The impact of the fertilizer subsidy programme on smallholder maize farmers' livelihoods in the Northern Region of Ghana

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ABSTRACT

Agriculture is one of the strongholds of Ghana's economy, with about half of the country dependent on the sector. However, farm yields are low because of the very minimal use of improved technologies and fertilizers. The government of Ghana has made fertilizer subsidy programmes available to boost production; the programme has not been able to meet all its goals. This research project adopted a descriptive cross-sectional survey design that encompassed both quantitative and qualitative approaches to evaluate the effects of the fertilizer subsidy programme on the livelihoods of the smallholder maize farmers in the Northern Region of Ghana. A sample of 400 farmers was selected from a population of 123,626 smallholder maize farmers in the Northern Region, based on the Cochran (1977) formula. Five districts were randomly selected, namely Tolon, Kumbungu, Yendi, Savelugu, and Mion. Four communities were randomly selected in each district, and 20 farmers per community were randomly sampled. Structured questionnaires were administered to the sampled farmers, followed by in-depth interviews with the 40 lead farmers. The research used descriptive statistics, chi-square tests, and ordered logistic regression models to analyze the data. A composite welfare index was also used to determine the programme's impact on outcome variables like maize yield, household income, and well-being. The results showed that fertilizer use alone accounted for a significant share of variation in maize yields, and the farmers who applied the recommended rates of fertilizers obtained better yields. The results showed delays in disbursement and improper targeting of farmers limited the economic impact of the programme on individual household members. This concludes that though the fertilizer subsidy programme has gone a long way in improving the livelihood of the smallholder maize farmers in Northern Ghana through increased yields and income, it failed in achieving all its stated goals. It is therefore recommended that efficient fertilizer distribution mechanisms be put in place to ensure timely delivery, coupled with a well-structured monitoring system to avoid smuggling into commercial shops and unintended beneficiaries.

Keywords: Fertilizer Subsidy Programme, Livelihoods, Maize Production, Smallholder Farmers

I. INTRODUCTION

The agricultural sector contributed approximately 20.1 percent of the Gross Domestic Product (GDP) of Ghana in 2020 and employed nearly half of the workforce in the country. It is considered the most important means of livelihood among the poorest households in the country. The economy of Ghana is expected to realize sustainable growth and development over a long period, with agriculture playing a strategic role in its achievement. This is due to the high number of people in the industry. It has been observed that the agricultural sector's share of Ghana's GDP has seen a decline in the recent past due in great measure to the explosion of the service sector. However, agriculture continues to be crucial for providing employment, generating income, and improving the livelihoods of the rural poor (Djanibekov & Gaur, 2018; Osabohien et al., 2019). The Ministry of Food and Agriculture (MoFA) estimated that agricultural employment in 2018 comprised about 45 percent of the national workforce, more than in any other sector of the economy.

Farming in Ghana is generally characterised by a high preponderance of smallholder farmers cultivating relatively small pieces of land scattered all over the rural landscape of the country. These smallholder farmers normally cultivate an average area of 1.5 hectares of farmland with limited access to improved agricultural technologies. The consequence is that agricultural productivity, taken as a whole, is generally below its full potential. Poor fertilizer use and poor soil fertility management result in low crop productivity levels. A high population of smallholder farmers in Ghana lives on less than US$2 per day and, due to the low purchasing power, are unable to afford adequate amounts of good quality chemical fertilizers. To overcome this weakness, the government and other development partners have provided farmers with input subsidies in the form of fertilizers, among others, with a view to increasing production. However, due to the economic crisis and fiscal space concerns throughout Africa in the late 1970s and early 1980s, national economic recovery programmes were then introduced by the World Bank (WB) and the International Monetary

Fund (IMF), particularly the Structural Adjustment Programme and Trade Liberalization programme. All these programmes for enhancing private sector development and fertilizer market deregulation meaning that African governments have gradually removed all agricultural subsidies (Odusola, 2021; Ignatova, 2021). The removal of fertilizer subsidy had a high tolling effect on crop production and poor rural welfare (Azik et al., 2021).

