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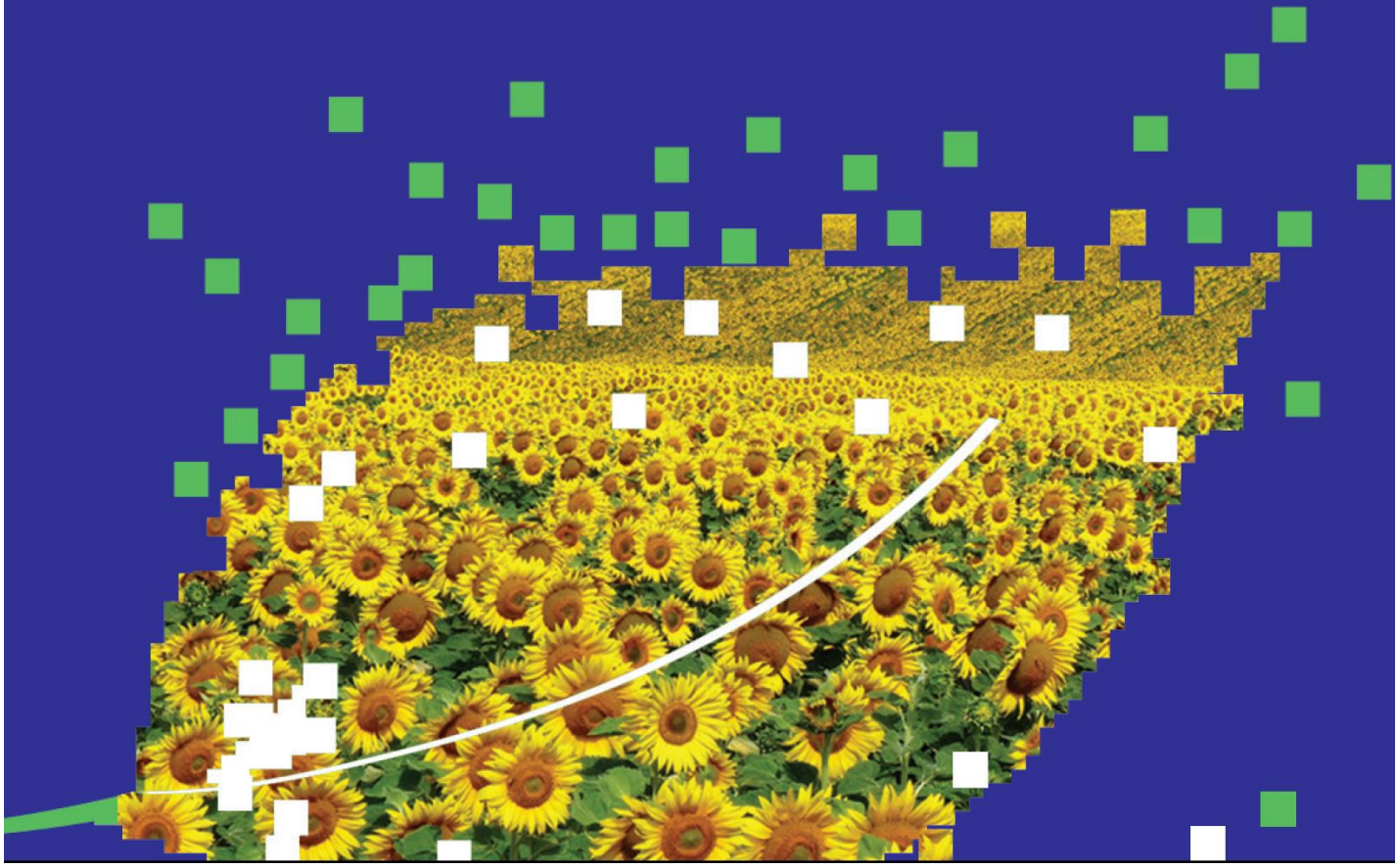

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Predicting sorghum performance from big on-farm data in the savannah zone of northern Nigeria

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Introduction

Smallholder farming systems in semi-arid regions are characterized by poor soil fertility and low agricultural input use. Sorghum production in tWest Africa is mainly rain-fed with many smallholder farmers dependent on it for their livelihoods. Process crop models serve as powerful tools for evaluating different cropping systems and for devising strategic and tactical decisions therein. The Agricultural Production Systems sIMulator (APSIM) is widely used to test the many combinations of production options and interventions under current and future climatic conditions, and to identify main constraints to sorghum production. Our study explores the adaptation and performance of contrasting sorghum cultivars ranging from early to late maturing, low to high photoperiod sensitivity over a wide range of sorghum production environments. It aims to combine simulation and field experimentation to evaluate crop response to variable climate risk and management practices, across different soil types and climate scenarios.

