Crop Modeling Team Highlights

Global AgMIP Kickoff & Formation of Crop Pilot Teams: Efforts of the crop modeling team were initiated at the global AgMIP kickoff meeting in Long Beach, CA, USA in October 2010, with the drafting of the Crop Model Team Protocols. Over the next 8 months, crop model pilot teams were initiated and the protocols improved and released July 28, 2011. We decided that crop model intercomparisons and improvements would be done one crop at a time in organized teams per crop. The goal of the crop pilot teams is to test sensitivity (uncertainty) responses of multiple models to temperature, CO_2, and various other climatic and management variables at four sentinel sites, and to evaluate model response to climate scenarios for those sites. Some teams also have plans for model comparison to observed CO_2 and temperature response data and plans for model improvement.

Figure 1. Crop Pilot Teams (leaders, # of participating models).

Wheat Crop Pilot – S. Asseng, F. Ewert (27 wheat models)

Rice Crop Pilot –T. Li, T. Hasegawa, Y. Zhu, U. Singh, D. Gaydon, Xinyou Yin, B. Bouman, (13 rice models)

Maize Crop Pilot –S. Bassu, J. Durand, K. Boote, J. Lizaso (19 maize models)

Maize Model Improvement Group – T. Tollenaar, K. Boote, J. Jones, J. Lizaso (open to all maize modelers)

Sugarcane Crop Pilot – P. Thorburn, A. Singels, F. Marin

Potato Crop Pilot – R. Quiroz, D. Fleisher, B. Condori (new)

Sorghum-Millet Model Pilot & Model Improvement – K.P.C. Rao, S. Traore, et al. (new).

Peanut/Groundnut Crop Pilot – P. Singh, K. Boote et al. (new)

Soybean Crop Pilot – K. Boote et al. (new)

Common Bean & Cotton – considering

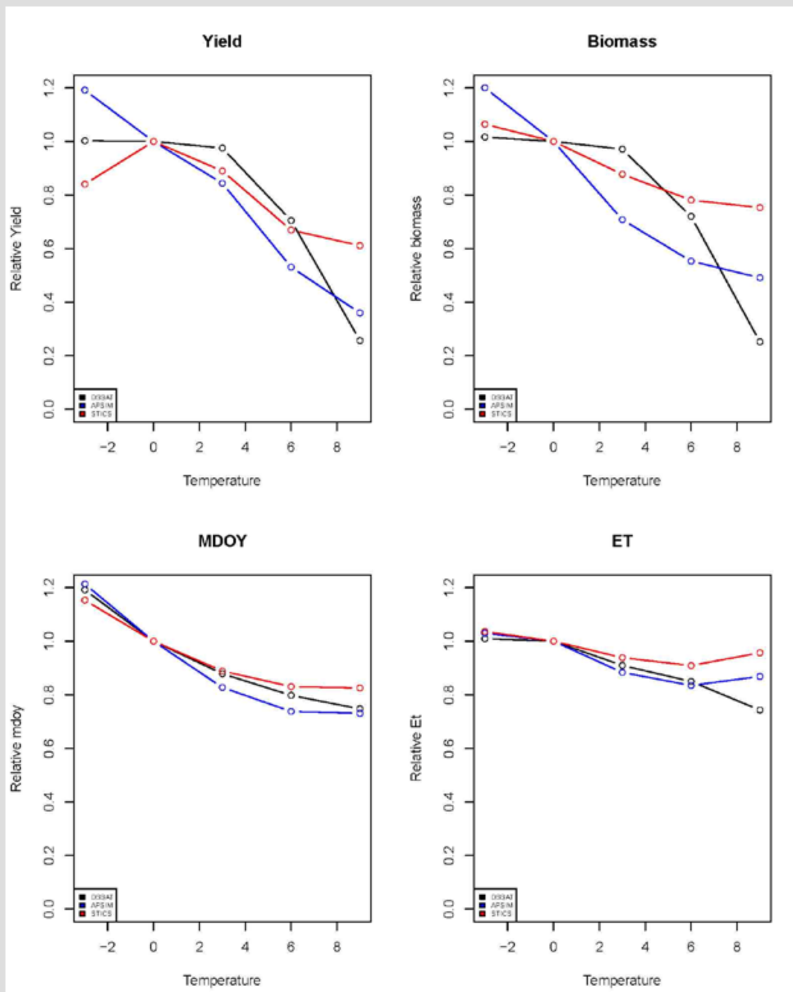
The wheat crop model pilot team was initiated by leaders S. Asseng and F. Ewert at a meeting held April 2011 in Amsterdam. During summer 2011, crop pilot teams were formed for rice, maize, and sugarcane (Figure 1 lists the respective teams and leadership of teams for various crops). The sugarcane crop pilot team led by Thorburn, Singels, and Marin was organized at the South American AgMIP meeting hosted in Brazil during August 1-5, 2011. The rice crop modeling pilot was formalized during a workshop held August 29-30, 2011 in Beijing, China. The maize modeling pilot was initially organized by Nadine Brisson, and now is led by S. Bassu, J. Durand, K. Boote, and J. Lizaso. A maize crop model improvement team was initiated in October 13-15, 2011 at the global AgMIP meeting held in San Antonio, TX, USA. The maize model improvement team will not conduct a crop pilot or climate scenarios, but is aimed at maize model improvement with open participation of maize modelers. These first four crop pilots (wheat, rice, maize, sugarcane) have identified four sentinel sites per crop and have begun model simulations. The wheat team has progressed rapidly and is drafting a paper on wheat model intercomparisons. Teams for potato, sorghum-millet, peanut, and soybean were formed between November 2011 through September 2012, at the North American Regional Workshop and DFID-sponsored workshops for SubSaharan Africa