Research on Asia's Green Revolution, for example, has demonstrated that a direct outcome of the implementation of fertilizer subsidy programs was that farmers started applying chemical fertilizers increasingly. This led to a tremendous increase in agricultural productivity. To be specific, at least 50 percent of the yield increase was credited to these fertilizer subsidy programs alone (Mason, et al., 2013; Rashid et al., 2013). The first African summit on fertilizer policy was held in Abuja, Nigeria, to increase fertilizer use among farmers. The summit, named "Fertilizer for African Green Revolution: The Abuja Declaration," sought to identify and discuss mechanisms that would improve fertilizer use in Africa. The summit mandated the African Union Member States to take action and make efforts towards improving access to fertilizer by farmers and achieve a consumption rate of 50 kilograms per hectare by 2015. The member states acted concerning the availability, accessibility, and affordability of chemical fertilizers to smallholder farmers. This involved abolishing the import levies and charges on chemical fertilizers and the readoption of fertilizer subsidy programs. In addition, African leaders were directed to allocate 10 percent of their annual budgets to agriculture to encourage more fertilizer application and improve the quality of life of people (AU, 2006).

In July 2008, Ghana introduced a nationwide voucher-based fertilizer subsidy programme covering Urea, Sulphate of Ammonia, and Nitrogen, Phosphorus, and Potassium (NPK) chemical fertilizers. This was to cushion farmers from the spiraling energy and food prices at that time (MoFA, 2018). The programme is implemented through a public-private partnership in which the procurement of fertilizers is through existing private importers of fertilizers, and the distribution is through private retail outlets. Distribution and reimbursement of the vouchers fell to the public sector. A subsidy was given to farmers for specific chemical fertilizers that they could purchase using vouchers given by the extension agents. In its 2008 reintroduction, the voucher initially covered 50 percent of the costs of the fertilizers. This had been done to minimize the overall cost and ensure that the prices are uniform within the country. In the light of Houssou et al. (2017); Fenzi & Couix (2022); Hill & Kirwan (2015) there have been various attempts, agricultural productivity within Ghana is still relatively low as opposed to the ideal level of productivity Scheiterle & Birner, 2018). Average maize yields for 2016 were projected at 1.72 million metric tons per hectare, increasing to 1.96 million metric tons per hectare in 2017. Remarkably, these were below the potential yield of 6 million metric tons per hectare. There has been a delay in the disbursing of funds, poor identification of target farmers, an inability by farmers to service debts on time, and a very limited understanding of best agronomic practices; hence, farmers' welfare and optimum fertilizer application rates are not fully realized. These challenges have raised concerns among policymakers and development actors about the extent to which the fertilizer subsidy program actually benefits smallholder farmers in Ghana. Various studies have been conducted with a view to researching different aspects of Ghana's fertilizer subsidy programme. Among others, such studies have investigated issues related to the performance regarding monitoring, procurement challenges, implementation performance, crop yield impact, and technical efficiency. These will include studies conducted by Banful (2011), Fearon, et al. (2015), Abubakari and Abubakari (2015), Houssou et al. (2017), and Anang and Kudadze (2019). Notwithstanding these, none of these works has critically assessed whether the programme has achieved its stated objectives of changing the behavior of smallholder farmers regarding the use of recommended fertilizers that should have resulted in improved yields and increases in farm incomes. It is, therefore, the purpose of this research work to do a comprehensive analysis of the fertilizer subsidy programme’s effect on the rates at which fertilizers are used, the yield of crops, and the livelihood of small-scale maize farmers in the Northern Region of Ghana. This region is characterized by high poverty rates and low agricultural productivity, as reported by the Ghana Statistical Service in 2014 and the Ministry of Food and Agriculture in 2018.

1.1 Research Objectives

The study aimed at evaluating the effects of the fertilizer subsidy programme on the livelihoods of the smallholder maize farmers in the Northern Region of Ghana. The study also determine the programme’s impact on outcome variables like maize yield, household income and farmers’ wellbeing.

