Yield Gap Analysis of Maize in Central Ghana

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Introduction

Agricultural productivity growth in Sub-Saharan Africa over the past four decades averaged only 2.4% compared with 4% in the rest of the developing world (World Bank, 2013). The world continues to face the challenge of feeding the growing population, increasing average yields by reducing the yield gap has become imperative. As one would expect, there exists enormous heterogeneity in yields across Africa. In Southern Africa over the past decade average cereal yields were 86% of that of the world average compared with Western, Eastern, and Central Africa where average yields were only 18%, 29%, and 35% of the world average (FAOSTAT, 2013). Average farmer yields in a region are inevitably smaller than yield potential, because achieving yield potential requires near perfect management of crop and soil factors that influence plant growth throughtout the growing cycle. The existence of a stable gap between average and potential yields can be caused by poor crop management, pests, diseases, economic reasons, soil degradation, pollution, or climate change.The yield gap is a concept (Figure 1) that rests on the definition of the yield potential. Here, we define yield potential as the yield of an adapted crop variety when grown under favorable conditions without growth limitations from water, nutrients, pests or diseases. For any given site and growing season, yield potential is determined by three factors: solar radiation, temperature, and crop genetic characteristics. In this study we estimated maize (*Zea mays* L) yield gap in two regions of Central Ghana which constitute major agricultural production areas.

