Use of Generalized Likelihood Uncertainty Estimation Technique to Estimate Genetic Parameters in CROPGRO Cotton Model

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The Cropping System Models (CSM) are complex models and it is practically impossible to measure or estimate all the model parameters with a high level of accuracy. The CSM CROPGRO Cotton model developed recently was initially parameterized using data from the literature. There was uncertainty in the values of parameters and how they may affect model output was a question. In a recent study, specific genetic parameters of CROPGRO-Cotton model were determined to be vital in inducing uncertainties to the above ground biomass yield, and maturity outputs of the model. As a next step, such parameters needed to be estimated accurately in order to minimize the model uncertainties and improve the model performance. The main objective of this study was to estimate the genetic parameters and evaluate the model performance at the field scale using observed field scale dataset.

For the estimation of genetic parameters of newly developed CROPGRO-Cotton model, the Generalized Likelihood Uncertainty Estimation (GLUE) technique is being used. The GLUE methodology is driven with an idea of equifinality i.e. many different sets of parameters are equally likely simulators of the system. In this methodology, parameters were randomly sampled from their prior distributions using Monte Carlo Simulation approach. Each set of parameters is then assigned likelihood values based on their agreements with the observed values. Posterior distribution would be determined from the acceptable sets of likelihood values to calculate expected values of each individual parameter. Two different cotton field experiments conducted at Quincy, Florida are being used to carry out the model evaluation with cross validation approach. Total of six parameters are being considered for the parameter estimation process. Results from this robust parameter estimation approach are expected to describe observed dataset better than traditionally estimated parameters.

The main advantage of using GLUE is that it rejects the concept of optimal solution of parameters. This method is easy to implement, however, reliable and robust at the same time. It uses prior information on the model parameter distribution in calculating likelihood values. Whenever the new observations are available, it is easy to update the likelihood weights rather than running the whole set of simulations again. Based on this parameter estimation, and model evaluation process, the cotton model can be used to more accurately simulate yield at field scale or county scale for many different purposes.

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