Usability of NASA Satellite Imagery-Based Daily Solar Radiation for Crop Yield Simulation and Management Decisions

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We tested the usability of NASA satellite imagery-based daily solar radiation for farm-specific crop yield simulation and management decisions using the Hybrid-Maize model (www.hybridmaize.unl.edu). Solar radiation is one of the key inputs for crop yield simulation. Farm-specific crop management decisions using simulation models requires long-term (i.e., 20 years or longer) daily local weather data including solar radiation for assessing crop yield potential and its variation, optimizing crop planting date, and predicting crop yield in a real time mode. Weather stations that record daily solar radiation have sparse coverage and many of them have record shorter than 15 years. Based on satellite imagery and other remote sensed information, NASA has provided estimates of daily climatic data including solar radiation at a resolution of 1 degree grid over the earth surface from 1983 to 2005. NASA is currently continuing to update the database and has plans to provide near real-time data in the future. This database, which is free to the public at http://power.larc.nasa.gov, is a potential surrogate for ground-measured climatic data for farm-specific crop yield simulation and management decisions.

In this report, we quantified (1) the similarities between NASA daily solar radiation and ground-measured data at 20 US sites and four international sites, and (2) the accuracy and precision of simulated corn yield potential and its variability using NASA solar radiation coupled with other weather data from ground measurements. The 20 US sites are in the western Corn Belt, including Iowa, South Dakota, Nebraska, and Kansas. The four international sites are Los Banos in the Philippines, Beijing in China, Cali in Columbia, and Ibatan in Nigeria. Those sites were selected because of their high quality weather record and long duration (more than 20 years on average).

We found that NASA solar radiation was highly significantly correlated (mean r^2 =0.88**) with the ground measurements at the 20 US sites, while the correlation was poor (mean r^2=0.55**, though significant) at the four international sites. At the 20 US sites, the mean root mean square error (RMSE) between NASA solar radiation and the ground data was 2.7 MJ/m^2/d, or 19% of the mean daily ground data. At the four international sites, the mean RMSE was 4.0 MJ/m^2/d, or 25% of the mean daily ground value. Large differences between NASA solar radiation and the ground data were likely associated with tropical environment or significant variation in elevation within a short distance.

When using NASA solar radiation coupled with other weather data from ground measurements, the simulated corn yields were highly significantly correlated (mean r^2=0.85**) with those using complete ground weather data at the 20 US sites, while the correlation (mean r^2=0.48**) was poor at the four international sites. The mean RMSE between the simulated corn yields of the two batches was 0.50 Mg/ha, or 3% of the mean absolute value using the ground data. At the four international sites, the RMSE of the

simulated yields was 1.5 Mg/ha, or 13% of the mean absolute value using the ground data.

We conclude that the NASA satellite imagery-based daily solar radiation is a reasonably reliable surrogate for the ground observations for farm-specific crop yield simulation and management decisions, especially at locations where ground-measured solar radiation is unavailable.