II. METHODOLOGY

The Northern Region is one of the constituent regions of Ghana, with its geographical location in the northern part of the country. Until the carving out of the Savannah and North East Regions in December 2018, the region was the largest in Ghana, covering an area of 70,384 square kilometres, accounting for 31 percent of the country's land area. The entire Northern Region is primarily a dry area and has only one rainy season that falls between the months of May and October. Annual rainfall ranges from 750 to 1050 millimeters, while the average temperature ranges around 35 degrees Celsius (GSS, 2014). Over 75 percent of the economically active population within the region is employed in

agriculture. The major economic activity of the people in the region is Agriculture: yam, maize, millet, guinea corn, rice, groundnuts, beans, soya beans, and cowpea are grown.

2.1 Research design, sampling techniques, data collection, and analysis

This study's objectives were answered by adopting quantitative and qualitative research approaches in data collection, verification, and analysis in order to provide in-depth information about the perceptions of the smallholder maize farmers on the fertilizer subsidy programme. The research design used was a descriptive cross-sectional survey. This was regarded as the best available design as it enabled the researchers to gather data from a large number of smallholder maize farmers at one time. This design was applicable in the evaluation of the fertilizer subsidy programme as it allowed describing the current situation, perceptions, and consequences (maize yield, income, and wellbeing) without controlling the variables. Using Cochran's (1977) sample size determination formula, the estimated total population of smallholder maize farmers in the northern region was about 123,626. Hence, the study considered a sample size of 400 smallholder maize farmers as an appropriate size for this study. In all, five (5) districts were randomly selected using simple random sampling. The selected districts included Tolon District, Kumbungu District, Yendi Municipal, Savelugu Municipal, and Mion District. This was based on the fact that maize farming is generally practised in all districts of the region. Four communities were randomly selected from each district. This kind of selection ensured that the needed information about the concepts studied was garnered through surveying. Twenty smallholder maize farmers were randomly sampled from each of the selected communities. Data collection was through personal in-depth interviews with 40 lead maize farmers and questionnaire administration to 400 smallholder maize farmers.

2.2 Analysis of the effects of fertilizer subsidy programme on Livelihoods

The effects of fertilizer subsidy programme on the livelihood outcomes of smallholder maize farmers were analyzed in terms of crop yield increase, increased income level, and well-being enhancement (DFID, 2009).

2.2.1 Measuring Crop Yields

Crop yield was measured using Rabbinge (1993), a view of crop yield estimator. Thus, where actual yield or farmer yield takes into account growth-reducing factors, such as weeds, pests, diseases and pollutants.
The equation for estimating yield is given below:

$$\text{Crop yield} = \frac{(\text{amount of crop harvested per acre})}{(\text{expected crop area per acre})} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This is normally expressed as kilograms (kg) or metric tonnes (t) of product per acre (a).
This study was limited to farmers' average of one acre of maize farm.

2.2.2 Measuring Crop Income

Crop Income was computed as shown below:

Y_1 = (Quantity of produce harvested per acre * Market price of a crop)…………… (2)

This study was limited to farmers' average income obtained within the farming calendar year of 2017, 2018 and 2019, expressed in GH₵.

Finally, cross tabulation with chi-square test was used to compare the relationship between the level of fertilizer usage and maize yield and the income status of smallholder maize farmers.

2.2.3 Measuring Household Wellbeing

The welfare index, derived as a factor score from nine subjective well-being indicators, was regressed on fertilizer use and other variables. The well-being indicators adapted from Organisation for Economic Co-operation and Development (OECD), 2017 and DFID, 2009, well-being measurement includes increased income, improved access to health and nutrition, improved food security, improved access to education, reduced poverty, reduced vulnerability, employment, farm expansion, status in the community and house ownership. The question asked the respondents to respond to the level of agreement on how the fertilizer subsidy programme influenced these well-being indicators. Responses were elicited using a Likert scale ranging from 1 to 5. The well-being index was generated using a factor analysis method, which reduces the attributes and minimizes multicollinearity.