Materials and Methods

Two datasets provided calibration and validation for five contrasted sorghum varieties. Calibration data came from 2016-2018 on-station field experiments conducted in the Savannah and Sudano-Sahelian agro-ecological zones. Validation data came from 2013-2017 on-farm measurements of the impacts of various improved agronomic practices including: seed treatment, minimum tillage and fertilization strategies. A total of 3,266 yield data points spread from Southern Guinea Savannah to the Sudano-Sahelian zone were assembled that included basic management data (sowing date, fertilizer application rate) and approximative location for each farm. APSIM was used to simulate crop grain yields under two different weather scenarios (historical and future) and three fertility levels (low, medium and high). Spatial information was normalized across scales to match with modelling outputs. Soil maps from FAO, agroecological zones from the national agencies, national and CHIRPS data, observed yield from the multilocal trials were used to understand the connectivity to markets and credit was compiled and used in a mapping framework to generate zones of adaptation.

Results and Discussion

Our results showed that APISM produced robust predictions of phenology (flowering and maturity) captured with high accuracy (MBE: 1-4 days; normalized RMSE < 10%). The prediction of grain yield (GY) and total biomass (TB) ranged from accurate RMSEn (SK5912: 9.2% for GY; 6.9% for TB) to low RMSEn (34.5% for GY; 36.8 % for TB) of the observed mean across the sorghum variety. Being able to accurately predict crop performance over widely differing agro-ecologies and soil types, is the basis for applying such tools for management. Simulated grain yield varied widely among cultivars CV varying from 12 - 31% depending on variety.The spatial dimension to this type of study will add value to predictions by providing a basis for scaling-out over larger areas.

Conclusion

This study is expected to strengthening digital farming solutions towards improving management practices and risk management strategies to cope with uncertainties and benefits African smallholder farmers productivity and financial security .

Acknowledgement

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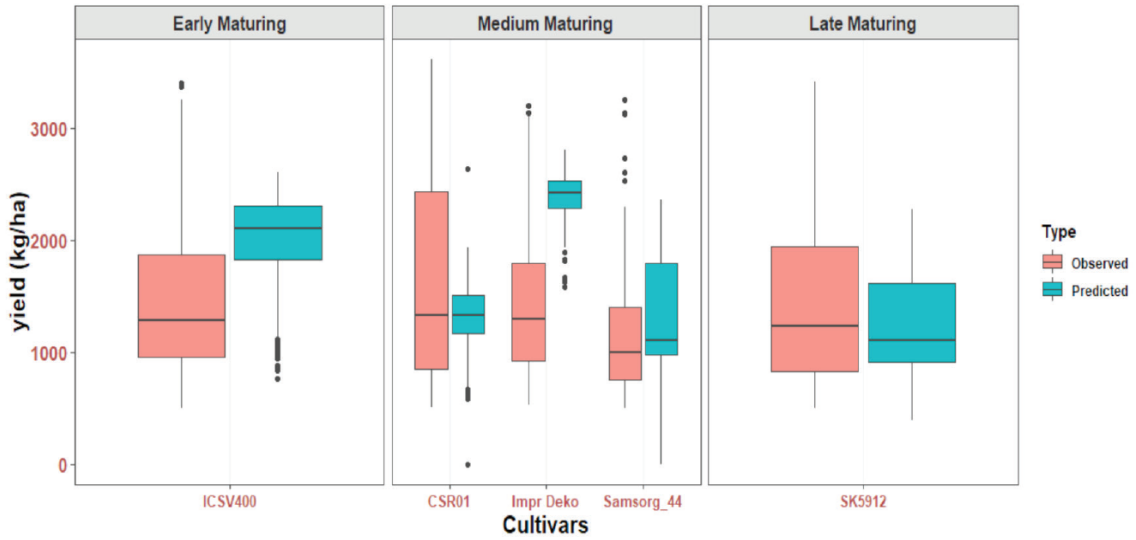

Figure 1: Yield of (observed and simulated) using on-farm data sets from 2013-2017 growing seasons from contrasting environment for five (5) sorghum cultivars ranged from early to late maturing.
ICSV-400 (N=1192; MBE = 535 kgha-1;RMSE =971kgha-1); Improved Deko (N=300; MBE= -960 kgha-1,RMSE = 1169 kgha-1); Samsorg-44 (N=100; MBE= 102 kgha-1;RMSE = 912 kgha-1);CSR01 (N=944; MBE= -228kgha-1,RMSE = 867 kgha-1); SK5912 (N=731; MBE= -219 kgha-1;RMSE = 839 kgha-1. Coefficients of variation (CV) ranged from 12 - 31% depending on variety, N= number of observation

Keywords: Sorghum, Nigeria, APSIM, big data, NADiRA.

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