POLICY BRIEF

IFDC
Developing Agriculture from the Ground Up

FERARI
FERTILIZER RESEARCH & RESPONSIBLE IMPLEMENTATION

POLICY BRIEF 6

Yield responses to fertilizers is extremely low despite the use of significant amounts of fertilizers.

FERTILIZER USE AND YIELDS OF MAIZE, RICE, AND SOYBEAN FARMERS IN GHANA

Farmers in the Guinea, Sudan, and Transitional agroecological zones of Ghana are unable to obtain the potential yields from their farms due to their inability to optimally manage production factors. One prime factor is soil degradation; this hampers agricultural intensification. Intensifying agriculture requires the application of mineral fertilizers to improve yields. Yet, fertilizer use in Ghana is, on average, low at about 20 kilograms per hectare (kg/ha). The FERARI program aims to understand the current fertilizer use and yield impacts at farmer field level to support the widespread adoption of appropriate fertilizers for sustainable food and nutrition security. FERARI conducted a baseline study in 2020 through a recall survey among 1,450 farmers about their farm practices in 2019. This policy brief is based on those findings, as presented in FERARI Research Report No. 5 (Adzawla et al., 2021)[1].

Authors:

W. Adzawla[1], I.N. Kissiedu[1], E. Martey[2], P.M. Etwire[2], W.K. Atakora[1*], A. Gouzaye[3], P.S. Bindraban[1*]

[1] *International Fertilizer Development Center (IFDC), USA*
[2] *Council for Scientific and Industrial Research – Savannah Agricultural Research Institute, Tamale, Ghana*
[3] *Mohammed VI Polytechnic University (UM6P), Ben Guerir, Morocco*
[*] *Correspondence: pbindraban@ifdc.org watakora@ifdc.org*

Contributing partners:

MOHAMMED VI POLYTECHNIC UNIVERSITY

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR GHANA

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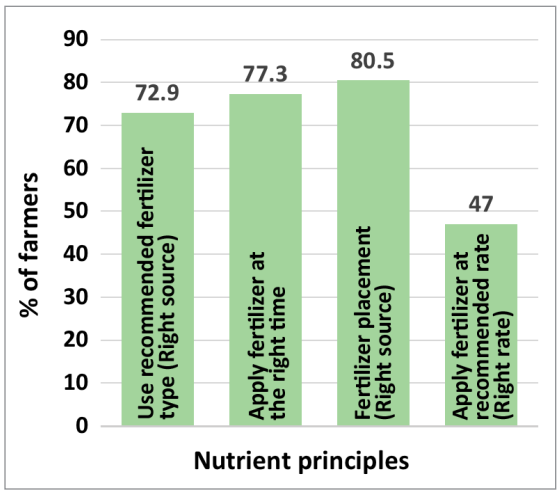
https://www.ifdc.org/projects/fertilizer-research-and-responsible-implementation-ferari/

Figure 1. *Percentage distribution of nutrient stewardship practiced by farmers.*



NUTRIENT PRACTICES

From the survey, 80.5% of the farmers used fertilizer during the 2019 cropping season. Figure 1 shows the extent these farmers adhered to recommended nutrient management practices. About three-quarters of the surveyed farmers indicated that they applied the right type of fertilizer at the right time, placing it near the plants. However, less than half of the farmers said they were applying fertilizer at the recommended rate. Inadequate capital was the dominant reason for not applying the recommended rate, while lack of labor, cost, and convenience

[1] *Adzawla, W., I.N. Kissidue, E. Martey, P.M. Etwire, W.K. Atakora, A. Gouzaye, and P.S. Bindraban. 2021. Baseline Study on Fertilizer Use and Food/Nutrition Security in Sudan Savannah, Guinea Savannah, and Transitional Zones of Ghana. IFDC FERARI Research Report No. 5.*

were the main factors for broadcasting, rather than placing, fertilizer.