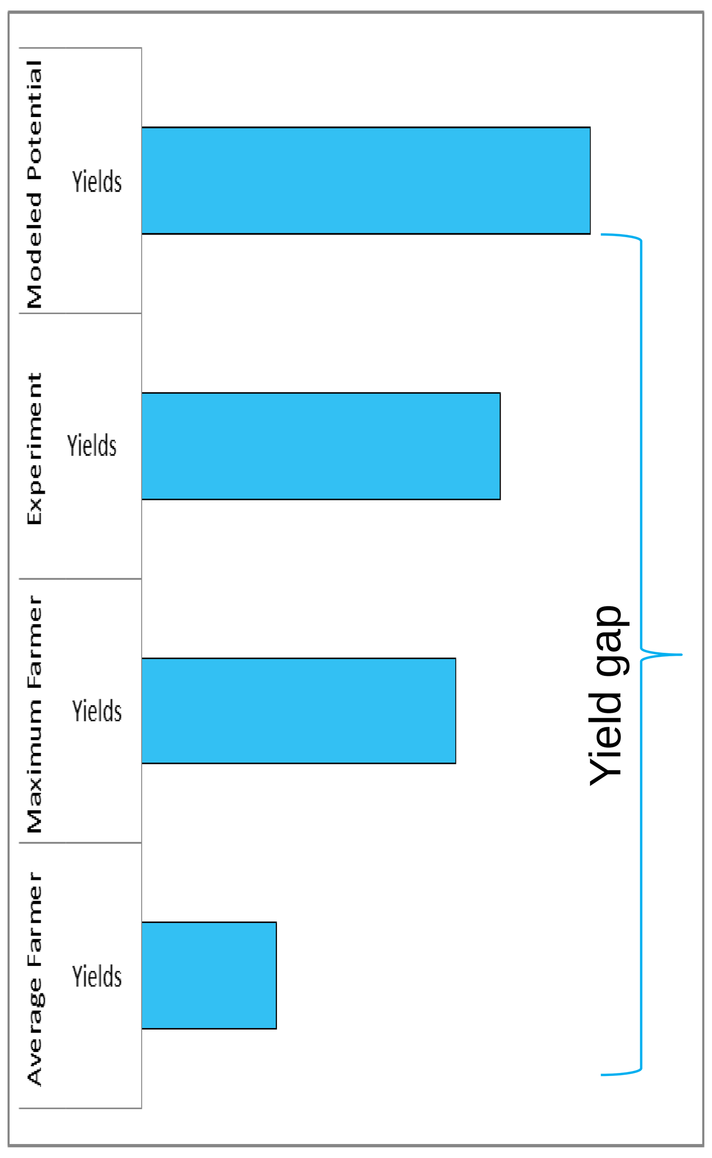

Fig 1: Conceptual diagram of Yield gap

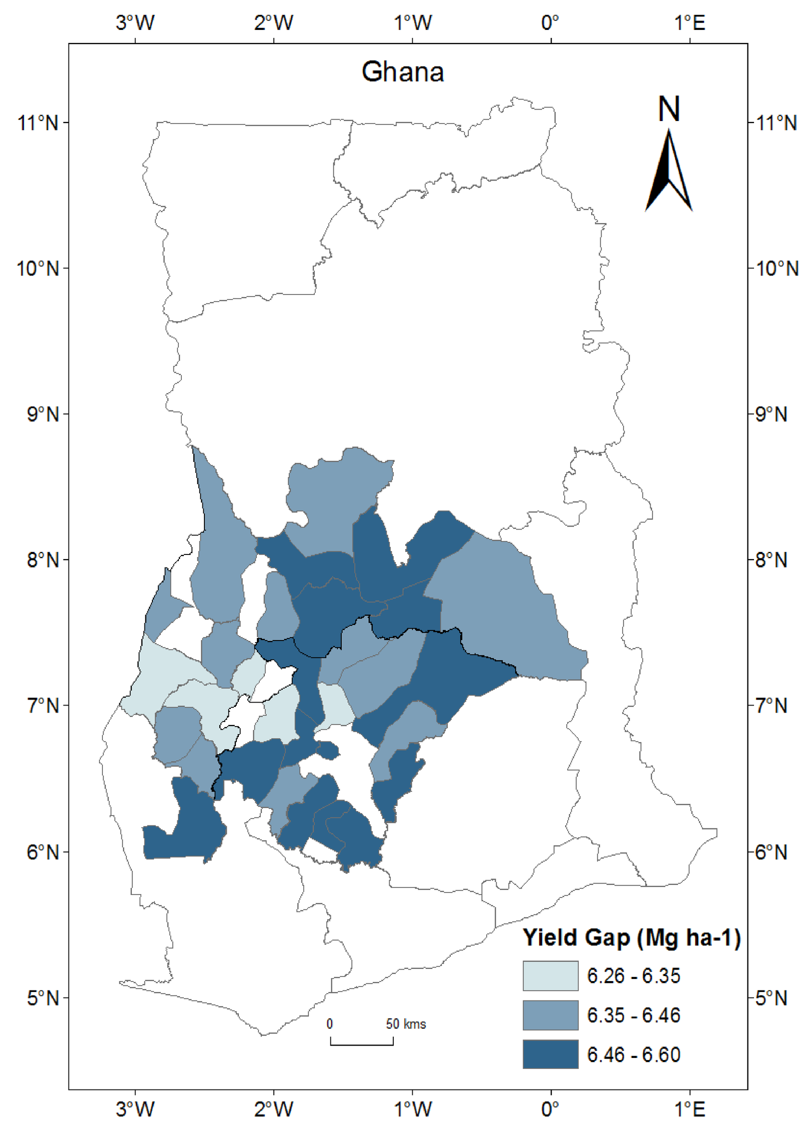

Fig 2: Difference between simulated potential and simulated actual yields (Mg ha^{-1}) in two regions of Central Ghana