III. FINDINGS & DISCUSSION

3.1 Effects of Fertilizer Usage on Smallholder Farmers Maize Yield

Most smallholder farmers in developing countries cultivate crops mainly for subsistence purposes --- to feed their own families. Although the estimated attainable yield is approximately 6 tonnes per hectare, the current average yield is about 3 tonnes per hectare, with an annual growth rate of 4.17%. In this study, the yield of the maize was

recorded as a continuous variable, measured in kilograms. The continuous variable, however, was transformed into categorical variables: low yield (0-309), moderate yield (400-999), and high yield (1000Kg and above). The impact of fertilizer usage on maize farmers' yields was documented for the farming seasons of 2017, 2018, and 2019.

3.1.1 Effect of Level of Fertilizer Usage on Maize Quantity Harvested in 2017

According to the results in Table 1, it is clear that a close relationship exists between the intensity of fertilizer use and maize output by smallholder farmers in the Northern Region during the 2017 agricultural season. From this, 11 small-scale maize farmers who used relatively low quantities of fertilizer were found to have recorded low maize yields. By contrast, only 5 farmers who applied a small quantity of fertilizer recorded high maize yields. This observation concurs with the study by Banful (2011), which also found that inadequate application of fertilizers often culminates in crop yields lower than the potential output of the crops. Of smallholder maize farmers who applied an average quantity of fertilizer, 37 farmers recorded average maize yields, while 13 farmers recorded low maize yields. This trend confirms Sheahan et al.'s (2013) finding, when these authors realized that the application of a moderate amount of fertilizer increases crop yield but lower than the higher application rate. Of the total number of smallholder maize farmers, which stands at 151 individuals, a greater portion of them realized a moderate level of maize yield when they used high levels of fertilizer. Conversely, 70 farmers realized high yields. These findings are in agreement with those of Schütz et al. 2018, who found that use rates of fertilizer tend to increase with increasing crop productivity. Still, the realization of high crop yields may further call for soil and weather conditions. The surprising thing, however, is that of those smallholder maize farmers who did not apply fertilizer, two had reasonably high yields, while three had low yields. This runs contrary to expectations by Hawkesford (2014) when he suggested that failure to use fertilizer always leads to low crop yields. However, it suggests that other factors besides fertilizer, such as soil fertility and farming practices, equally determine crop yields. During the 2017 cropping season, most of the maize farmers applied fertilizer at the recommended rate, meaning the programme was able to induce behavioural change among beneficiaries.

These results underscore a good application of fertilizers to ensure maximum output in crop production and the overall improvement of the living standards of farmers. This agrees with the views by Ochola and Fengying (2015) who stated that fertilizer subsidy programmes work well. These results indicate similar trends of fertilizer subsidies to that of Chirwa and Dorward (2013), in Malawi. However, the percentage yield improvement differs due to regional variation. The present study successfully depicts the positive and good association of high rates of fertilizer use with improved yield. Again, this imposes the need for continued support and improvement in the dissemination and pattern guidelines of use for fertilizers, as suggested by Pandey and Diwan (2021). The estimated chi-square value from the chi-square test was 12.995, with a p-value of 0.043, indicating that there is a significant relationship between the intensity of fertilizer use and maize yield during the 2017 farming season at 5% significance. Based on the findings in Table 1, therefore, the yield of maize in the 2017 farming season is determined by the application rate of fertilizer. This finding implies that farmers who, during the 2017 agricultural season, applied the recommended rates of fertilizer on the maize fields got a higher yield than farmers who did not apply the recommended rates of fertilizer.