QUANTITIES OF FERTILIZER USED ON CROPS

The data show that 17%, 20%, and 9% of maize, rice, and soybean farmers, respectively, used only NPK fertilizers, while 28%, 22%, and 41%, respectively, used an NPK plus micronutrient fertilizer (e.g., NPK 15-20-20+0.7Zn). A relatively high proportion of farmers – 22%, 20%, and 13% – used NPK fertilizers, respectively, with urea or ammonium sulfate as a topdressing. The specific quantities of each fertilizer type applied per crop are shown in Figure 2. The principal additional micro-nutrients included zinc (Zn), sulfur (S), magnesium (Mg), and boron (B). Under the Ghana Ministry of Food and Agriculture's (MoFA) recommendation, NPK 15-20-20+0.7Zn is to be used at 300 kg/ha for cereal production. It is unclear why this fertilizer was applied in large quantities to soybean as well. Fertilizer application to soybean is a recent phenomenon, which may explain the use of less diverse fertilizer types. The data from Figure 2 is analyzed in Figure 3 and this shows large quantities of NPK+Zn+S were applied to soybean and NPK+Zn+S+Mg to maize and rice.

CHALLENGES TO FERTILIZER ACCESS AND USE

According to farmers, the major challenges that restrict fertilizer access and use are limited credit for small farmers, limited reach of subsidized fertilizer in adequate quantities, high cost of unsubsidized fertilizer, inadequate extension service support, lack of fertilizer at the right time, and lack of confidence in fertilizer quality. Although a lack of credit was mentioned as the primary challenge, the outcome of access was mixed. Specifically, maize and soybean farmers who had access to credit used more fertilizer than those who did not, but the effect was significant only for maize farmers. Rice farmers who had access to credit used less fertilizer than those who did not.

Figure 2. *Average quantities (kg/ha) of fertilizers used for crop production by type.*

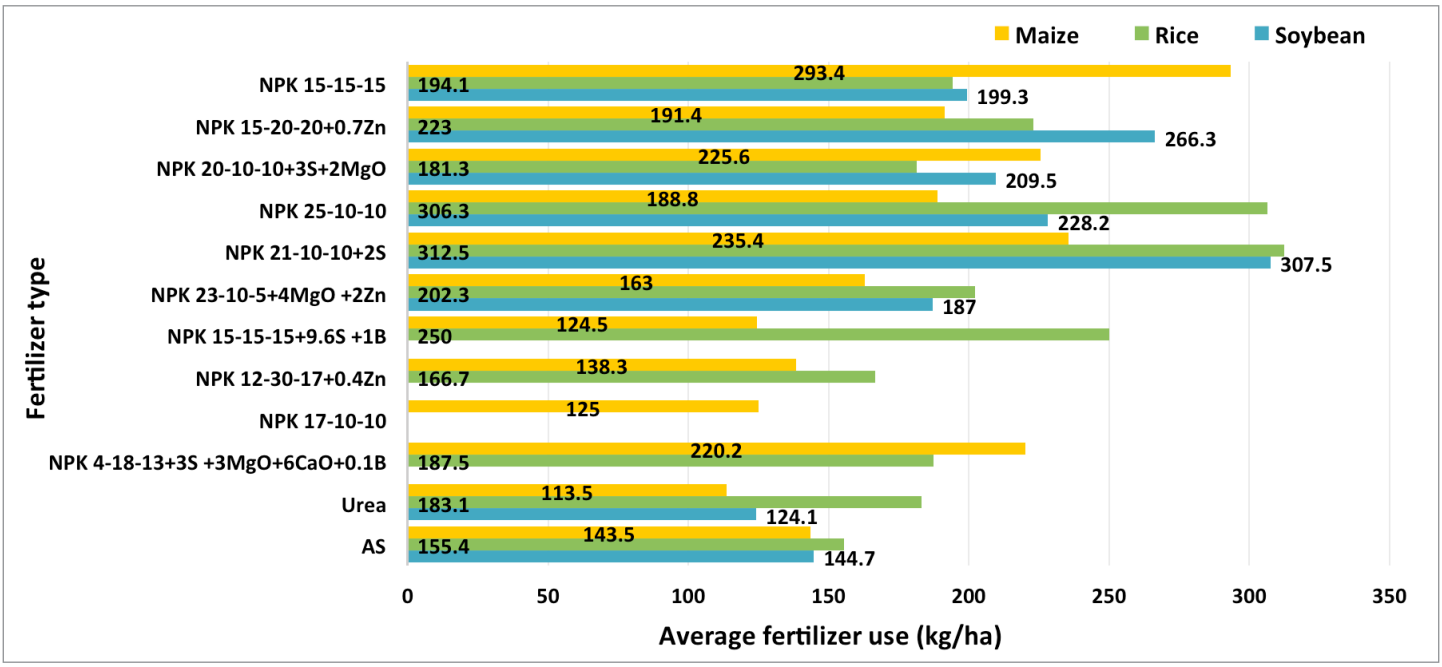
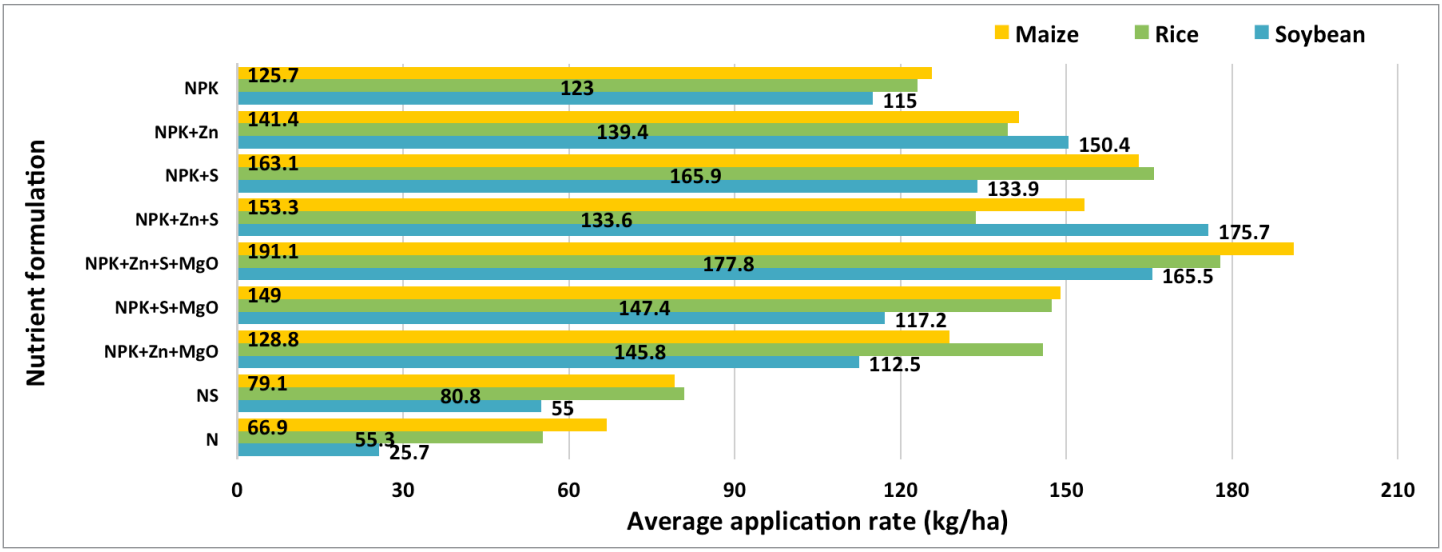