AgMIP and South Asia AgMIP. For the latter pilots, sentinel sites are not yet identified and number of participating models is not definite.

Work of the Crop Modeling Teams has included: refining the crop modeling protocols, defining sentinel data sets (silver, gold, platinum), initiating the crop pilots, organizing workshops for South American AgMIP (August 2011), Rice Crop Pilot (August 2011), Global AgMIP meeting (October 2011), SubSaharan Africa AgMIP (January 2012), South Asia AgMIP (February 2012), North American AgMIP (September 2012), and Global AgMIP (Rome, October 2012).

Intercomparison of Crop Models at the South American AgMIP Workshop: A major goal of the AgMIP project is a comparison of the simulated results from multiple crop models for the purposes of quantifying model uncertainties and as a basis for model improvement. The South American AgMIP workshop held Aug 1-5, 2011 in Campinas, Brazil, provided a practice run of this intercomparison with three maize models (APSIM, CERES-Maize, and STICS), two rice models (APSIM-ORZYA, CERES-Rice), and two sugarcane models (APSIM, DSSAT-Canegro) for single sites in Brazil, where weather was manipulated to evaluate response to temperature, CO_2, rainfall, and N fertilization. A single climate scenario was also compared to historical baseline weather for those single sites. Figure 2 illustrates our first confirmation that multiple maize models, while similar in the big picture, did differ in their sensitivity to temperature with different optima and temperature responses for yield, biomass, maturity date (MDOY), and season-long ET for step-changes in temperature compared to baseline for Sete Lagoas, Brazil (site data provided by Camilo Andrade). The two rice models were different in their life cycle duration response to above-ambient temperature as ORYZA showed slower life cycle progression at supra-optimum temperature.

Figure 2. Yield, biomass, maturity date (MDAY), and season-long evapotranspiration (ET) response to temperature predicted by APSIM (blue), DSSAT (black), and STICS (red) maize models for Sete Lagoas, Brazil.



