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Crop Yield Estimation Using Multi-source Satellite Image Series and Deep Learning

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Timely monitoring of agricultural production and early yield predictions are essential for food security. Crop growth conditions and yield are related to climate variability and extreme events. Remotely sensed time-series can be used to study the variability in crop growth and agricultural production. However, the choice of remotely sensed data and methods is still an issue, as different datasets have different spatiotemporal characteristics. Thus, our primary goal was to study the impact of applying different remotely sensed time series on yield estimation in U.S. at the county and field scale. Furthermore, the impact of crop growth conditions on yield variability was assessed. For county-level analysis, MODIS-based surface reflectance, Land Surface Temperature, and Evapotranspiration time series were used as input datasets. Whereas field-level analysis was carried out using NASA's Harmonized Landsat Sentinel-2 (HLS) product. 3D convolutional neural network (CNN) and CNN followed by long-short term memory (LSTM) were used. For county-level analysis, the CNN-LSTM model had the highest accuracy, with a mean percentage error of 10.3% for maize and 9.6% for soybean. This model presented robust results for the year 2012, which is considered a drought year. In the case of field-level analysis, all models achieved accurate results with R^2 exceeding 0.8 when data from mid growing season were used. The results highlight the potential of yield estimation at different management scales.