Modelling soybean yield response to nutrients applications under projected climate change scenarios in Benin

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Introduction

- Soybean is part of the main annual crops in Benin and served as cash crops for the producers and strategic crops in the maintenance of the country's food security (Chabi *et al.,* 2019). As sources of food, feed, and biofuel, soybean demand will continuously increase in the future.
- Climate change will have an important impact on agricultural production and sustainable development of the environment especially in West Africa.
- Based on the limitations of land resources, it is important to explore a sustainable and effective fertilization strategy to reduce risks and ensure there is a high grain yield and a sustainable development of agriculture.
- Objectives of this study were to develop a CROPGRO model to estimate soybean yield cultivars in Southern Borgou and the cotton zone of the Centre in Benin and evaluate the influence of climate change on soybean yield in Southern Borgou and the cotton zone of the Centre under fertilizer application.

Methods & Materials

- Simulations carried out in this study concerned two agro-ecological zones of Benin namely Southern Borgou and the cotton zone of the Centre (Figure 1)
- Soybean variety used was TGX 1448-2E (105 days of growth cycle and an achievable yield of 1.8 t. ha^{-1}).
- Historic weather data between 1980 to 2017 were used for the initial fertilizer dose simulation and daily data of 2018 and 2019 were used for the on-farm validation of the fertilizer recommendation. The future climate data used was obtained from the CORDEX database.
- Model results have been evaluated by computing three parameters including the root mean square error (RMSE), the normalized root mean square error (NRMSE) and the determination coefficient (R^2).

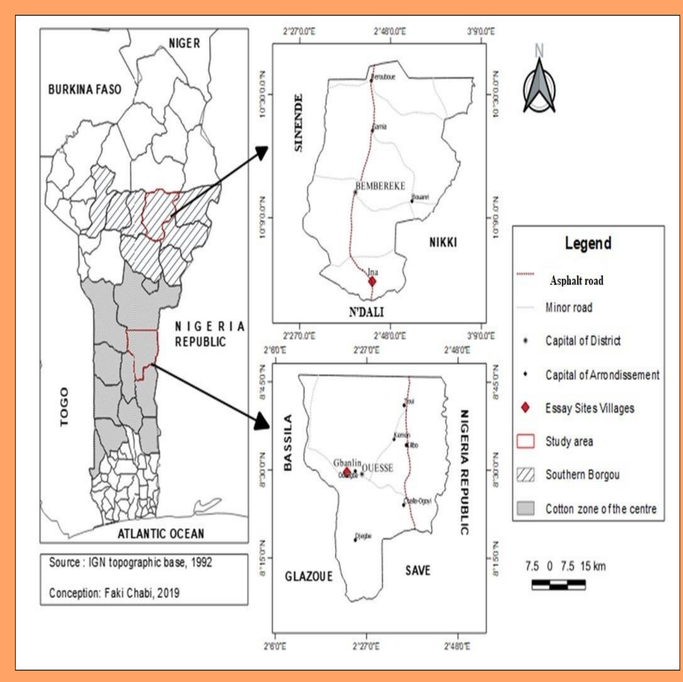

Figure 1: Study zone

Results

❑ Model calibration and validation

Variables	2018		2019	
	Bembereke	Ouesse	Bembereke	Ouesse
Observed (kg ha^{-1})	2200	2076	1980	1883
Simulated (kg ha^{-1})	2051	1986	1772	1731
MD	-149**	-90**	-208***	-152*
Ratio	0.93	0.95	0.89	0.91
R^2	0.86	0.94	0.96	0.76
RMSE (%)	243.16	315.23	452.6	263.9
NRMSE (%)	11.05	15.18	22.8	14.01