Figure 3. *Average quantities (kg/ha) of nutrients from various fertilizer types used by farmers.*



This raises concern over whether providing credit to farmers could address their low fertilizer use. The 19.5% of the farmers who did not use any fertilizer mentioned that they did not have information on how to obtain fertilizer or could not give a reason. Some farmers, especially those in the Middle Belt, did not use fertilizer because their soils are fertile and they did not see the need for external fertilization.

MOTIVATIONAL FACTORS FOR FERTILIZER USE

Figure 4 shows the reasons farmers used fertilizer or a particular fertilizer type. Three-quarters of farmers used fertilizer to increase crop yields, and about half the farmers used it to improve crop health. About 9% of farmers compared fertilizer prices to determine which type to use, and tended to buy cheaper ones.

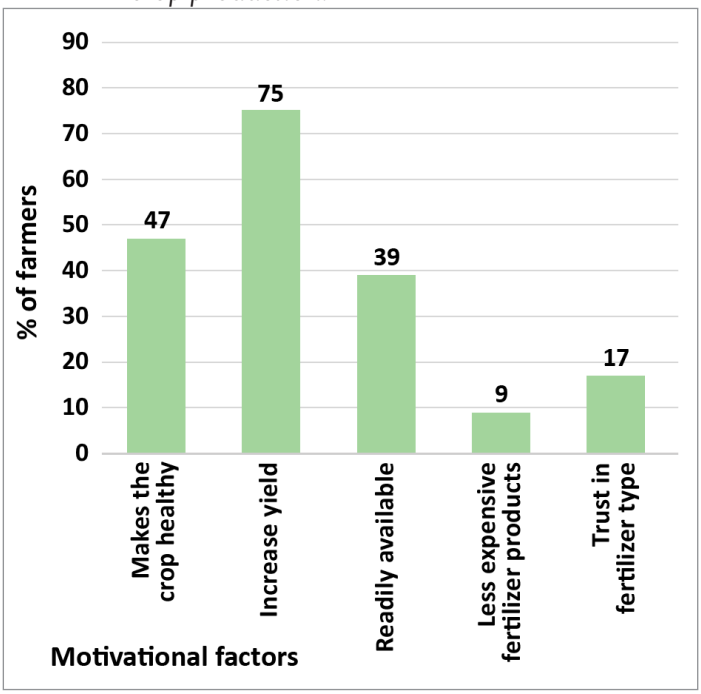
AVERAGE CROP YIELDS

Farmers' yields averaged 1.4 tons per hectare (t/ha), 2.1 t/ha, and 1.5 t/ha (Figure 5), as compared to national potential yields of 5.5 t/ha, 6 t/ha, and 3 t/ha and average reported yields of 2.0 t/ha, 2.9 t/ha, and 1.7 t/ha, for maize, rice, and soybean, respectively (MoFA, 2017); comparable yield levels are reported for 2019. Overall, yields were low without fertilizer use. The highest maize yield was obtained with NPK+S+Mg and NPK+S; for rice with NPK+Zn+S, urea, and sole NPK fertilizers; and for soybean with urea and NPK+Zn+Mg. NKP+Zn did not produce higher yields for any crop, as compared to sole NPK, which raises concern since the former formulation is promoted under the Government's Planting for Food and Jobs fertilizer subsidy program. The error bars show the yields are dispersed around average yield values.

EFFECTS OF FERTILIZER ON MAIZE YIELD

The effects of fertilizer and other factors on maize yield were estimated using an econometric model (Table 2). The model was used to identify factors that influenced the yield and level of production

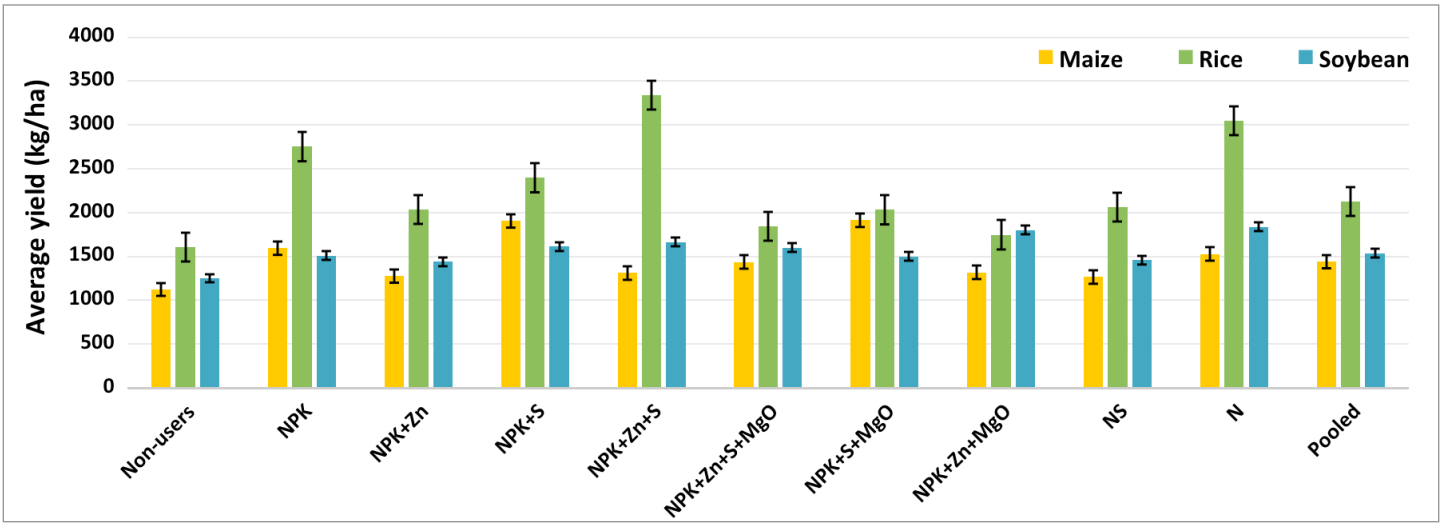
Figure 4. *Reasons farmers used fertilizers in crop production.*



efficiency. Efficiency measures the effectiveness of inputs used to produce a given yield. This means efficient farmers would use less inputs effectively to produce more yield, while less-efficient farmers would use more inputs yet have lower yields. Understanding these efficiency drivers is important since adoption of good agronomic practices is low among farmers.

