Model based Estimation of Resource Use Efficiency in Current Maize Production Systems in Ethiopia, Ghana and Nigeria

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Introduction

Understanding the resource use and resource use efficiencies of current production systems could help to identify possibilities of producing more with the available resources and to address the variability in yield and biomass production. Estimation of Rain Water Use Efficiency (WUE), Radiation Use Efficiency (RUE) and Agronomic Fertilizer Use Efficiency (FUE) will allow farmers to optimize their production practices under rain-fed agricultural production systems. Moreover, quantifying the relationships between RUE, WUE, FUE and biomass yields would facilitate the calculation of economic returns to fertilizer and guide breeding programs to develop cultivars with optimal resource use efficiencies.

Materials and Methods

A gridded data set was built covering the major maize producing regions in Ethiopia Ghana and Nigeria. Within the SIMPLACE modelling framework (www.simplace.net), a combination of the LINTUL5 crop model with a detailed soil water balance model (SLIM) was used to simulate yield and biomass productivity of dominant maize varieties under prevailing agri-management practices.The simulations were run at 25 x 25 km grid cells and WUE, RUE and FUE was calculated for each simulation grid and aggregated from the simulation grid to the district level for comparing them with the statistics.

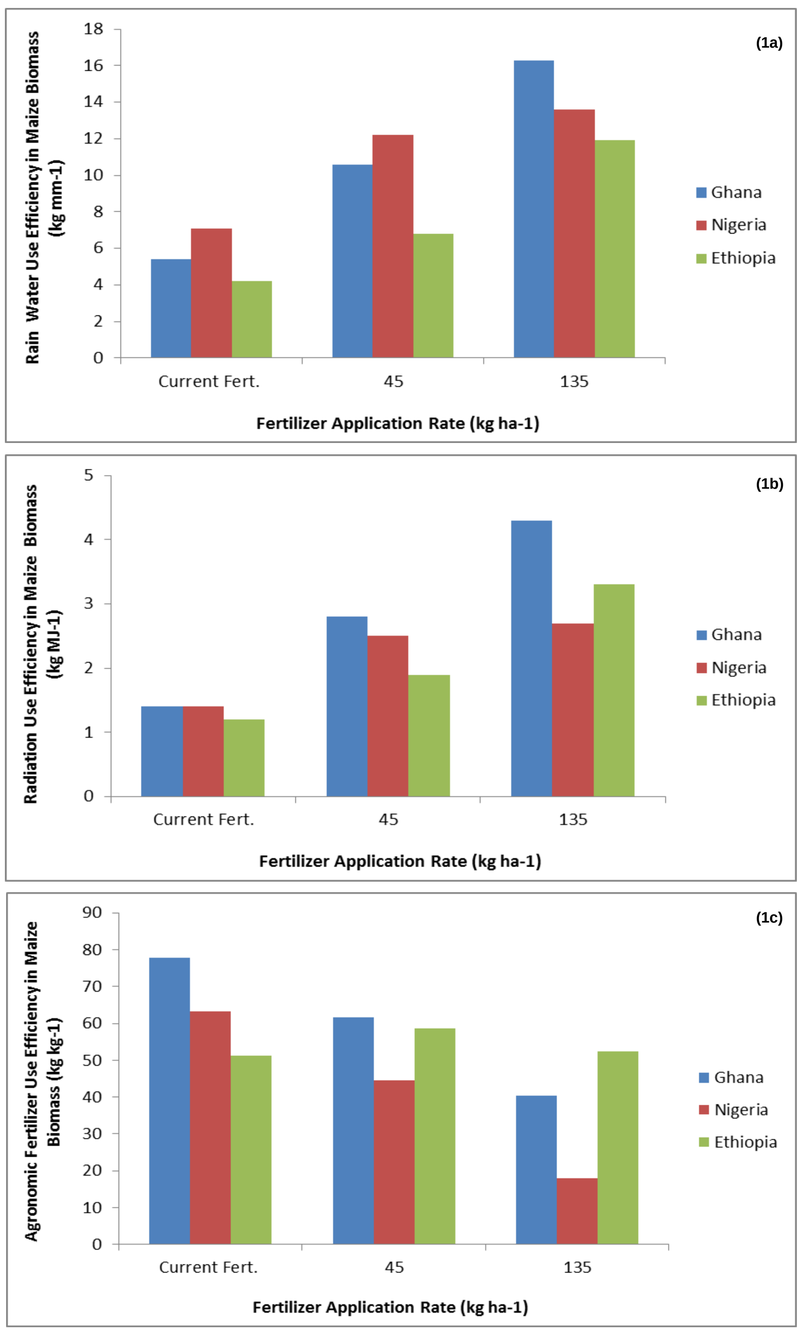

Fig.1: Comparison of WUE (a), RUE (b) and FUE (c) in focus regions n Ghana, Nigeria and Ethiopia under current fertilizer application rate, 45 kg ha-1 N and 135 kg ha-1 N respectively.

