Development, Calibration, and Validation of an Intercropping Model

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Background and Methodology

Introduction and Objective

- Intercropping is an agricultural practice of cultivating two or more crop species simultaneously in the same field.
- The main advantages of intercropping are an increase of the interception of solar radiation and increased nutrient supply when compared with sole crop systems.
- ➢ Develop a new intercropping model by integrating different modules using the Scientific Impact assessment and Modelling Platform for Advanced Crop and Ecosystem management (SIMPLACE) framework.

Modules Development

- Light competition module was selected from literatures with sensitivity and uncertainly analysis and plausibility check to model light transformation and allocation by considering both crop characteristics and arrangements of intercropping system (Fig. 1).
- Belowground water resource are calculated based on the root restriction factor (FRR) per layer. Water resource are firstly separated based on the ratio of FRRs, then limited with the crop water demand and surplus water can be redistributed to the other crop and soils per layer.

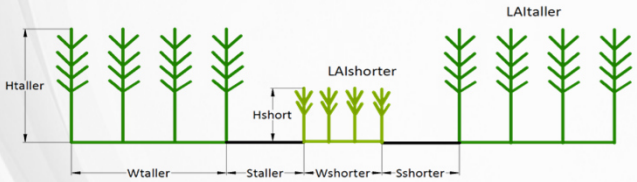

Figure 1: schematic diagram of intercropping system.

Model Establishment

- Original sole crop modules in SIMPLACE database were also modified to fit the intercropping system.
- Nitrogen allocation was presently considered by LINTUL5 module.
- New developed modules for both above-ground and below-ground competitions were coupled together with modified and original other SIMPLACE modules (Fig. 2) to establish the new intercropping model.

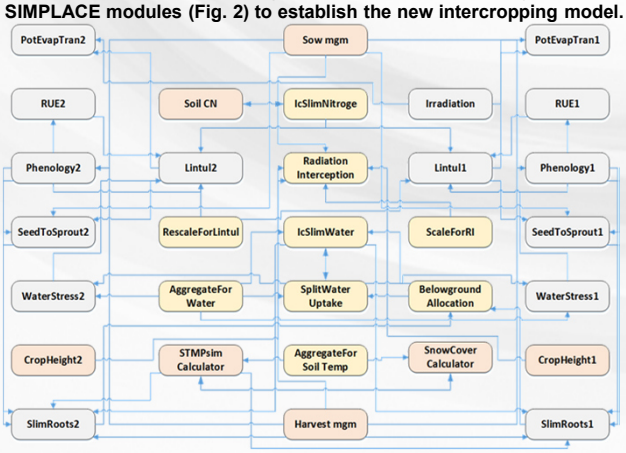

Figure 2: Module integration to establish new intercropping models

Model Calibration and Validation

- Field data were collected in Dassari, Burkina Faso. (Year: 2015 and 2016). Maize, millet, sorghum, and two cultivars of cowpea were planted in sole and intercropping systems respectively.
- The new developed intercropping model was calibrated based on field data of sole crops in 2015 and validated with other field data in both 2015 and 2016.

Results

Biomass of sole crops in 2015 and 2016

- ➢ Simulation accuracy was higher for cereals than legumes in sole crop systems.
- ➢ Environmental stresses varied with different crop cultivars and different crop growth periods.

Results

Biomass of sole crops in 2015 and 2016

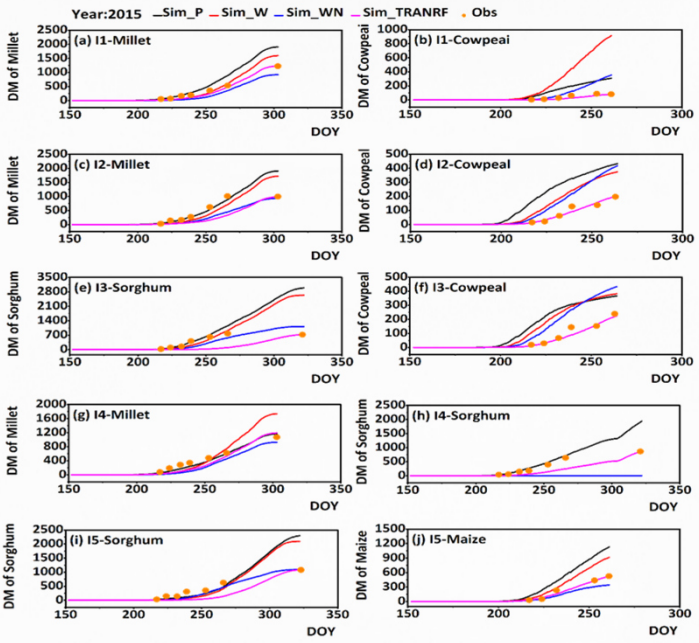

Figure 3: Biomass simulations for sole crops in both 2015 and 2016. Black lines indicate potential condition; red lines indicate water stress condition; blue lines indicate water and nitrogen stress condition; pink lines indicate stress factors were defined by hand instead of calculating by specific stress modules of SIMPLACE; orange dots were observations.

Biomass of intercrops in 2016

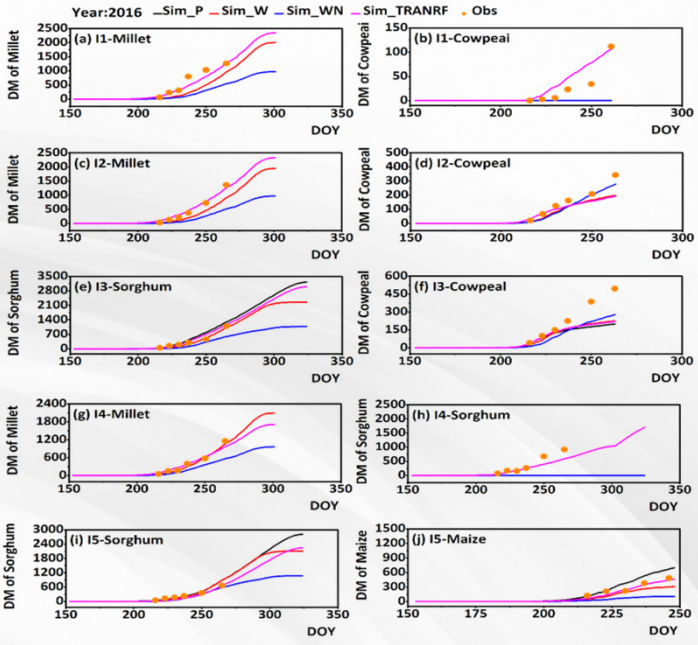

Figure 4: Biomass simulations for intercrops in 2016. Black lines indicate potential condition; red lines indicate water stress condition; blue lines indicate water and nitrogen stress condition; pink lines indicate stress factors were defined by hand instead of calculating by specific stress modules of SIMPLACE. orange dots were observations.

- ➢ Simulation accuracy was higher for cereals than legumes in intercropping systems. Water and nitrogen resources were almost sufficient in 2016 for intercropping systems.
- ➢ For some intercropping systems, simulated biomass in potential condition were found to be smaller than stress conditions, which might be caused by the interactions between above- and below-ground competitions.

Conclusion and outlook

- Novel modules for simulating aboveground and belowground competition have been integrated
- The model can give us relatively accurate simulations for cereals, but relatively poor accuracy for legumes.
- To increase the accuracy, we are now developing new modules considering plant density

References

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