Estimated returns to scale suggest that a 100% increase in all inputs would result in about an 84% increase in maize yield. Overall, factors that most affected maize yield were seed, herbicide, hired labor, and fertilizer. Also, the farmers who used their inputs effectively with little loss of production resources were those who had more formal education and access to extension services, who perceived their soil to be fertile, and were less likely to be poor. Even though low access to credit was said to be a major challenge to fertilizer use, access does

Figure 5. *Average yields by fertilizer formulation.*



not improve farmer efficiency. Addressing these factors will be key in improving maize production. For instance, providing extension services to farmers would help them adopt good agronomic practices for higher yield. Addressing farmer poverty would help them make needed capital investments in their farms.

Both improved and local seed had a positive effect on maize yield, and respective application rates at 31.3 kg/ha and 30.0 kg/ha were higher than the 25 kg/ha recommended seed rate for northern Ghana. This calls for an examination of the quality of seeds used. Additional hired labor (number of workers per hectare) results in an increase in maize yield. Access to labor is a major factor in determining how and when agronomic practices, such as weeding and fertilizer application, are done. Herbicide use to manage weeds increases maize yield and lifts the burden of manual weeding, which requires longer working days and more labor.

All fertilizer formulations had a positive effect on maize yield, hence, increased use led to increased yield. However, the increase varied by fertilizer type and was highest with NPK+S fertilizer and lowest with NPK+Zn fertilizer (Figure 5). Although the results suggest an overall increase in fertilizer application for higher yields, there was little yield increase from the fertilizer and depended on the formulation. For instance, if the current NPK+S quantity was doubled, the maize yield would increase by 11.6%, while the increment is only 5.3% with double the amount of NPK+Zn fertilizer. The reasons for this phenomenon are not examined in this policy brief, but they should be further investigated to arrive at appropriate fertilizer policy recommendations.

CONCLUSIONS

This study established that fertilizer use and the resulting maize, rice, and soybean yields were moderate to high among farmers. Although the use of fertilizer led to increases in yields of all three crops, the yield response to fertilizer was low. Promotion of good agronomic practices, along with more appropriate fertilizer products to increase the efficiency of fertilizers are essential for their sustainable use. NPK with S proved to be more effective in increasing yields than NPK with Zn. This requires further verification, especially under experimental design, since NPK with Zn fertilizer is also one of the formulations that is promoted under the fertilizer subsidy program.

Table 2. *Effects of application of fertilizer and other inputs on maize yield.*

VARIABLE	COEFFICIENT	STD. ERR.
Output model		
Farm size	-0.012	0.027
Improved seed	0.005	0.014
Local seed	0.022**	0.009
Herbicide	0.097***	0.014
Family labor	0.016	0.017
Hired labor	0.030***	0.011
NPK	0.084***	0.007
NPK+Zn	0.053***	0.008
NPK+S	0.116***	0.008
NPK+Zn+S	0.056***	0.014
NPK+Zn+S+Mg	0.057***	0.01
NPK+S+Mg	0.115***	0.011
NPK+Zn+Mg	0.055***	0.009
NS	0.057***	0.015
N	0.084***	0.014
Constant	6.706	0.055
Returns to Scale	0.84	
Inefficiency model		
Youth	0.041	0.631
Gender	0.38	0.596
Education	-0.298*	0.158
Farmer-based organization	-0.267	0.609
Experience	0.011	0.02
Smallholder farmer	-0.5	0.609
Distance to input shop	0.001	0.002
Extension services	-0.969*	0.561
Credit access	0.448	0.576
Mixed cropping	-0.048	0.468
Improved seed	-2.243	2.341
Poverty Probability Index	0.029*	0.015
Soil Fertility (reference is less fertile):		
Very fertile soil	-29.204	1638.89
Fertile soil	-0.795*	0.441
Constant	-4.858	1.896

*, **, and *** indicate a significant effect on yield at 10%, 5%, and 1%, respectively.