An Automated Crop Intensity Algorithm (ACIA) for global cropland intensity mapping at 30-m using multi-source time-series data and Google Earth Engine*

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ABSTRACT:
Agricultural practices and investments vary by season due to the different challenges faced, such as drought, salinity, or flooding, and the different requirements such as varietal choice, water source (rainfall or irrigation or a mix of the two), inputs, and crop establishment methods. Both cropping intensity and the number of crops planted annually in an area can be used as a measures of food security given that these factors can greatly affect overall gross production for that location. Traditionally, MODIS Normalized Difference Vegetation Index (NDVI) has routinely been used to investigate crop intensity, since MODIS provides global coverage and sufficient temporal observance. However, current techniques for quantifying cropping intensity may not be accurate in regions of the world like Africa and South Asia, which are dominated by smallholder farms where the size of one field is typically much smaller than a MODIS pixel (250 m). As a result, we investigated the capability of combining Landsat 8 (16 day – 30 m) data with Sentinal-2 (5 day – 10 to 20 m) to map crop intensity over very large areas such as Africa and South Asia. We developed the Automated Crop Intensity Algorithm (ACIA) to produce crop intensity at 30-m using our Landsat-8 and Sentinel-2 combination data through Google Earth Engine (GEE) cloud computing platform. We smoothed the temporal 30-m NDVI data from our Landsat-8 and Sentinel-2 combination to overcome cloud effects. The 30-m NDVI time-series were then identified into 4 crop intensity classes with ACIA. The 4 crop intensity classes were: 1) Single crop, season 1, 2) Single crop season 2, 3) Double crop, and 4) continuous crop. When performing cropping intensity mapping with ACIA, we introduced the global crop seasonality map from SAGE Crop Calendar Dataset (Sacks, 2010) as a reference. The final 30-m crop intensity map was evaluated by comparing with: 1) random samples interpreted by validators; 2) MODIS results; and 3) survey-based statistics. Although temporal frequency of our Landsat-8 and Sentinel-2 30-m combination is far less than daily coverage of MODIS data, the results of crop intensity were comparable between the ACIA algorithm and MODIS r for the study areas ($R2 > 0.75$ and RMSE < 0.15). Given the scaling ability provided by Google Earth Engine, the ACIA algorithm can also be applied to agricultural croplands anywhere in the world.

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