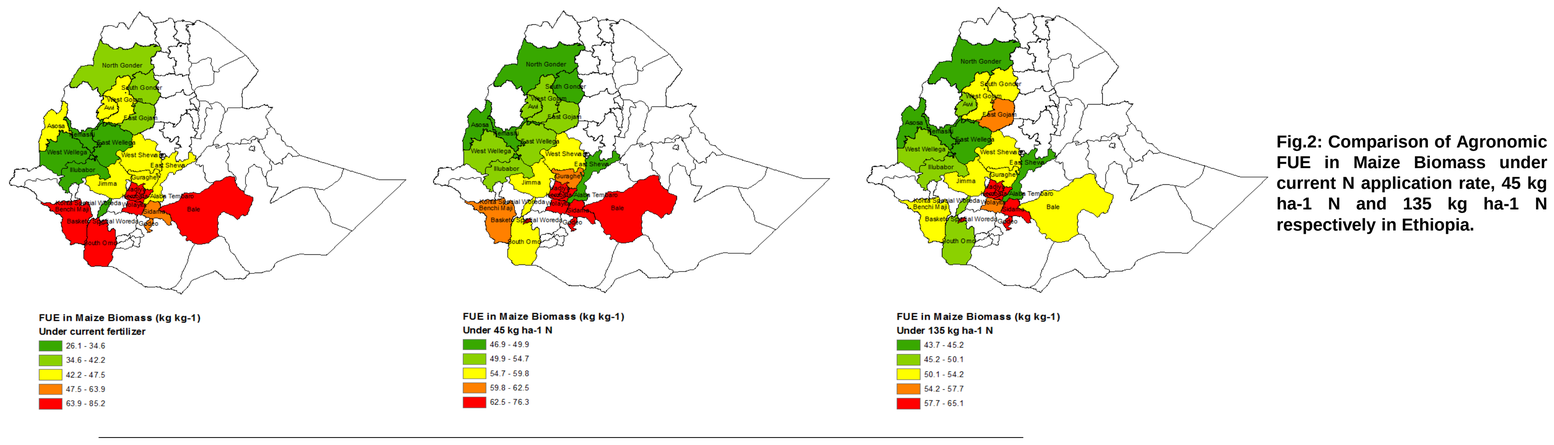

Fig.2: Comparison of Agronomic FUE in Maize Biomass under current N application rate, 45 kg ha-1 N and 135 kg ha-1 N respectively in Ethiopia.

