Impacts of drought on crop yield in the semiarid region

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Abstract: Drought is one of the major causes of crop yield loss. Studying the impacts of drought on crop yield is essential to take appropriate mitigation measures and ensure food security. Many studies have estimated crop yield with crop system models, but most of them are limited by the model simulation scales (Araya et al., 2021). It is essential to simulate crop yield at regional scales for a better representation of drought effects (Leng, 2021).

This study used the Agricultural Production Systems Simulator (APSIM) and high-resolution remote sensing to simulate regional maize yield. To achieve that, we have done three important steps. First, we used the extended Fourier amplitude sensitivity test (EFAST) to identify sensitive cultivar parameters of the APSIM to maize yield and investigated how climate variability influences APSIM-Maize parameter sensitivity in a semiarid region. Our results show that transpiration efficiency coefficient (*transp_eff_cf*) is the most sensitive parameter to maize yield, followed by grain growth rate (*grain_gth_rate)*. They both influence simulated yield directly and their sensitivity is both noticeably influenced by rainfall and maximum temperature.

Second, we evaluated the reliability of parameters with leave-one-out cross validation and calibrated the sensitive parameters to get a reliable model. Our results show that the calibrated APSIM-Maize model performs well (R^2 = 0.72; RMSE = 401.5 kg/ha) and is reliable to simulate maize in the semiarid region.

Third, we interpolated rainfall, maximum temperature, minimum temperature and solar radiation with ANUSPLINE based on meteorological stations in the study area. We also identified maize planting area with mean absolute deviation (MAD) based on the standard NDVI time series extracting from Sentinel-2. Based on the above spatial data and reliable calibrated model, we run APSIM on each pixel to simulate regional maize yield in different irrigation scenarios. Our study can reveal the impacts of drought on regional crop yield and the function of irrigation in mitigating agricultural drought. This can provide optimized management measures for drought mitigation and government decision-making.

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Keywords: *Drought, crop yields, agricultural production, food security*