Cropping systems modeling tools to improve soybean management and yield in Iowa

Sotirios V. Archontoulis, Michael Castellano, Andy VanLoocke, Ranae Dietzel, Mark Licht, Peter Kyveryga, Pat Reeg, Tristan Mueller

Our goal is to improve soybean yields per unit area in Iowa by using science based simulation models. The proposed modeling program integrates two projects. The first project aims to measure N fixation and other critical experimental crop/soil data needed to test, improve and therefore apply the Agricultural Production Systems sIMulator (APSIM) model to develop pre-season decision support tools and shed light on critical questions regarding soybean growth in Iowa. The second project aims to use the improved model from project 1 as an in-season management tool to forecast soybean yields, crop growth and water/nitrogen requirements during the growing season in representative soybean fields. Project 1 is a continuation of the previous year's project funded by ISA while project 2 is new and it will be the first attempt to forecast soybean yields in real time in Iowa.

Regarding the project 1, over the last months we have incorporated several experimental datasets into APSIM for the model analysis, and we established N fixation experiments to fill knowledge gaps. The experiments are located at central and northwestern Iowa State University Experimental farms. Within each site we designed sophisticated experiments to measure N fixation at different crop stages and collect data on crop growth, staging, biomass partitioning, tissue N concentration, and soil water, temperature and nitrogen. Our approach to estimate N fixation is unique, as we are the first to measure both crop and soil aspects and apply cropping system modeling to analyze the experimental data and extrapolate the results in time and space. As of August 25, 2015 the experiments are in progress and we propose to continue the experimentation in 2016. In addition to field experiments we have developed an interactive web-based tool, the Soybean Planting Decision Tool (http://www.agron.iastate.edu/CroppingSystemsTools/), to help growers optimize selection of varieties and planting dates in order to set a high yield potential in their fields. The tool contains information for 11 locations, 24 planting dates within each location, 12 maturities within a planting date and integrates 34 years of weather variability. Since its announcement on April 16th the tool has reached more than 3000 users. Finally we performed a management risk analysis evaluating soybean yield gap, frost risk, planting dates, and plant population effects on yield. The results are part of the pre-season web tool and were also announced in the ISA research conference. The management risk analysis will be updated as new experimental information will become available.

Regarding the second project, we propose to combine a climate model (WRF) that can provide a 14-day weather forecast with the APSIM cropping systems model to synthesize soil-crop-climate information and deliver in-season forecasts that can answer the following questions: (a) What is the crop and soil status at the time of the forecast date?; (b) How do the current weather and crop growth compare with historical years?; (c) What is the expected soil water and N status and crop needs over the next 14 days?; and (d) What is the expected grain yield at the end of the season? The prediction accuracy of APSIM will be verified from project 1 high resolution field measurements. In 2015, we implemented a "proof of concept" version of this project and disseminated biweekly updates through ICM news and website to a group of 100 people to help us through their feedback standardize this very challenging effort. Results as of August 26, 2015 are very encouraging and we propose to implement this project in 2016 growing season and make the real-time information available in public for free.