REGULAR ARTICLE

PROFIT EFFICIENCY OF SMALLHOLDER MAIZE FARMERS IN SAGNARIGU MUNICIPAL OF NORTHERN GHANA

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ABSTRACT

Research background: Maize is the most important cereal crop produced by most households in Ghana for income and household food security. Despite its economic importance, not much study has been carried out on maize profit efficiency in Ghana, hence this study.

Purpose of the article: This study estimated profit efficiency of maize farmers in the Sagnarigu municipal of Ghana to understand producers' profit efficiency level and its determinants as well as the challenges faced by maize producers.

Methods: Data was sourced from small-scale maize producers while stochastic frontier analysis was applied to estimate a Cobb-Douglas profit function that simultaneously identified the sources of inefficiency. Kendall's coefficient of concordance was used to analyse the constraints facing maize producers.

Findings & Value added: The findings indicated that maize farmers produced at 71% profit efficiency. This is one of very few studies on profit efficiency of Ghanaian maize farmers. The result means that 29% of the achievable maximum profit was forfeited as a result of production inefficiency. Educational attainment and access to agricultural extension service decreased the level of profit inefficiency while age, herd ownership and membership of farmer organization increased profit inefficiency level of farmers. The most critical challenges reported by farmers were financial constraints, high cost of ploughing and difficulty in acquiring chemical fertilizer. The study recommends that access to agricultural extension service should be improved to cover more farmers while efforts should be made to expand educational access in rural areas to enhance the profit efficiency of farmers.

Keywords: profit efficiency; maize; stochastic frontier analysis; smallholder farmers; Ghana
JEL Codes: C21; D24; Q12

INTRODUCTION

The multi-dimensional role of agriculture in reducing hunger and poverty under the Sustainable Development Goals (SDGs) is well acknowledged. The agricultural sector in Africa is estimated to play a key role in poverty reduction **(Christiaensen *et al*., 2011)**. Small-scale farming accounts for over 90 per cent of the economically active rural population of Ghana **(Ghana Statistical Service, 2014)**. Farmers involved in small-scale agriculture have limited access to assets that facilitate the transition from less productive farming to modern commercial farming. Compared to other countries worldwide in terms of agricultural productivity, Ghana still lags behind **(Fuglie & Rada, 2013)**.

Invariably, certain obstacles exist that prevent Ghana's agricultural sector from realising its full potential. Studies have shown that inefficiencies and significant yield gaps exist in small-scale farming in several developing countries **(Anang *et al*., 2016; Abdulai et *al.,* 2013; Al-hassan, 2012).** These inefficiencies are related to factors such as low adoption of improved technologies, lack of access to farm inputs and services, poor technical knowhow, environmental factors, among others.

Improving the profitability of farming particularly among smallholder farmers is a very important goal for most developing countries because majority of the population in these countries are engaged in farming as a source of livelihood. Farm households are involved in agricultural production with the aim of achieving household livelihood goals such as food and income security. Farmers operate in a competitive environment and must therefore combine resources in a judicious manner to ensure that they achieve optimum levels of production and profit from farming.

The goal of profit maximization may not be explicitly stated by smallholders, nevertheless, any production system that is not profitable may not be sustainable over time. Enhancing the level of profitability requires technical skills in producing optimally and eliminating waste. It also relates to right combination of inputs taking into consideration the input price levels. Thus, profitability can be influenced by managerial as well as institutional and marketing factors. Factor prices and capability in allocating these resources are essential to raise profitability of smallholder farmers.

Maize is an important staple food and cash crop produced by most smallholder farmers in Ghana. The crop is produced by most farm households as it forms an important part of the diet of Ghanaians and brings considerable income to producers. Maize production is however not without challenges, especially with regards to acquisition of external inputs such as chemical fertilizers, cost of land preparation, unavailability of improved seeds and pest and disease challenges. These challenges affect the profitability of maize production and the total area farmers are likely to put under cultivation.

This study therefore explores the profit efficiency of small-scale maize farmers in the Sagnarigu municipal of Ghana to highlight the sources of inefficiency as well as the critical challenges confronting farmers.
There are not many studies focusing on profit efficiency of maize production in Ghana which warrants this study. A search through the literature reveals that there is paucity of research on profitability and profit efficiency of maize cultivation in Ghana and particularly the study area. This is against the backdrop that maize is the most widely cultivated and consumed cereal crop in Ghana, and plays a very crucial role in household food and income security. The few studies that have examined maize profit efficiency in Ghana have shown varied results and include **Wongnaa *et al. (2019)***, **Ansah *et al. (2014),*** and **Bidzakin *et al.* (2014).** The study by **Wongnaa *et al*. (2019)** focused on four ecological zones of Ghana and estimated the mean profit efficiency at 48.4%, while **Ansah *et al.* (2014)** focused their study on the forest belt of Ghana and reported a mean profit efficiency of 89**%. Bidzakin *et al.* (2014)** undertook their study in northern Ghana and reported a mean profit efficiency of 61%. Clearly, the results are quite inconclusive regarding the level of profit efficiency among Ghanaian maize farmers. The scarcity of research in this area of study means that there exist inadequate research findings necessary to enhance maize profit efficiency and profitability across the country. This study therefore contributes to the body of knowledge on maize profit efficiency of peasant farmers and fills an important research gap.

