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# POLICY BRIEF



## FERARI

FERTILIZER RESEARCH & RESPONSIBLE IMPLEMENTATION



## DOES FERTILIZER USE AFFECT MAIZE YIELDS IN GHANA?

Continued cultivation of farmland leads to diminishing nutrient stock in soils due to its offtake by the harvested crops. Over time, this results in declining yields, jeopardizing food security and worsening poverty. Thus, fertilization to balance soil nutrients and attain higher yields and better nutritional quality of produce is necessary. Successive governments of Ghana have implemented various fertilizer subsidy programs to encourage fertilizer use in the country for sustainable agricultural production and food security. To this aim, the use of fertilizers must be effective in increasing yield as a means of

improving income. Obtaining maximum yield with minimum fertilizer use will give the highest fertilizer, or nutrient, use efficiency and result in the least waste of applied fertilizers.

Because of the important role of maize in the Ghanaian economy, an understanding of the use of fertilizers and their efficiency will help sustainably achieve food security in the country. This policy brief, based on FERARI Research Report No. 5 (Adzawla et al., 2021)<sup>1</sup>, analyzes the nutrient use efficiency obtained by 1,085 fertilizer users and 278 fertilizer non-users in the Transitional, Guinea Savannah, and Sudan Savannah agroecological zones of Ghana.

### YIELD, FERTILIZER USE, AND NUTRIENT USE EFFICIENCY

Farmers who used fertilizers produced 400.1 kg ha<sup>-1</sup> more maize grain than non-users. This statistically significant difference justifies the use of fertilizers. Farmers used an average 277.9 kg ha<sup>-1</sup> of fertilizer, lower than the recommended 400 kg ha<sup>-1</sup>. This quantity of fertilizer contained an average of 137.4 kg ha<sup>-1</sup> of nutrients. Therefore, each kilogram of fertilizer gave only 1.4 kg of maize grain (400.1 kg grain/277.9 kg fertilizers). This amounts to 2.9 kg of grain per kilogram of applied nutrients (400.1 kg grain/137.4 kg nutrients), which is the agronomic efficiency, or the kilograms of additional grain obtained per kilogram of nutrients applied, relative to the quantity obtained without fertilizer use. Only 1.6% of farmers obtained an agronomic efficiency above 20.0 kg kg<sup>-1</sup>,

Low agronomic efficiency in farmer fertilizer use on maize crops may affect food security in Ghana.

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Visit the FERARI project online at:

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

<sup>1</sup> 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.

while 50.7% obtained a negative agronomic efficiency (yield lower than the average yield of fertilizer non-users). The low agronomic efficiency obtained by farmers calls for implementation of efficient nutrient management strategies along the entire value chain, from the supply of appropriate balanced fertilizer products to proper fertilizer management by farmers.

### NUTRIENT USE EFFICIENCY BY FERTILIZER FORMULATION APPLIED

Figure 1 shows the agronomic efficiency by fertilizer formulation used. Overall, farmers who used only urea (N) had high N efficiency, but the sole use of N does not translate into the highest yield. The highest maize yields were found for farmers who used fertilizers containing NPK+S or NPK+S+Mg, and these correspond with higher agronomic efficiencies. Therefore, the appropriate fertilizer formulation contributes to higher yield through a higher agronomic efficiency.

### NUTRIENT USE EFFICIENCY BY SOCIOECONOMIC CHARACTERISTIC

Figure 2 shows the agronomic efficiencies for various socioeconomic characteristics of the farmers. Farmers who perceived their farmlands to be fertile expected to produce their anticipated yield with minimal fertilizer application and thus applied less fertilizer. These farmers obtained a higher agronomic efficiency than those who perceived their farmlands to be less fertile. Farmers with access to extension services obtained the highest agronomic efficiency. Overall, the farmers who accessed credit and extension services, who were youths, who cultivated no more than 2 hectares of maize, and who solely used subsidized fertilizers,

obtained relatively higher agronomic efficiencies. The associated yields obtained by these farmers were also higher than their counterparts who had no access to credit or extension, who cultivated more than 2 hectares, and who used both subsidized and commercial fertilizers.

