



# Zinc and Boron application in agroforestry parklands: Impacts on maize grain yields in northern Ghana and Benin

Amisu Mohammed<sup>1</sup>, Geronime Mariene Houeto<sup>3</sup>, Vincent Kodjo Avorny<sup>1</sup>,

Deogratias Kofi Agbotui<sup>2</sup>, Andreas Buerkert<sup>2</sup>

<sup>1</sup>University for Development Studies (UIDS), Department of soil science, Nvankala, Ghana

<sup>2</sup>Organic Plant production and Agronecosystem research in the Tronic and Subtronic (OPATS), University of Kassel, Steintrasse 19, 37213 Witzenhausen, Germany

<sup>3</sup>West African Science Service Center for Climate Change and Adaption Land Use, Agriculture and Climate Change (WASCAL), Ouagadougou, Burkina Faso

UNI KASSEL  
VERSITÄT



## Introduction

- Smallholder farmers widely use nitrogen (N), phosphorus (P) and potassium (K) fertilizers for maize production in northern Ghana and Benin
- NPK fertilizer-induced yield increases appears to have plateaued, making it necessary to reevaluate other soil nutrients for their potential to boost crop yield. The objective of this study is to evaluate the effect of Zn and B on maize grain yield in a typical open parkland systems dominated by shea trees (*Vitellaria paradoxa* C. F. Gaertn)

## Methods

- In a farmer – researcher trial shea trees were divided into zones: 0 m (under canopy), 3 m, 10 m and 20 m away from the canopy (Fig. 1, Fig. 2, Table 1)
- Each zone was sub-divided to implement different fertilizer applications: (i) farmer's practice without fertilizer application (FP) (ii) sole NPK fertilizer (national recommended rate (NR): 60 kg N ha<sup>-1</sup>, 13 kg P ha<sup>-1</sup>, 25 kg K ha<sup>-1</sup>) (iii) NR plus 7.5 kg Zn ha<sup>-1</sup> (NRZn), and (iv) NR plus 1.5 kg B ha<sup>-1</sup> (NRB)



Figure 1. Maize plants under tree canopy (A), maize plants outside tree shade in Ghana (B)

## Results & Discussion

- Maize grain yield increased ( $p < 0.05$ ) from zone 0 m to 20 m in Ghana and Benin (Fig. 3)
- Zone and fertilizer application interaction increased ( $p < 0.05$ ) grain yield of NPK plus Zn in zone 20 m in Ghana. It was 2.8 times larger than FP in zone 0 m (Fig. 3)
- Fertilizer use efficiency (FUE) increased ( $p < 0.05$ ) from 0 m to 20 m zones in both Ghana and Benin

Table 1. Soil chemical properties under zones in Ghana and Benin

| Zone    | Busunu (Ghana) |                               |                                |                           | Wewe (Benin) |                               |                                |                           |
|---------|----------------|-------------------------------|--------------------------------|---------------------------|--------------|-------------------------------|--------------------------------|---------------------------|
|         | pH             | Bray P<br>mg kg <sup>-1</sup> | Ex. K<br>cmol kg <sup>-1</sup> | Zn<br>mg kg <sup>-1</sup> | pH           | Bray P<br>mg kg <sup>-1</sup> | Ex. K<br>cmol kg <sup>-1</sup> | Zn<br>mg kg <sup>-1</sup> |
| 0       | 6.41           | 4.82                          | 0.19                           | 0.7                       | 6.44         | 4.92                          | 0.15                           | 0.56                      |
| 3       | 6.43           | 4.06                          | 0.16                           | 0.69                      | 6.25         | 4.65                          | 0.15                           | 0.52                      |
| 10      | 6.52           | 3.22                          | 0.15                           | 0.54                      | 6.18         | 4.69                          | 0.15                           | 0.51                      |
| 20      | 6.48           | 3.01                          | 0.15                           | 0.64                      | 6.26         | 3.94                          | 0.12                           | 0.57                      |
| p value | 0.62           | 0.65                          | 0.66                           | 0.79                      | 0.2          | 0.56                          | 0.77                           | 0.55                      |

