Evaluating the African Cassava Agronomy Initiative's Framework for Site-Specific Fertilizer Recommendation

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Introduction

The African Cassava Agronomy Initiative (ACAI) is set to develop decision support tools (DST) to provide advise on site-specific fertilizer recommendations to extension agents and farmers to sustainably intensify and increase cassava production with a focus on commercial farmers. These DSTs are based on the combination of two complementary crop models: the Light INTerception and UtiLization (LINTUL) and the Quantitative Evaluation of the Fertility of Tropical Soils (QUEFTS). Although QUEFTS is known to be useful for understanding N, P and K nutrient interactions and effects on crop production, it is a static model limited in capturing the effect of seasonal weather variability on root yield, which is meant to be effectively handled by mechanistic models like LINTUL. We set to evaluation the performance of this framework involving these two models, and the effects on cassava yields of the resulting site-specific fertilizer recommendations as compared to farmer's practice without fertilizer application.

Site-Specific Fertilizer Recommendation Framework

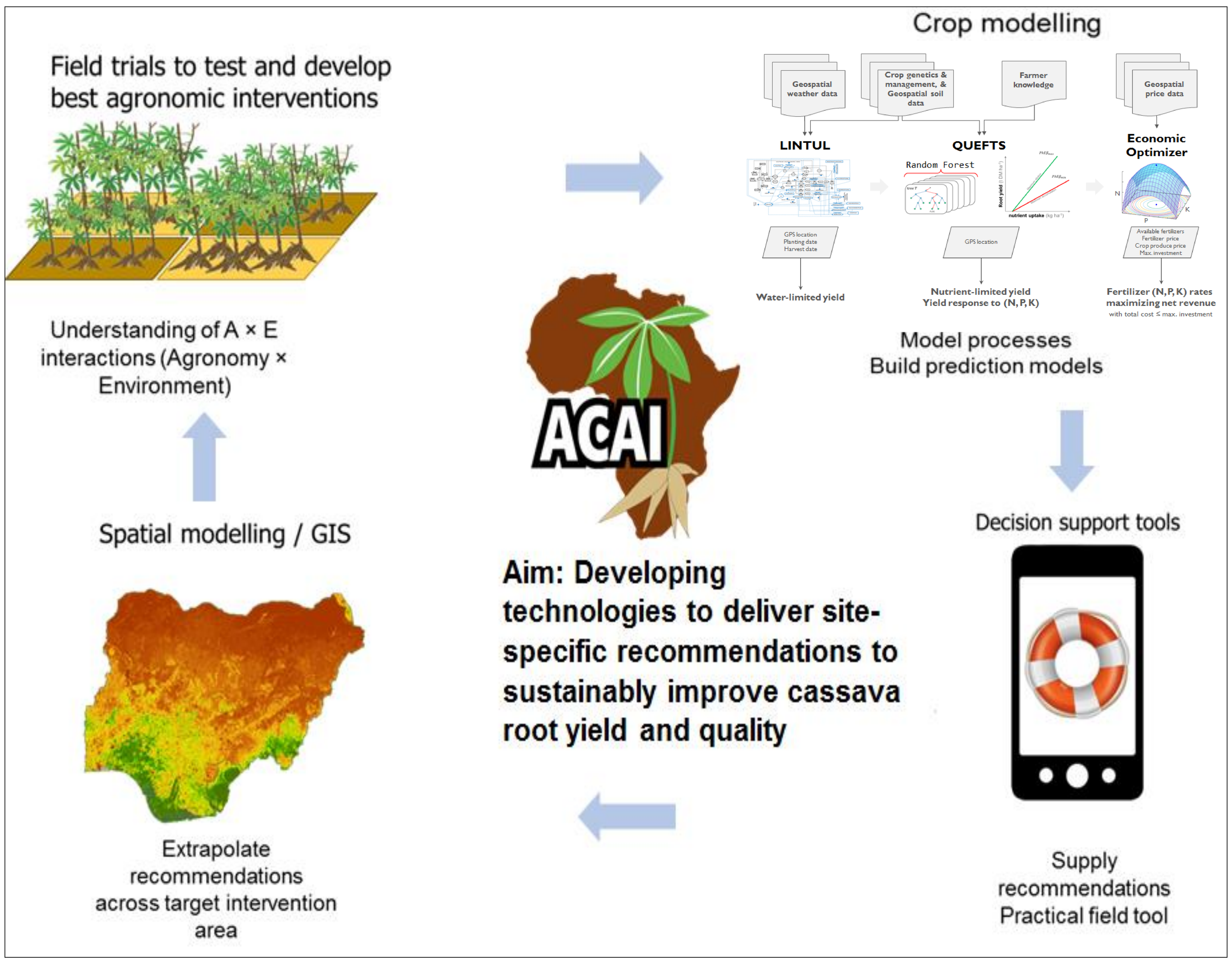

Fig. 1. Simplified schema of ACAI site-specific fertilizer recommendation framework

Field experiments were conducted in Nigeria and Tanzania from 2016 to 2018: i) to collect data for understanding cassava response to fertilizer (nutrient omission trials (NOT)), ii) to calibrate crop models, LINTUL and QUEFTS, that can be used to generate agronomic recommendations, iii) to test recommendations from the modelling framework through validation trials. The trials were established in pre-defined major geographies across cassava productions belts in the two countries. Table 1 shows counts of the number nutrient omission trials conducted across the years.