Intercomparison of Crop Models at the SubSaharan African AgMIP Workshop held January 16-20, 2012 at Mount Kenya, Kenya. Model intercomparisons were made for two sugarcane models (APSIM and DSSAT-Canegro) with two East African data sets and two millet models (DSSAT-Millet and SARRAH-Millet) with data from Mali. Three maize models (APSIM, CERES-Maize, and AQUACROP) were calibrated for a 4-year data set on N fertilization levels at Wa, Ghana (courtesy, J. B. Naab), and calibrated for a 10-year data set with 20 maize crops at high and low N fertility at Katumani, Kenya (data of Okwach and Simiyu). The maize exercises taxed the ability of the crop modelers to account for the low soil fertility and low soil organic matter status of the two African sites. We did not test model sensitivity to separate climatic factors, but directly compared model performance at baseline 30 years of weather compared to 30 years of future climate scenario (several scenarios at elevated CO2). This effort showed the uncertainty of model performance associated with multiple weather years. For example, Figure 3A illustrates that yield variability with weather years is muted for unfertilized maize, but is much larger for fertilized maize (shown for CERES-Maize, but also true for APSIM). Figure 3B also shows that the APSIM and DSSAT models gave somewhat different response to climate scenarios. We believe this is related to different methods for predicting transpiration and for CO2 effects on transpiration. In addition, an integrated assessment exercise was conducted for Muchakos, Kenya, where maize models (APSIM and CERES) were simulated for 47 farmer sites (inputs from scouting data over 2 years). Model outputs under baseline climate was compared to future climate scenario, linked and analyzed economically with the TOA household economic model of Antle.

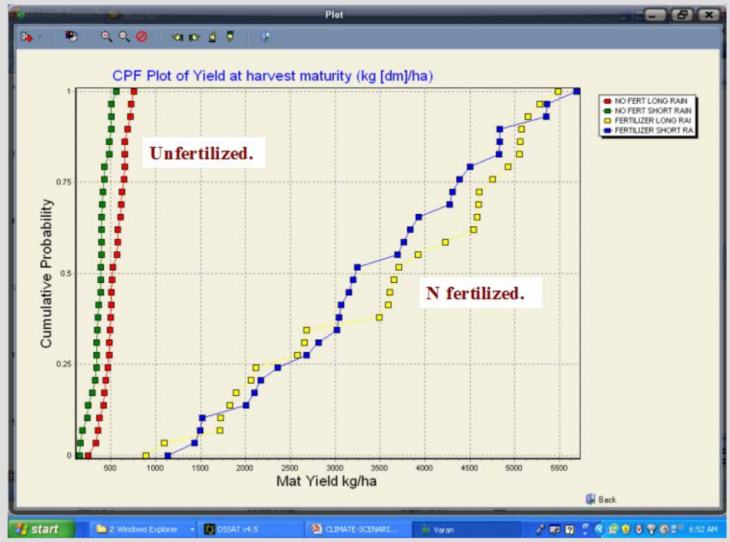


Figure 3A. CERES-Maize simulation of cumulative probability of yield for unfertilized and N fertilized fields for short rainy season and long rainy seasons at Katumani, Kenya, with 30 years baseline weather.

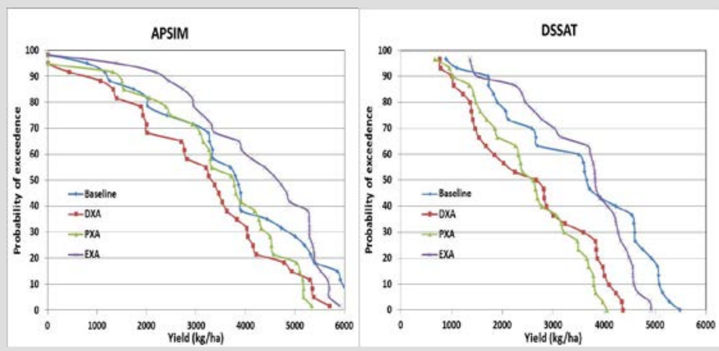


Figure 3B. Probability of yield exceedance predicted for 30-year baseline and three climate scenarios for APSIM and DSSAT models