Table 1

Association between Level of Fertilizer Usage and Maize Quantity Harvested in 2017

Level of fertilizer usage for 2017	Quantity of maize harvested in 2017 (100Kg)			Total
	Low maize yield	Moderate maize yield	High maize yield	
Low usage	11	10	5	26
Moderate usage	13	37	24	74
High usage	74	151	70	295
No usage	3	0	2	5
Total	**101**	**198**	**101**	**400**

(X^2 =12.995 p=0. 043)

3.1.2 Effect of Level of Fertilizer Usage on Maize Quantity Harvested in 2018

From Table 2, the findings of this study indicated a clear relationship between the quantity of fertilizer used and the yield of maize in the 2018 farming season, among small-scale maize farmers. More precisely, 11 small-scale maize farmers who applied small amounts of fertilizer had low yields, except one farmer. Conversely, the majority of farmers (49) who used fertilizer at a moderate level achieved moderate yields of crops, yet 10 farmers in this category realized low crop yields. Surprisingly, the majority of farmers who applied large quantities of fertilizers achieved just moderate yields of crops. Only 53 farmers were able to achieve high yields. Of those who did not use fertilizer, three had low crop yield while one farmer had a high crop yield. These findings indicate that an increase in the usage of fertilizers leads to a proportionate rise in crop yields. As Danso-Abbeam et al. (2018) and Salam et al. (2021) noted, efficient use of fertilizers greatly improves agricultural output and farm income. Still, the differential output between those who applied average and high quantity levels of fertilizer indicated underlying factors that must be put into place for full crop output

to be achieved. However, Javed et al. (2022) pointed out that other variables such as soil fertility, weather conditions, and farming practices have strong influences on crop yields. Contrary to Ganiyou and Yovo's 2022 findings in Togo, the results of this study provide evidence of gaps in how fertilizer subsidies influence crop yield improvements at various levels among rural households. This divergence can be attributed to differences in local agricultural practices, subsidy usage mechanisms, and natural conditions. Apart from this, Jena et al. (2021) considered that fertilizer subsidy programmes implemented in Kenya resulted in higher country-level crop yields. However, they also outlined that the government subsidy benefits accrued inequitably, which corroborates the diverging yield behaviour as discovered in this research. The chi-square test results indicated that X2 = 12.632, p = 0.049; hence, there was a significant relationship between the level of fertilizer usage and the yield of maize in the 2018 farming season at a 5% confidence level. This implied that the yield of maize for the 2018 farming season depended on the amount of fertilizer used (see Table 2). That meant a better yield for the farmers who had applied the recommended quantity of fertilizer on their maize fields during the 2018 farming season, as opposed to farmers who had not applied the recommended quantity of fertilizer.

Table 2

Association between Level of Fertilizer Usage and Quantity Harvested for 2018

Level of fertilizer usage for 2018	**Quantity harvested for 2018 (100Kg)**			**Total**
	Low maize yield	**Moderate maize yield**	**High maize yield**	
Low usage	11	14	1	26
Moderate usage	10	49	15	74
High usage	55	181	53	289
No usage	2	8	1	11
Total	**78**	**252**	**70**	**400**

(X^2 =12.632 p=0.049)

3.1.3 Effect of Level of Fertilizer Usage on Maize Quantity Harvested in 2019

Table 3 presents the level of fertilizer use in 2019 and the quantity of maize harvested in the 2019 farming season. Among small-scale maize farmers who applied low fertilizer for the 2019 farming season, 13 had a moderate yield of maize in that farming season. In addition, 6 smallholder maize farmers who used low fertilizer for the 2019 farming season had a yield ranging from low to high within the same season. Among those smallholder maize farmers who had applied moderate fertilizer in the 2019 farming season, a total of 37 farmers in that category had a moderate yield of maize. Just 5 out of the smallholder maize farmers who had used moderate fertilizer had a low yield of maize in that same season. Besides, out of the smallholder maize farmers who used high fertilizer for the 2019 farming season, 161 had a moderate yield of maize compared to 126 who had a high yield for the same season.