LINTUL simulated water-limited yields (WLY) using daily historical weather data from CHRISP (rainfall) and NASA-POWER (solar radiation, wind speed, minimum and maximum temperature), soil grid data from ISRIC (International Soil Reference and Information Centre) as well as crop genetic and management information like planting and harvest date. Whereas QUEFTS calculated fertilizer recommendations using WLY as maximum attainable yield, as well as soil chemical and physical properties data, and crop response parameters (harvest index, internal efficiency and recovery fractions).

LINTUL performance was evaluated by comparing simulated WLY with measured NPK treatments. QUEFTS was evaluated by back-calculating apparent indigenous soil NPK using yields from PK, NK and NP treatments from the NOTs and minimizing the sum of errors of the difference with the NPK 150-40-180 treatments. The control and ½ NPK treatments were not included, and were used later to test the model performance. The overall apparent soil NPK estimation was thereafter defined according to soil properties using machine learning for the extrapolation across agroecologies of fertilizer recommendations, which were tested in the validation trials.

Table. 1. Number of nutrient omission trials planted per country from 2016 to 2018

Tanzania	NOT 2016		NOT 2017		NOT 2018
Zone	planted	harvested	planted	harvested	planted
Lake	112	73	109	65	0
Eastern	80	22	50	42	17
Southern	99	72	99	59	75
Total	**291**	**167**	**235**	**166**	**92**

Nigeria	NOT 2016		NOT 2017		NOT 2018
Zone	planted	harvested	planted	harvested	planted
South East	85	56	140	123	36
South West	58	33	90	60	24
Total	**143**	**89**	**230**	**183**	**60**

Results and Discussion

Models evaluations using field experiments data indicated on the one hand that LINTUL estimates of water-limited yields were mostly higher than NPK treatment yields (Fig. 2A). Detailed analysis of the results revealed sub-optimal estimates of water-stress, especially for planting dates between July and March. On the other hand, an acceptable performance of QUEFTS was noted (Fig. 2B and Fig. 2C). There were good fits between the predicted and measured control treatment yields, and between the predicted and measured ½ NPK treatment yields. These treatments were not involved in the back-calculation of indigenous soil NPK based on the nutrient omission trials yields.

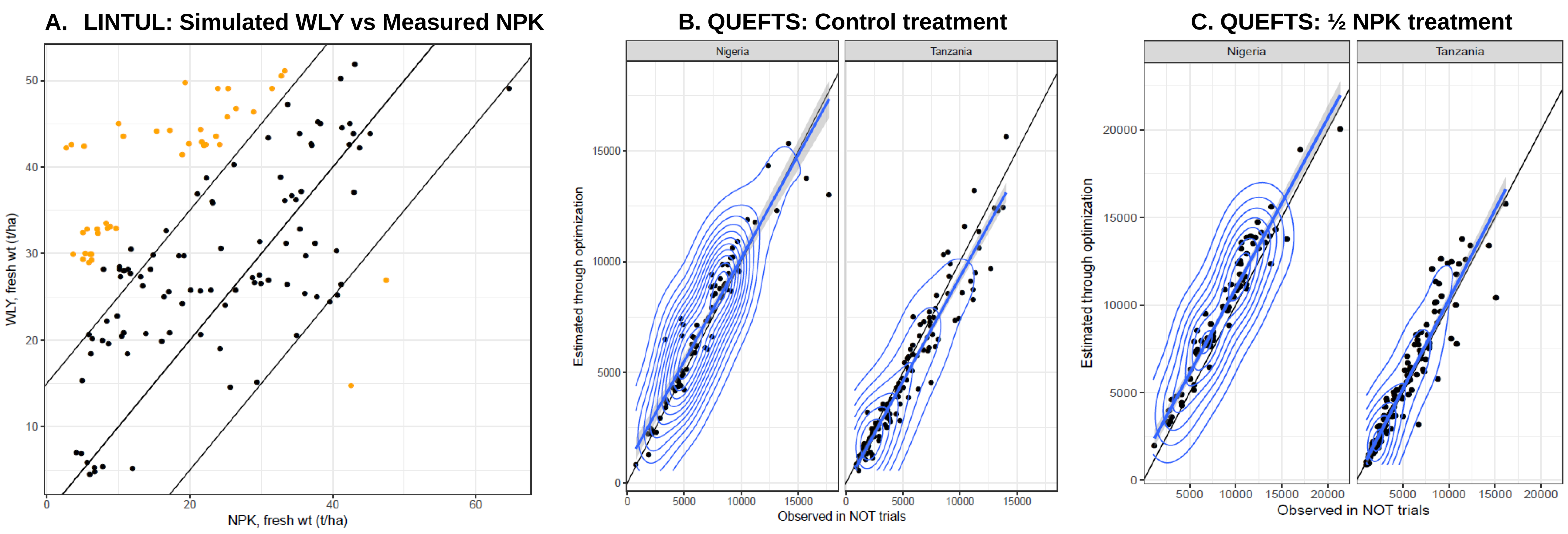

Fig. 2. Models performance evaluation with A. for LINTUL simulating water-limited yield (WLY) as compared to measured NPK treatments, B. for QUEFTS comparing predicted and measured control yields and C. comparing predicted and measured ½ NPK treatment rate that were not involved in soil NPK supply assessment