Crop Model Intercomparison at the AgMIP South Asia Regional workshop held February 20-24, 2012 at ICRISAT in Patancheru, India. Model sensitivity to climate variables of temperature and CO_2 were evaluated for a single site for rice with three models (APSIM-ORYZA, CERES-Rice, and INFOCROP), and for wheat with four models (APSIM, CERES-

Wheat, INFOCROP, and STICS). For example, the multiple crop models for rice had somewhat different responses to temperature (Figure 4). The CO_2 responses were less than expected for three of the four wheat models, which was attributed to N limitation (reported N fertilization was more limiting at high CO_2). An exercise to predict historical peanut yields for the Anantapur district of India was conducted with three peanut crop models (DSSAT, APSIM, and INFOCROP). The models were calibrated with 6 years of experimental data for the Anantapur site. Then peanut yields were simulated for 1980 to 2007 weather (actually 9 rainfall sites, 3 sowing windows, and 3 soil types). Results per year were averaged over the 81 cases and the simulated mean yield compared to the observed district yield for those 28 years. A bias factor was computed and then bias-corrected yield was predicted (Figure 5).

AgMIP websites. AgMIP has two web sites: a public website www.agmip.org, with general information, team descriptions, protocols, events, and presentation of reports. The second website, research.agmip.org, is used by AgMIP researchers for file sharing, model improvement activities, and links to the harmonized database. Much of this website may be restricted to users with the proper authentication.

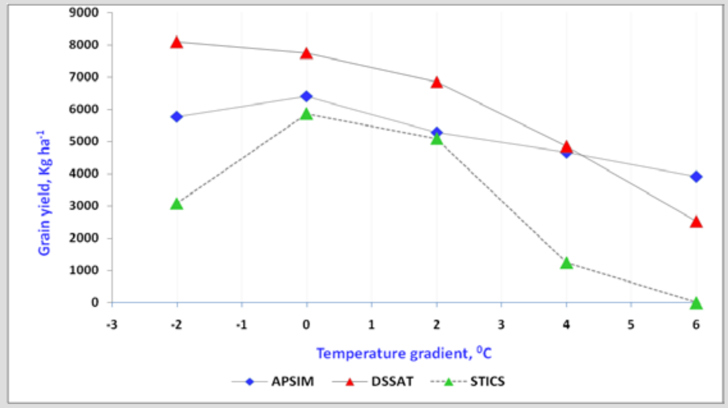


Figure 4. Sensitivity of predicted rice yield to temperature change at 360 ppm for APSIM, DSSAT, and STICS models.

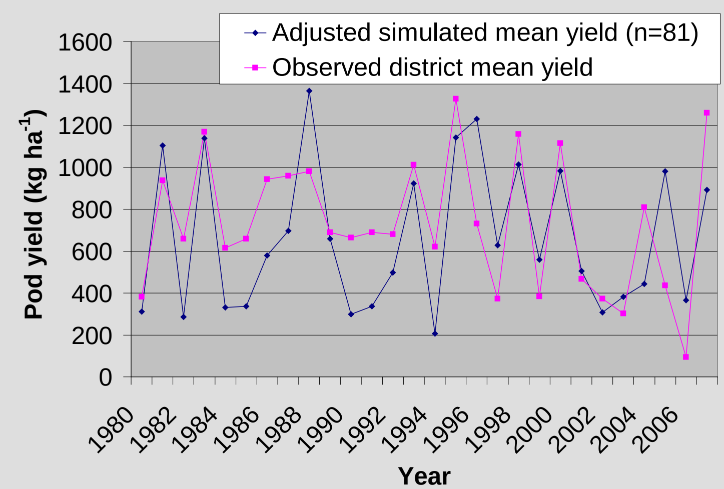


Figure 5. Observed historical district yields and DSSAT-simulated peanut yields (after bias-adjustment and aggregation) for Anantapur district.