It can be deduced from the results that among the small-scale maize farmers who had not applied fertilizer during the 2019 farming season, only 1 had a low maize yield and only 1 had a moderate maize yield. Also, during the 2019 agricultural season, most of the maize farmers applied the recommended rates of fertilizer application. Generally, farmers with a low level of fertilizer applied had moderate maize yields, and those with a moderate level predominantly reaped moderate yields. On the other hand, farmers with large quantities of fertilizer application generally reaped either moderate or high yields. Of importance, those not using fertilizer wholly had low or moderate maize yields. These findings are consistent with prior research that tested the effect of fertilizer use on crop yields.

Chivenge et al. (2022) also demonstrated in their study that as the rate of fertilizer application increased, crop yields were significantly improved among small-scale farmers in sub-Saharan Africa. In contrast, Tripathi et al. (2020) observed that differences exist in the results of fertilizer application. They proposed that soil quality, weather conditions, and agricultural practices also play an important role in determining crop yields. This study confirmed that the use of fertilizer directly influences maize production, but it points out that detailed agricultural guidance and support are required in order to realize full benefits from fertilizer application among small-scale farmers in the Northern Region of Ghana. Indeed, the a chi-square test showed significant results at 5% confidence level; X2 = 18.464, p-value = 0.005, hence showing that there is a significant association between the intensity of fertilizer use and maize yield in the 2019 farming season. Hence, the yield of maize in the 2019 farming season is dependent on fertilizer application rate as indicated in Table 3. The finding here showed that for the 2019 agricultural season, farmers who used the recommended quantity of fertilizer in their maize farms reaped a better yield than those who did not apply the recommended quantity of fertilizer.

Table 3

Association between Level of Fertilizer Usage and Quantity Harvested in 2019

Level of fertilizer usage in 2019	Quantity harvested for 2019 (100Kg)			Total
	Low maize yield	Moderate maize yield	High maize yield	
Low usage	6	13	6	25
Moderate usage	5	37	27	69
High usage	17	161	126	304
No usage	1	1	0	2
Total	**29**	**212**	**159**	**400**

(X^2 =18.464 p=0.005)

3.2 Effect of Level of Fertilizer Usage on Maize Farmers' Income

Smallholder farmers in developing countries largely depend on farming to feed their households. This is the case for farmers in northern Ghana. Whatever produce they derive from maize is mainly meant to keep them through consumption by the household members. If there are excess resources, the family heads sell these to meet other vital needs of their families. It is, however, important to note that the average income that is accrued by maize farmers in developing countries is USD 55.14 per crop season. Besides, farmers are very selective about investments they make, given the cost of tilling, wages of workers, and cost of fertilizers. Returns to their investments depend upon the gains they would incur at the end of the agricultural cycle. Income status in this study is measured on a continuous variable in cedis. However, the continuous variable was transformed into categorical variables representing the different levels of income: low-income level (GHc 0-360), moderate-income level (GHc 361-960), and high-income level (GHc 961 and above).

3.2.1 Effect of Level of Fertilizer Usage on Maize Farmers' Income in 2017

From Table 4, there was indeed an important trend in the correlation between levels of fertilizer usage and the income levels of farmers in the 2017 farming season. Among the smallholder maize farmers who applied low levels of fertilizer, a larger percentage of those had low-income levels than did a few who had moderate income. This infers an evident linkage of extremely low application of fertilizer to low economic returns. Also, for those farmers who applied fertilizer in their fields in the average quantities, a considerably larger proportion of 57 farmers reported low levels of income, while a smaller group of 7 farmers had moderate levels of income. This means that although with a moderate quantity of fertilizer, the chances of earning a better income are slightly higher compared to low use, most people were still at a low level of income. Contrary to this, the farmers who dependented on a large quantity of fertilizer had a bigger share of income than people who fell into the low-income category of 232 farmers and a smaller but significant chunk of 35 farmers able to achieve a high level of income.

This means that whereas the heavy application of fertilizers may result in high production in crops and, therefore, more income for some individuals, the majority of the people in a country where heavy fertilizer application is used still have to struggle to make ends meet. Results among those farmers who did not apply fertilizer reveal that the majority of them, 4, fall in the low-income category, while only 1 farmer enjoys a high income level. Again, fertilizer should be noted as one of the key factors that enhance crop yield and consequently increase the income of small-scale maize farmers. In relation to established literature on the issue, we have indeed noted similar trends in other regions and contexts. In an empirical analysis done by Assefa et al. (2021), it was established that in most cases, farmers who used a higher rate of fertilizer gained more in yield and higher income compared to users of the lower rates.