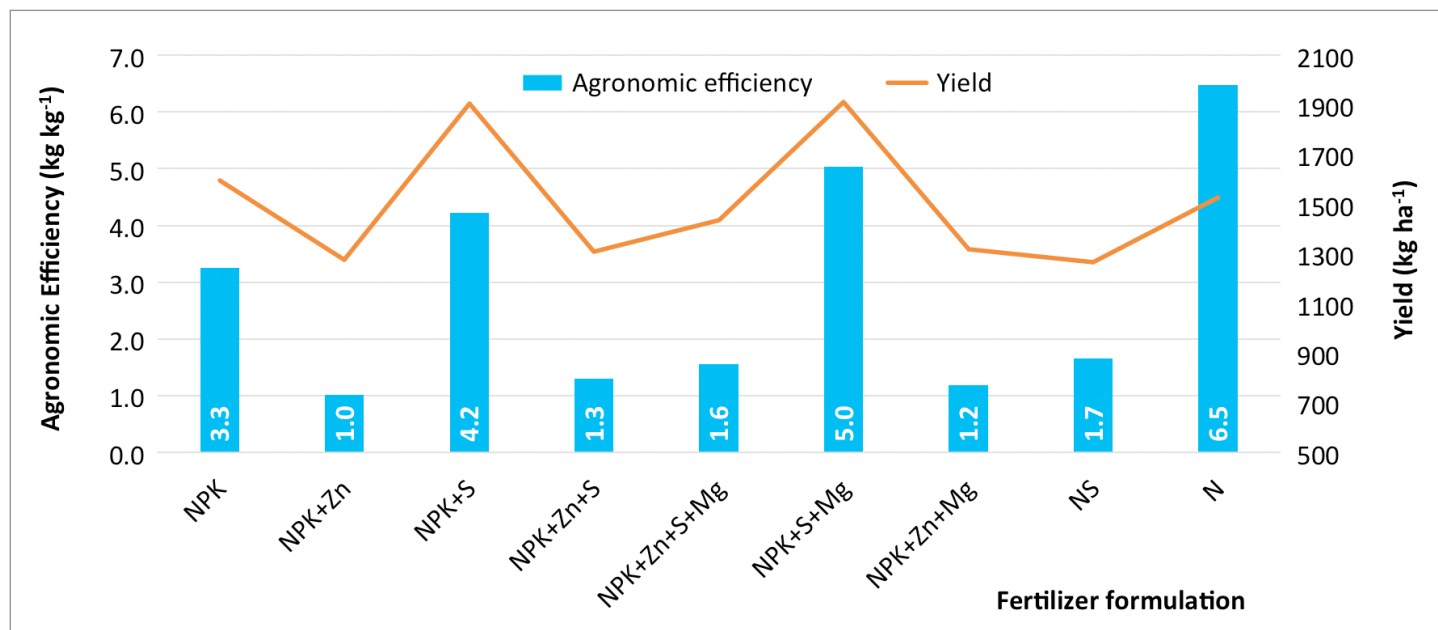
**Table 1.** Crop yield, fertilizer use, and nutrient use efficiency of maize farmers.

CATEGORY	MEAN	STD DEV	MIN	MAX
<b>Yield (kg ha<sup>-1</sup>)</b>				
Fertilizer non-users	1,123.1	533.7	500.0	2,000.0
Fertilizer users	1,523.3	786.1	1,000.0	4,000.0
Yield difference*	400.1			
<b>Fertilizer and nutrient use (kg ha<sup>-1</sup>)</b>				
Total fertilizer	277.9	210.4	50.0	1,000.0
Total nutrients	137.4	58.4	50.0	339.5
Nitrogen	68.5	29.8	50.0	150.0
Phosphorus	29.6	17.2	0.0	60.0
Potassium	28.9	17.0	0.0	60.0
<b>Nutrient use efficiency [AE=(Y-Y<sub>0</sub>)/F]</b>				
Total nutrients <sup>#</sup>	2.7	5.7	-2.5	50.0
Nitrogen	5.3	11.1	-2.5	57.5
Phosphorus	11.2	25.1	-6.2	143.8
Potassium	11.5	25.4	-6.2	143.8