Table 2. Grain yield as affected by zone and fertilizer application

| Zone                   | Busunu (Ghana)                        |                  | Wewe (Ghana)                          |                  |
|------------------------|---------------------------------------|------------------|---------------------------------------|------------------|
|                        | Grain yield<br>(kg ha <sup>-1</sup> ) | Harvest<br>index | Grain yield<br>(kg ha <sup>-1</sup> ) | Harvest<br>index |
| 0                      | 2412.2                                | 0.44             | 1579.4                                | 0.42             |
| 3                      | 2842.1                                | 0.46             | 2089.1                                | 0.45             |
| 10                     | 2990.9                                | 0.47             | 2089.5                                | 0.45             |
| 20                     | 3133.2                                | 0.48             | 2243.8                                | 0.49             |
| Lsd                    | 277.3                                 | 0.04             | 503                                   | 0.1              |
| p-value                | 0.00                                  | 0.16             | 0.07                                  | 0.41             |
| Fertilizer application |                                       |                  |                                       |                  |
| FP                     | 1604.5                                | 0.35             | 1177.1                                | 0.36             |
| NR                     | 3224.6                                | 0.49             | 2194.6                                | 0.44             |
| NRZn                   | 3305.2                                | 0.51             | 2353.5                                | 0.52             |
| NRB                    | 3244.1                                | 0.5              | 2276.5                                | 0.48             |
| Lsd                    | 114.5                                 | 0.04             | 269.4                                 | 0.06             |
| p-value                | 0.00                                  | 0.00             | 0.00                                  | 0.00             |
| Zone X fertilizer      |                                       |                  |                                       |                  |
| p-value                | 0.01                                  | 0.94             | 0.34                                  | 0.64             |

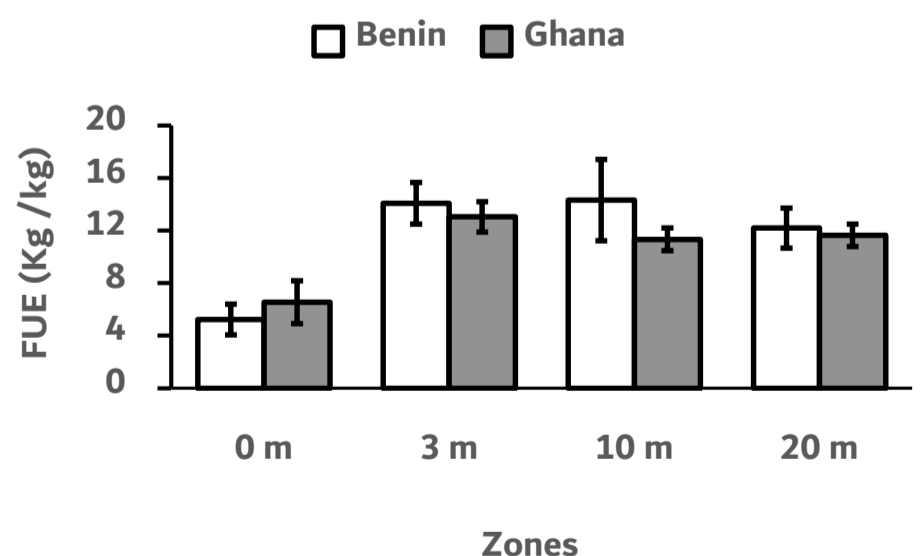


Figure 2. Fertilizer use efficiency as affected by Zones

## Conclusions

- Zn and B are not limiting farmers' maize yields in northern Ghana and Benin.
- Sole NPK fertilizer produced comparable yields and FUE with micronutrients fertilizers
- Smallholder farmers could use sole NPK for sustainable maize production in open agroforestry parklands



DecLaRe: Decision Support for Strengthening Land Resilience in the Face of Global Challenges;  
www.uni-kassel.de/forschung/declare/home



DecLaRe is coordinated by the University of Kassel:  
declare\_kassel@uni-kassel.de  
Funding: BMBF - ID: 100537724  
Umbrella programme "Sustainable Land Management in sub-Saharan Africa: Improving Livelihoods through On-the-Ground Research"