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# IMPORTANCE OF SECONDARY AND MICRONUTRIENTS IN SUB-SAHARAN AFRICA

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Crop nutrition research in sub-Saharan Africa (SSA) has largely focused on macronutrients, leading to fertilizer recommendations for field crops that generally cover only nitrogen, phosphorus, and potassium. However, evidence suggests significant effects of secondary and micronutrients (SMN) on crop productivity in SSA. This is expected, given that majority of soils are inherently infertile with low nutrient reserves (due to a bedrock consisting of mostly granites and gneiss). The common practice of continuous cultivation with minimal nutrient applications as fertilizer or organic resources also intensify the depletion of soil SMN.

The need for addressing SMN in fertilizer recommendations is gaining increasing recognition, not only due to their importance for increasing crop productivity, but also their association with micronutrient availability in the food produced and consumed by smallholder farmers in SSA. The influence of soil micronutrient deficiencies on low micronutrient contents of crops and human micronutrient deficiencies in SSA is particularly evident for zinc (Zn) and selenium (Se). Application of micronutrient-containing fertilizers to deficient soils is an effective bio-fortification strategy to enhance the grain content of Zn and Se.

We recently conducted a meta-analysis across 40 scientific publications reporting crop response to SMN to determine the productivity increase that is achievable, and provide a synthesis of responses to SMN in SSA. Data included yield responses to sulfur (S) (49%), Zn (23%), S and micronutrient combinations (12%), and <10% each for copper (Cu), molybdenum (Mo), iron (Fe), and boron (B).

The analysis showed that responses to SMN, based on the density of data points above or below the 1:1 dotted line in **Figure 1**, were high for maize, wheat, and rice, but low for sorghum, cowpea, and soybean. In the case of maize, application of SMN resulted in 0.7 t/ha (i.e., 20%) more yield compared to the macronutrient control treatment. Wheat and rice yields following additional application of S and micronutrients were 27% and 12% higher, respectively, than the macronutrient-only treatment. For maize and wheat, responses to S and micronutrients decreased with increasing macronutrient control yields. The average yield increase for each specific nutrient was 26% for S, 6% for B, 15% for Zn, 13% for Cu, 9% for Fe, and 20% for combinations of SMN.

The overall positive response to micronutrients indicates that these nutrients are holding back crop productivity, particularly in areas with low response to macronutrients, and that their application can have a large

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*"Addressing such secondary and micronutrient deficiencies is critical to resolve the recurrent food and nutritional insecurity challenge facing SSA that is heightened by a rapidly increasing population and climate change."*

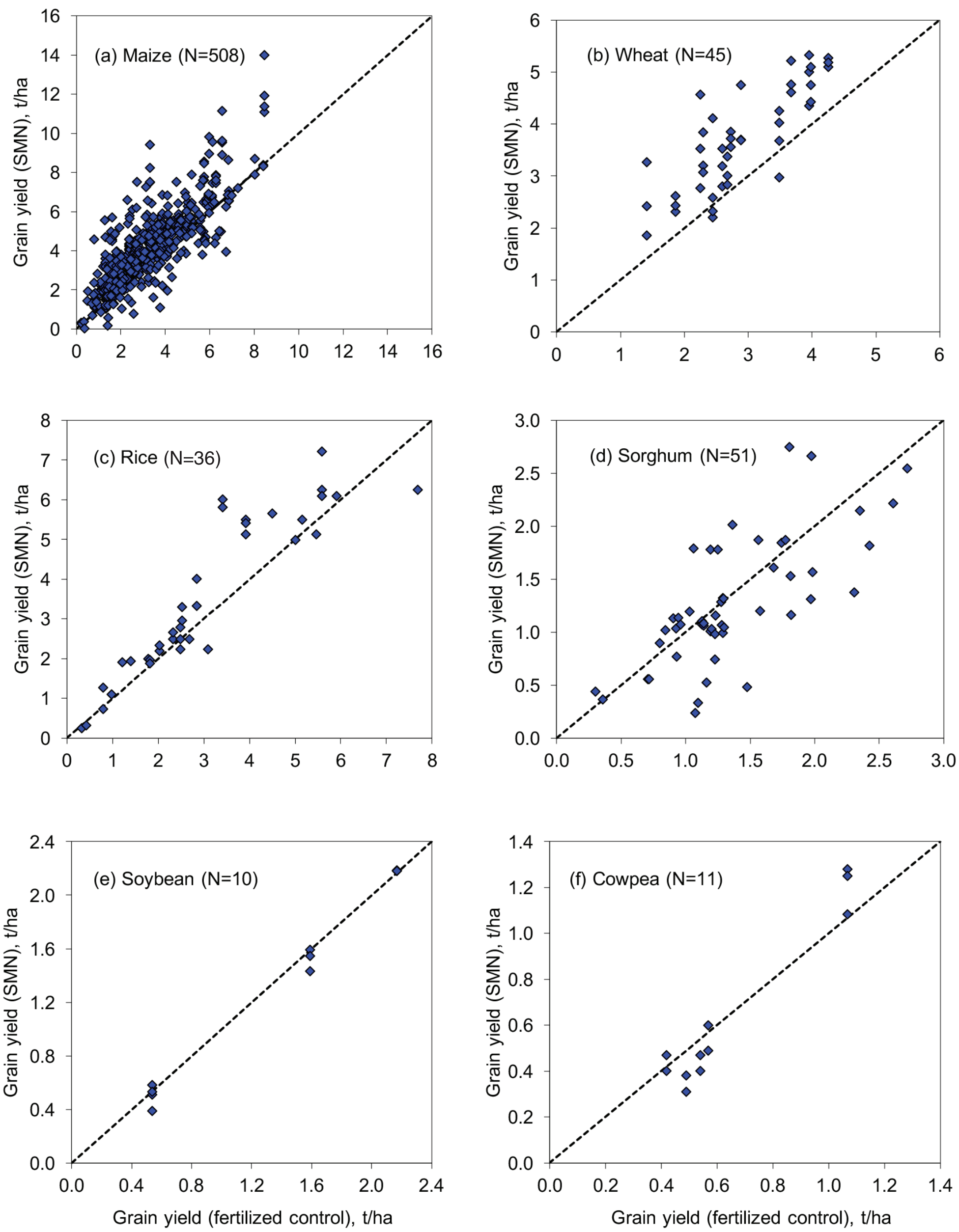


*Figure 1. Effect of secondary micronutrient (SMN) application on yield of various crops in SSA. The fertilized control was the crop that received the recommended rate of N, P, and K fertilizer. Data above the 1:1 (dotted) line show positive yield contributions of SMN. Data were derived from experiments comparing the effects of macronutrients and macronutrients + SMN across a wide range of cropping systems and soil conditions. N represents the sample size. Source: Kihara, J. et al. 2017. Agronomy for Sustainable Development 37:25.*

effect in hot-spots of SNM deficiencies and for high yielding cereal crops. Low crop productivity under macronutrient application in SSA has often been reported, and it has been suggested that deficiencies of secondary and micronutrients could be one of the causes to limited crop response to macronutrients.

Addressing such secondary and micronutrient deficiencies is critical to resolve the recurrent food and nutritional insecurity challenge facing SSA that is heightened by a rapidly increasing population and climate change. Understanding the conditions under which different responses occur and designing fertilizer solutions to address the limitations will be critical in achieving sustainable crop production intensification.


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