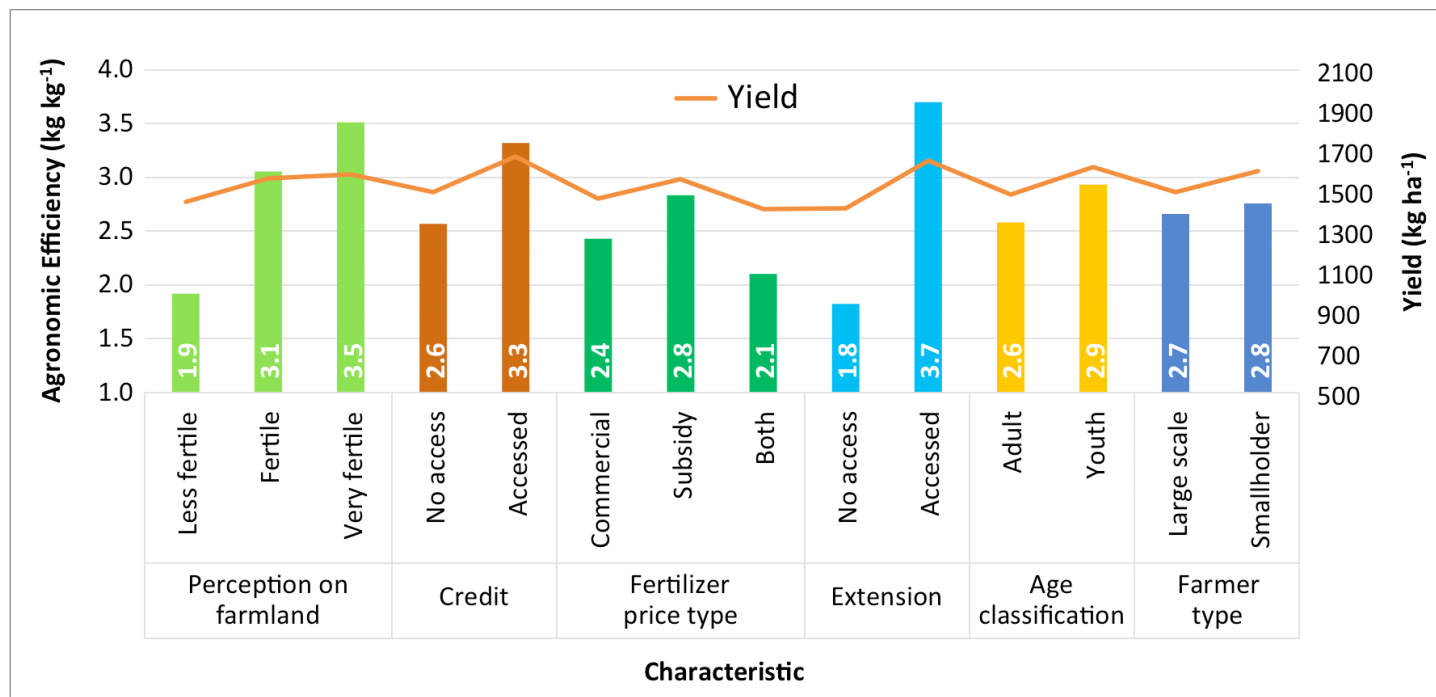
\* indicates significant yield difference between fertilizer users and non-users. AE = agronomic efficiency; Y = average yield (kg ha<sup>-1</sup>) for fertilizer users; Y<sub>0</sub> = average yield (kg ha<sup>-1</sup>) for non-fertilizer users.

<sup>#</sup> N+P+K equals 145.7 kg; the remainder is the amount other nutrients, including S, Mg, and Zn.

**Figure 1.** Agronomic efficiency for total nutrient use and crop yield by nutrient formulation.



**Figure 2.** Agronomic efficiency and crop yield by socioeconomic characteristic.



Despite the slight differences among fertilizer products and socioeconomic factors, the agronomic efficiencies observed from the farmers' fields were lower than those obtained in experimental trials and other regions in the world and thus unsustainable. The agronomic efficiency of nitrogen should reach 40–50 kilogram maize grain per kilogram of nitrogen applied. These alarming findings call for measures to close the gap in agronomic efficiency between field trials and farmers' fields.

### FERTILIZER COST FOR MAIZE PRODUCTION

Table 2 shows the cost of fertilizer required for the production of one additional kilogram of maize grain. To produce 1 kg of maize, 0.36 and 0.61 Ghana cedis (GHS) must be invested in subsidized and commercial fertilizer costs, respectively. Figures 3 and 4 show that an increase in fertilizer cost per kilogram of maize leads to a decline in agronomic efficiency of fertilizer use and maize yield, respectively. These findings imply that low fertilizer cost stimulates an increase in maize yield and improvement in nutrient use efficiency of farmers.

### CONCLUSION

The importance of fertilizers in improving crop yields, along with their agronomic and economic efficiencies, must be discussed. The use of fertilizers to increase maize yields has been found to be unsustainable due to the low agronomic efficiency. The low agronomic efficiency is also a major threat to maize production in the region, especially as climatic conditions become more unfavorable for cropping. The efficiency of fertilizers differs by nutrient formulation, suggesting the need for greater use of *appropriate* fertilizer products rather

**Table 2.** Fertilizer cost\* per unit of maize production (GHS kg<sup>-1</sup>).

FERTILIZER USED	MEAN	STD DEV	MIN	MAX
Subsidized	0.36	0.30	0.03	3.00
Commercial	0.61	0.51	0.05	3.00
Combined	0.39	0.27	0.07	1.26
<b>Total</b>	<b>0.43</b>	<b>0.38</b>	<b>0.03</b>	<b>3.00</b>

\* The cost of 50 kg of commercial and subsidized fertilizer is GHS 150 and GHS 75, respectively.