The convergence of these various studies underlines that fertilizer is an important determinant of the nature of agricultural productivity and income outcomes for small-scale farmers. However, diverging results from the work of Hassa and Idris (2022) in Nigeria indicate that even as fertilizer subsidy programmes have the potential to bring about improvements in yields, their economic benefits could be marred by issues related to market access and price. Such divergent outcomes of these various approaches underpin the need for specific interventions, coupled with supportive policies, to realize the full impacts of fertilizer subsidies on the livelihoods of farmers. This section presents the chi-square test conducted to analyze the relationship between fertilizer usage and income status for the 2017 farming season. Results: X2 = 1.315, p = 0.971. Since that was above the 5%, there was no relationship between these variables. Consequently, from Table 4, the income status for the farming season of 2017 was not affected by the quantity of fertilizer used. Such a finding pointed to the fact that the level of investment made by maize farmers in buying fertilizer for their maize did not necessarily translate into the expected profit they intended to realize in the 2017 farming season.

Table 4

Association between Level of Fertilizer Usage and Farmers' Income Level in 2017

Level of fertilizer usage for 2017	Farmer's income level for 2017			Total
	Low-income level	Moderate Income level	High Income level	
Low usage	21	2	3	26
Moderate usage	56	7	11	74
High usage	232	28	35	295
No usage	4	0	1	5
Total	**313**	**37**	**50**	**400**

(X^2 =1.315 p=0.971)

3.2.2 Effect of Level of Fertilizer Usage on Maize Farmers' Income in 2018

The result from this study, as stated in Table 5, indicated that the use of fertilizers and the income of farmers in the 2018 farming season were positively related. There is a significant relationship between the intensity of the use of fertilizers and income among small-scale maize farmers in the Northern Region of Ghana, within that period. For example, in 2018, farmers using a lower level of fertilizers had high proportions with low-income levels compared to those using moderate or higher levels of fertilizers. In fact, only 3 of the 13 farmers who applied small amounts of fertilizer had their income levels fall under the category of moderate levels. The rest of them had low levels of income. That was because too little use of fertilizer could constrain potential income due to the lower productivity of crops. On the other hand, farmers who applied fertilizer on average in moderate quantities received a higher income level in 2018. In fact, the results showed that out of the total, 48 farmers who used moderate amounts of fertilizer, the majority received high income levels and only a small minority received a moderate level of income. That indicated that the application of fertilizer judiciously had a positive impact on income through yield improvement. Besides, a very large number of farmers who had used large quantities of fertilizer in 2018 were ranked high in their levels of income. More precisely, the 153 farmers who used a large amount of fertilizer, had higher levels of income. In contrast, 27 farmers had their income at a moderate level. This indicates that the optimum application of fertilizer boosts the incomes of farmers through the maximization of crop yields. On the other hand, for the farmers in 2018 who did not use fertilizers, the growth of their incomes was limited. From the total number of non-users, only 6 people reached high levels of income, while only 1 person attained a moderate level of income. This shows a great disparity, hence the importance of applying fertilizer as a vital means of improving agricultural productivity and, therefore, increasing the levels of income amongst small-scale maize farmers.

The results of this study agreed with those across Africa that indicate the vital role of fertilizer in improving agricultural yields and economic outcomes among small-scale farmers. However, deviations from those reported in the study of Boulanger et al. (2022) only showed a positive effect of fertilizer subsidy on income level. These evidences reveal the volatility of results depending on the approach taken for implementation and local farming conditions. These variations in findings bring into focus the need for site-specific strategies that target fertilizer subsidy programmes for maximum impact to be created by these programmes on the improvement of the livelihoods of farmers. The chi-square test gave nonsignificant results at 5% confidence level; that is, X2 = 6.982, p = 0.323, showing there was no significant association between the level of fertilizer use and income status during the 2018 farming season. Hence, the quantity of fertilizer used did not matter for income status for the 2018 farming season, as reflected in Table 5. That therefore implied that maize farmers invested in buying fertilizer for their maize at a level that did not guarantee the expected profit they intended to make from their maize for the 2018 farming season.