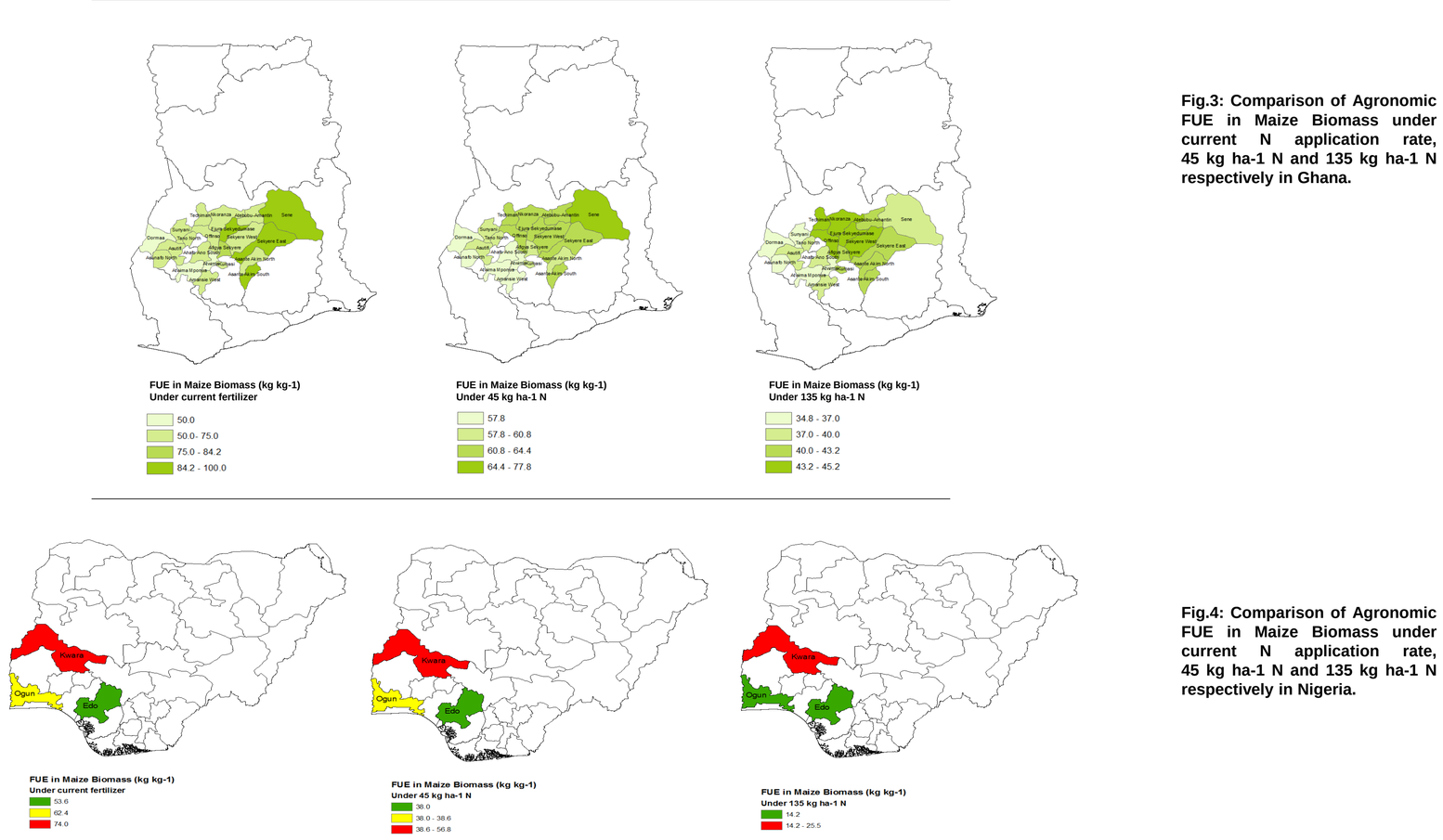

Fig.3: Comparison of Agronomic FUE in Maize Biomass under current N application rate, 45 kg ha-1 N and 135 kg ha-1 N respectively in Ghana.

Fig.4: Comparison of Agronomic FUE in Maize Biomass under current N application rate, 45 kg ha-1 N and 135 kg ha-1 N respectively in Nigeria.

Results and Discussion

The WUE and RUE increases whereas FUE (except for Ethiopia) decreases with higher rates of N fertilizer application (Fig. 1a, b, c).Highest WUE and RUE were estimated in Ghana under 135 kg ha^{-1} N application compared to corresponding values in Nigeria and Ethiopia. Highest FUE under current fertilizer application was estimated in Ghana and Nigeria in tune of 77.7 and 63.3 kg DM kg^{-1} N respectively. In Ethiopia, highest FUE of 58.7 kg DM kg^{-1} N was estimated under 45 kg ha^{-1} N. The spatial variability and the lowest FUE values across the regions in Ethiopia, Ghana and Nigeria was attributed to the lowest cumulative precipitation amount in the crop growth period.

Conclusion

Results obatained suggest that rain water would be most efficiently used for biomass production from maize in Ghana, Nigeria and Enthiopia when combined with 135 kg ha^{-1} N fertilizer application.The calculations of optimal application rates at administrative zone level should not be applied to individual farms, because at this level, the soil endowment of a farm is a decisive factor.

Acknowledgement

Funding by Federal Ministry of Education and Research (BMBF) of Germany is highly acknowledged for GlobeE project.

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Federal Ministry of Education and Research
Federal Ministry for Economic Cooperation and Development