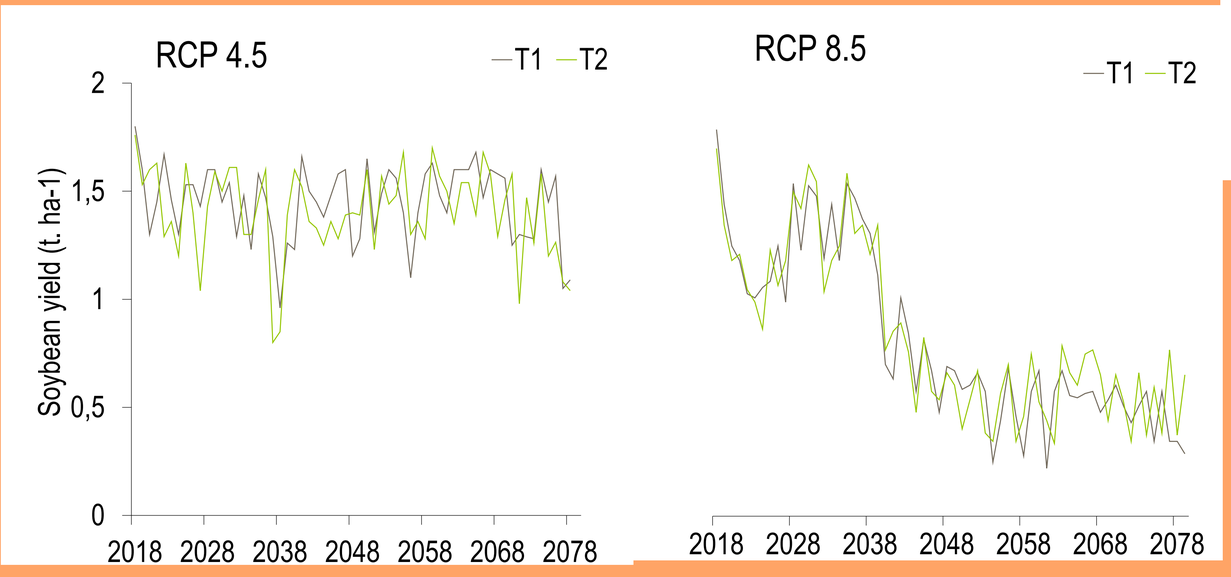

Figure 3 : Annual grain yields of soybean under the climate scenarios between 2018 and 2078 at Ouesse site

❑ Influence of climate change on soybean yield

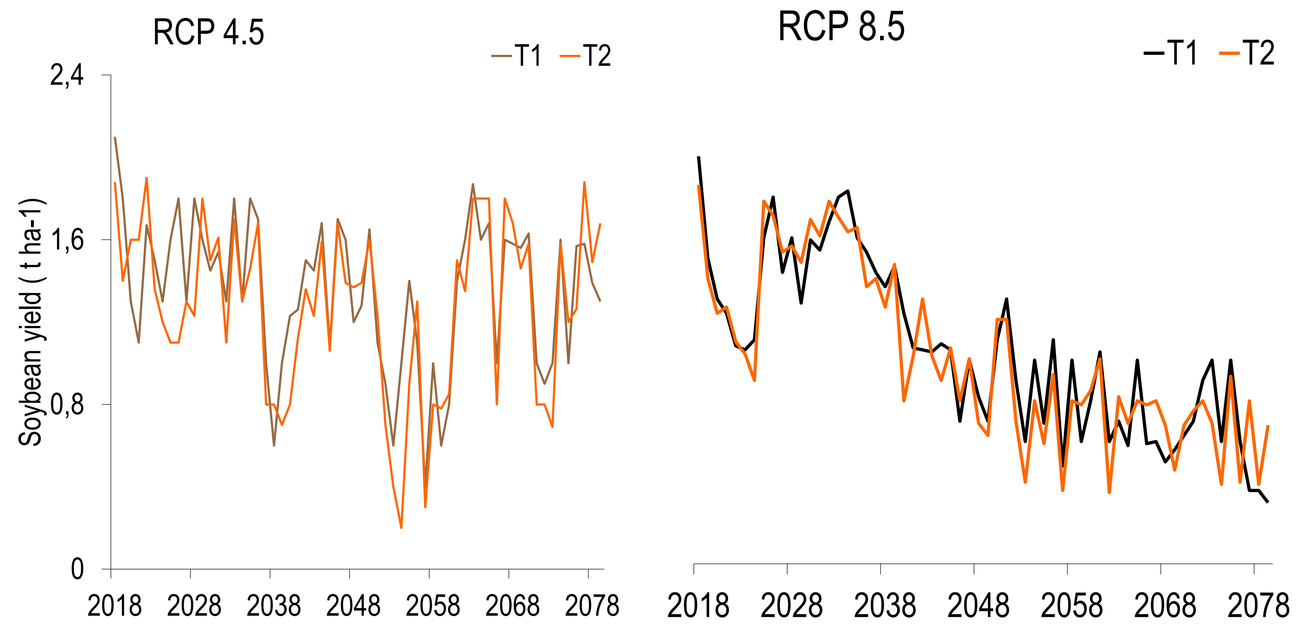

Figure 2 : Annual grain yields of soybean under the climate scenarios between 2018 and 2078 at Bembereke site (T1=$N_{14}P_{23.9}K_{18.18}Mg_{11.45}Zn_{4.14}$; T2=$N_{16.6}P_{23.5}K_{29}Mg_{15.2}Zn_{7.7}$)

- Model can therefore be used to recommend optimal agronomic parameters for soybean production in regions exhibiting similar climatic conditions with ours
- Results indicates a 9% (T1) to 19% (T2) decrease in soybean yield when we consider the optimistic scenario and yield decreases of 38% when we consider the pessimistic scenario
- Tracking the changes in projected annual soybean yields for both sites (Figures 2 and 3), declines in soybean grain yields will be more accelerated by mid-century and this trend will continue as we move toward the end of the century.

Conclusion

- Future climatic conditions between now and 2079 will lead to a decrease in soybean yields in both agro-ecological zones with different nutrient combinations
- This calls for the implementation of adaptation strategies to ensure good soybean production in these areas with the application of fertilizers

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