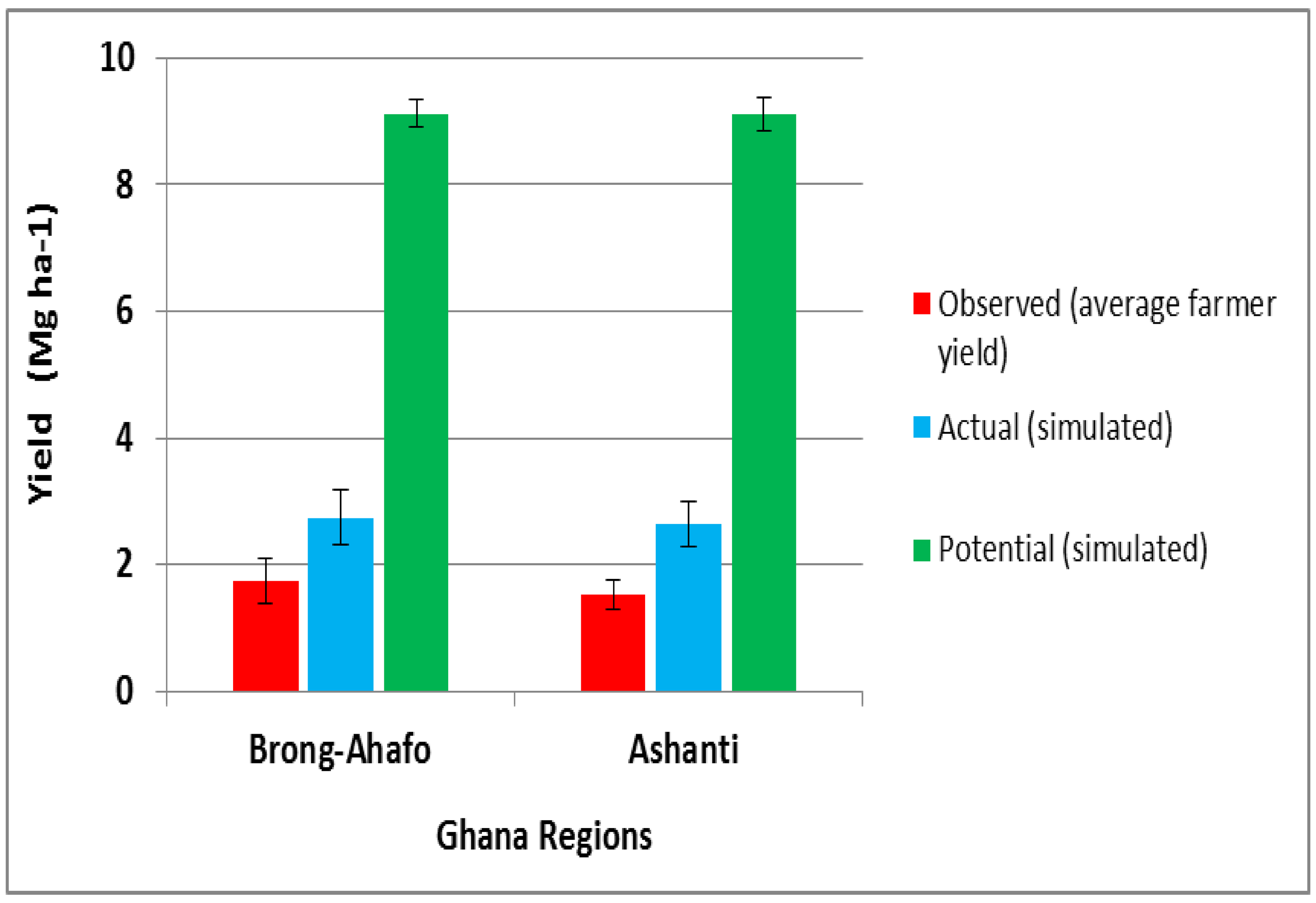

Fig 3: Simulated potential and simulated actual maize yields versus observed average farmers yields in two regions of Central Ghana

Materials and methods

Ashanti Region is centrally located in the middle belt of Ghana lying between longitudes 0.15°W and 2.25°W, and latitudes 5.50°N and 7.46°N and occupies a total land surface area of 24,389 km^2. **Brong-Ahafo Region** lies between latitude 7.75°N and longitude 1.5°W, occupying a total land surface of 39,557 km^2. The average annual rainfall in both the regions are 1270 and 1000 mm respectively. Within the SIMPLACE modelling framework, a combination of the LINTUL5 crop model with a detailed soil water balance model (SLIM) was used to simulate the maize yield of two varieties (Obatanpa & Dodzie). Weather data for use as model input was derived from the Africa Rainfall Climatology Version 2 (ARC2), ERA-interim and GEWEX databases. Soil parameters were extracted from the soil property maps of Africa (ISRIC soil database).The simulations were run at 38 x 38 km grid cells across the target regions. Maize yield was calculated for each simulation grid for the period of 16 years (1992-2007) and aggregated to the district level to compare with observed yields provided by the Agriculture Statistics & Census Division, Ministry of Agriculture, Ghana. Yield gap was calculated as the difference between simulated potential and observed average farmer yields in Mg ha^{-1} .

Results and discussion

The mean yield gap in the period 1992-2007 varies from 6.2 to 6.6 Mg ha^{-1} in central Ghana (Fig. 2). There is no spatial pattern of the average yield gaps across the districts and there is no significant differences in the magnitude of yield gaps in both the regions as the difference is 0.08 Mg ha^{-1} only (Fig.3). Average farmer's yield are around 17.8 % of potential yields which is mainly due to nutrient limitations because of poor soil fertility management. Nitrogen (N) application rates are <10 kg N ha^{-1}yr^{-1} in Ghana compared to >150 kg N ha^{-1}yr^{-1} in Europe for maize production. The model captures well the observed yield and explains that N and P supply are the major constraints.

Conclusion

There is ample potential to increase maize yield and biomass production in Central Ghana. BiomassWeb will identify measures to improve biomass production in a stakeholder driven process supported by model simulations.

References

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