Table 5

Association between Level of Fertilizer Usage and Farmers' Income Level for 2018

Level of fertilizer usage for 2018	Farmer's income level for 2018			Total
	Low-income level	Moderate Income level	High Income level	
Low usage	13	3	10	26
Moderate usage	23	3	48	74
High usage	109	27	153	289
No usage	4	1	6	11
Total	**149**	**34**	**217**	**400**

(X^2 =6.982 p=0.323)

3.2.3 Effect of Level of Fertilizer Usage on Maize Farmers' Income in 2019

Table 6 indicates the fertilizer usage and income levels among the farmers for the 2019 farming season. Farmers who used more fertilizers had relatively higher incomes compared to those who applied smaller quantities of fertilizer. More specifically, 172 farmers who used substantial amounts of fertilizer achieved high levels of income in 2019, while

24 achieved moderate incomes. This number stands in radical contrast to those farmers using minimal levels of fertilizer, where only 13 individuals achieved high-income levels, and only 2 attained moderate levels of income. These findings are in line with Andani et al. (2020) and Osabohien et al. (2019) who reported significant positive relationships between fertilizer usage, yield and the income levels of rice farmers in Ghana and Nigeria respectively.

The study also demonstrated that among farmers who used only moderate quantities of fertilizer 31 realized high incomes and 10 earned moderate incomes. This indicates that application of a moderate quantity of fertilizer can still raise incomes, though higher applications tend to result in more lucrative economic returns. This agrees with the findings of Asai et al.(2021), who noted that farmers obtained low and high levels of yield and income even without using fertilizers. That is further corroborated by Harwood (2020), who discussed the complex linkage between fertilizer use, crop productivity, and income outcomes from the green revolution in Asia, suggesting interdependence of several factors. The chi-square result from this analysis was not significant (X2 = 4.939, p = 0.552 at a 5% level of confidence), meaning there was no relationship between the intensity of fertilizer use and income status in the 2019 farming season. The level of income for the 2019 farming season did not depend on the quantity of fertilizer applied, as shown in Table 6. A finding such as this one, therefore, suggests that the level of investment in fertilizers by maize farmers does not eventually create the expected profit from their maize crop.

Table 6

Association between Level of Fertilizer Usage and Maize Farmers' Income Level in 2019

Level of fertilizer usage for 2019	**Farmer's income level for 2019**			**Total**
	Low-income level	**Moderate Income level**	**High Income level**	
Low usage	10	2	13	25
Moderate usage	28	10	31	69
High usage	108	24	172	304
No usage	1	0	1	2
Total	**147**	**36**	**217**	**400**

(X^2 =4.939 p=0.552)

IV. CONCLUSION & RECOMMENDATIONS

4.1 Conclusion

The fertilizer subsidy programme made quite a moderate impact on the livelihoods of the smallholder maize farmers within the Northern Region of Ghana. A positive relationship existed between the intensity of fertilizer use and maize yields throughout the 2017, 2018, and 2019 farming seasons. Farmers who applied the recommended fertilizer rates produced better crop yields compared to those who applied lower quantities. The programme also promoted increased incomes, and reduced poverty among farmers.

4.2 Recommendations

The study recommends that there should be an improvement in fertilizer distribution efficiency by the government and all its stakeholders. This would ensure that prompt delivery of subsidized fertilizers to the farmers was available to them at their most critical periods of planting. Similarly, an expanded monitoring and tracking system would help avoid delays and make sure that these fertilizers reach their intended beneficiaries.

Conflict of Interests

The authors have not declared any conflict of interest.

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