in Brazil under climate change

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While several studies have been developed for understanding the impact of climate change on Brazilian sugarcane production, the underlying mechanisms that lead to increase or decrease in production are seldom evaluated. This may be due to the complexity of analyzing the great and intricate amount of data of the outputs from the simulation models. Decision trees are powerful tools to deal with complex data for their ability of using different types of response variables, of interactive exploration, description and prediction and of providing graphical interpretation of results involving interactions. Thus, they allow us to both quantify and better understand the impacts of the variables in each process. This approach could lead to insights when searching for improved varieties. We simulated the effects of climate change in the production using both the DSSAT/Canegro and the APSIM-Sugar models in three different locations, under two different soils, with three planting dates, two cultivars, irrigated and rainfed. As for the climate change scenarios, they were generated by two different techniques for twenty-six different General Circulation Models (GCMs) and two different Representative Concentration Pathways (RCPs), for two different periods, plus the baseline. This yields 15,048 combinations and since each is repeated 30 times, there are 451,440 results. We then analyzed them by using decision trees. From the daily outputs of the simulations, we created variables to group the effects in four quarters of the cycle. We also discretized the results considering the deviation of one standard deviation from the baseline years and created two classes for dry mass sucrose content: lower and equal or higher. Three levels of trees were developed: one referring to the high-level scenario description, one to the boundary conditions (weather and soil) and one to the growth process variables. In the high-level trees, we observed the DSSAT-Canegro model was more severe in its predictions, leading to most cases in which sugar content decrease was observed. These cases were often detected for the later planting date both in one expansion area of sugarcane and, in the cases of more rigorous scenarios, in sandy soils of the other locations evaluated. From the boundary tree, we noticed all these effects were mainly led by higher temperatures in the third quarter of the cycle associated to either higher temperatures in the beginning of the cycle or low soil evaporation in the last quarter. Finally, the low-level tree showed these conditions increased plant transpiration in the third quarter and daily biomass increase in the last quarter. This approach allowed for analyzing the growth of sugarcane for several climate change scenarios that had not been previously considered, and stablishing in more detail the potential negative effects of climate change on the crop results.

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