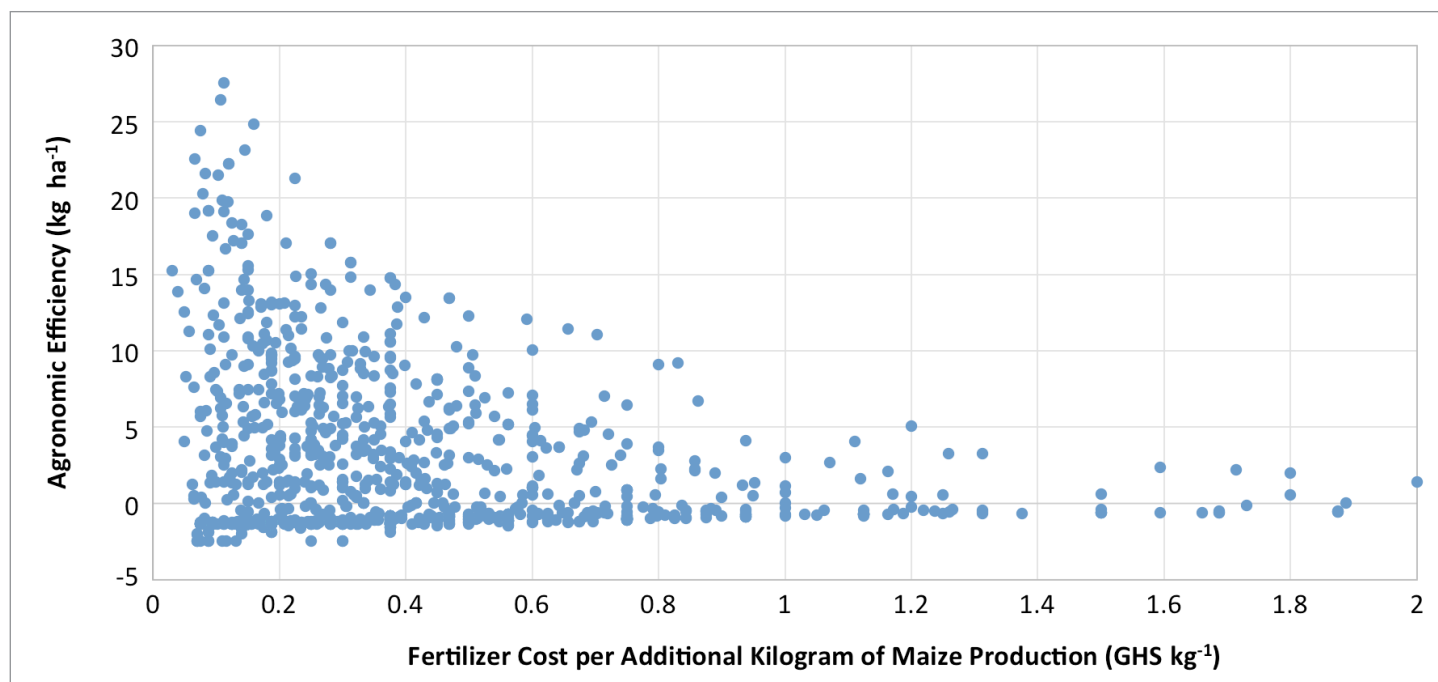


Extension worker Grace examines the nutrient status of maize in a FERARI on-farm trial.

than simply increasing the quantity. In addition, higher agronomic efficiencies are observed among younger farmers with access to credit and to extension services, who use only subsidized fertilizers, cultivate 2 hectares or less of land, and believe their land is fertile. The cost of producing 1 kg of maize differs between commercial and subsidized fertilizers; it is higher for commercial and lower for subsidized products. The results indicate that an increase in the cost of fertilizer for producing 1 kg of maize leads to a decline in both the agronomic efficiency and yield of farmers.

Considering the financial implications on the sustainability of any subsidy program, optimal fertilizer pricing must be determined under the Ghanaian government's fertilizer subsidy program. Policymakers, particular the Ministry of Food and Agriculture, must begin to integrate strategies for improving nutrient use efficiency into their fertilizer policies. Considering the increasing global cost of fertilizers, ensuring their efficient use, as well as simultaneous improvements in agronomic practices is necessary.

**Figure 3.** Relationship between fertilizer cost per additional kilogram of maize production and agronomic efficiency.



**Figure 4.** Relationship between fertilizer cost per additional kilogram of maize production and maize yield.