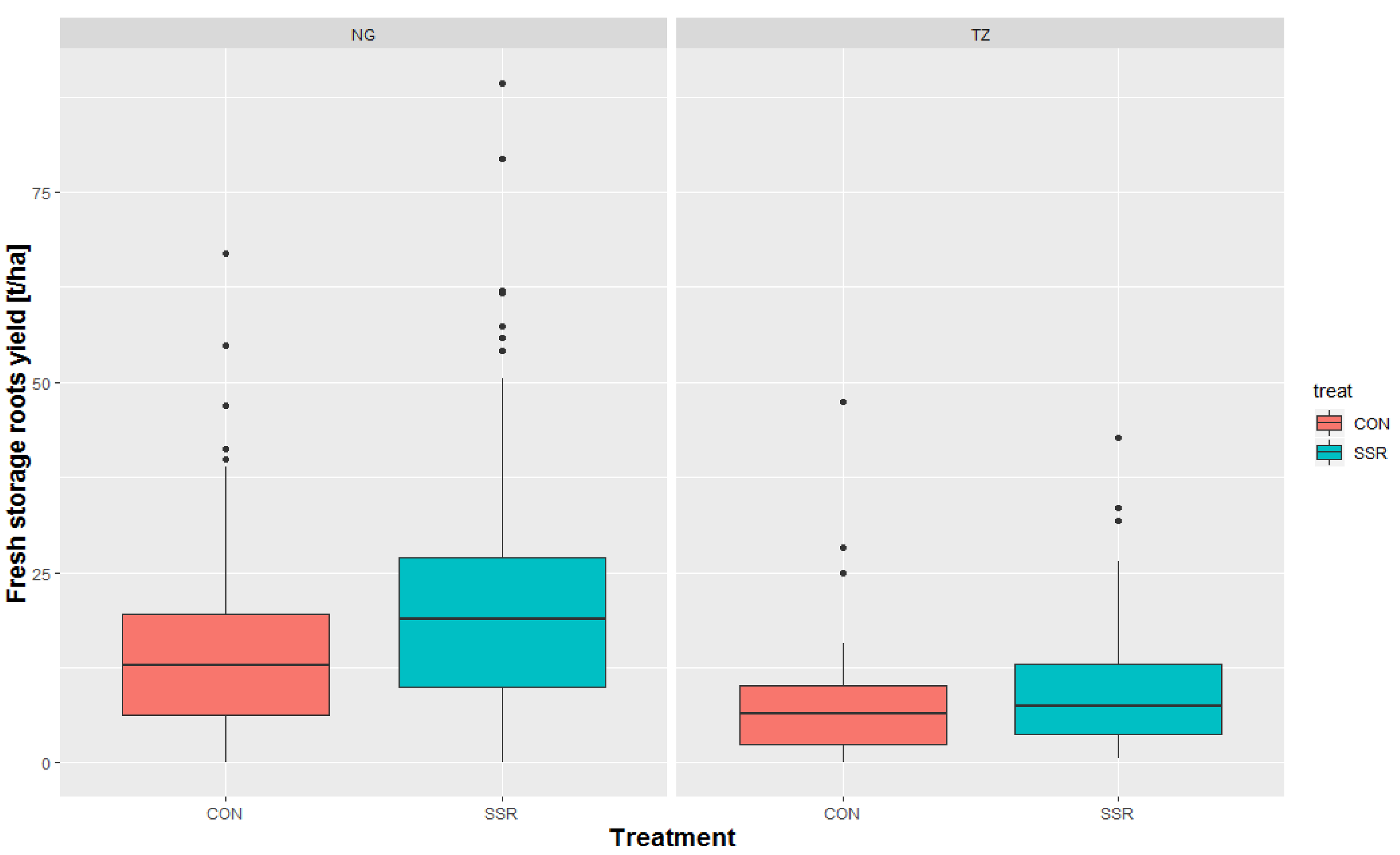

Fig. 3. Validation trials results comparing the control (CON) with the site-specific fertilizer rate (SSR) recommended using the ACAI fertilizer recommendation framework in Nigeria and Tanzania

The validation trial treatments also (Fig. 3) showed the better performance of the site-specific (SSR) compared to the control (CON) across Nigeria and Tanzania, indicating an added value of tailoring fertilizer rates to local conditions of the farmer in order to achieve increased yields.

Conclusion

The current modelling framework for site-specific fertilizer recommendation for cassava production of the African Cassava Agronomy Initiative has led to increased yields as per the validation exercise results. However, efforts towards improving the modelling framework should continue using the additional data from the on-going field validation trials in order to achieve better recommendations as necessary to increase farmers confidence in investing in fertilizer for cassava production.

Acknowledgements

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