LITERATURE REVIEW

According to **Konja *et al.* (2019)**, agriculture is key to economic development in Ghana, hence the need to pay attention to output and productivity growth. Resource constraints, high cost of farm inputs, use of rudimentary equipment in farming among others contribute to low farm profits in many developing countries. Most farms in Ghana and other developing countries remain small with little investment of capital to increase farm profits. Increasing the profitability of smallholder farmers therefore remains a critical challenge confronting policymakers and researchers.
Agriculture in sub-Saharan Africa is dominated by food crop production **(Mujuru *et al.,* 2022)**, with crop farming contributing immensely to rural development, income and food security and rural livelihoods **(Khoza *et al.,* 2019)**. Maize is an important food crop produced in most parts of Africa, notably among farm households and is the main dietary staple in Ghana and several African countries. The profitability of maize production hinges very much on conditions in the input and output markets **(Mujuru *et al.,* 2022)**, as well as farm and farmer characteristics that influence the level of productivity. Farmers' ability to reduce inefficiency in production and optimise resource-use efficiency are necessary to improve productivity and profitability of maize production.
Profit efficiency connotes the ability of farmers to produce at the highest possible profit taking into account input prices and the level of fixed production inputs **(Ali and Flinn, 1989; Rahman, 2003).** It entails producers' ability to produce on the profit frontier while any deviations from the frontier are construed as inefficiency of production. In profit efficiency analysis, producers are regarded as profit-maximisers, as opposed to cost-minimisers (where output level is regarded as exogenously given). Output and inputs are decided by the producer, with the objective of maximizing profits.
Measurement of efficiency typically follows a parametric or non-parametric approach. The parametric approach is centred on econometric estimation of a production frontier. The approach is made up of the stochastic frontier and deterministic frontier models. The parametric frontier methods impose a functional form on the production function based on assumptions made about the data. The commonly used functional forms consist of the Cobb–Douglas, constant elasticity of substitution, and translog production functions. The parametric approaches are divided into deterministic frontiers and stochastic frontiers. A deterministic frontier is based on the assumption that all deviations from the production or cost frontier are as a result of inefficiency of firms/farmers. Conversely, stochastic frontiers assume that a portion of the discrepancies from the frontier is as a result of random noise such as measurement error and statistical noise and also partially as a result of firm-specific inefficiency **(Forsund *et al.,* 1980; Coelli *et al.,* 2002).** The stochastic frontier approach tries to differentiate effects of random noises from the effects of inefficiency. As a result, it has the strength of testing statistical hypothesis over the deterministic frontier.
The application of the non-parametric approach in efficiency analysis includes the free disposal hull (FDH) and the data envelopment analysis (DEA), with DEA being the most popular non-parametric method. DEA was first initiated by Farrell (1957) and introduced into modern economic literature by **Charnes *et al.* (1978)** while FDH was developed by **Deprins *et al.* (1984).** DEA is used to analyse production, cost and revenue and profit data without technology parameterization (Greene, 2008). It does not impose a functional form on the production and cost frontier nor make any assumptions about the distribution of the error term. DEA uses either an input or output orientation to measure efficiency, based on whether the producer has more control over inputs or output level. The efficiency frontier in DEA stems from the concept of Pareto optimality; a firm may increase (decrease) output without necessarily increasing (decreasing) production of another product. DMUs on the frontier are considered as Pareto optimal units and are assigned an efficiency score of one (fully efficient). DMUs that are not on the efficient frontier are considered to be relatively inefficient and are given a positive efficiency index of less than one **(Chimai, 2011).**
While there are also semi-parametric techniques in assessing efficiency, these techniques have not gained much prominence in the literature. Semi-parametric techniques are statistical models that have parametric and nonparametric components; a finite-dimensional component and an infinite-dimensional component. Semi-parametric techniques include productivity indices, growth accounting, index theory, and many others.

RESEARCH METHODOLOGY

The study area and sampling procedure

The research was carried in the Sagnarigu municipality of the Northern Region of Ghana. The municipality is located in the Guinea savanna and covers 200.4 km² of land with a population of 148,099 **(Ghana Statistical Service, 2010).** It has a single rainfall regime and a long dry spell during the dry season. The area experiences high annual temperatures during the dry season (up to about 40 degrees Celsius) and dry harmattan winds. The economy of the municipality is mainly agriculture and commerce-based. The cultivation of maize, rice, and soybean is a major activity in the municipality.

The research involved primary data collection from smallholder farm households in the area. Multistage random sampling was used in the data collection. Sagnarigu municipal was first chosen within the northern savanna as a major maize producing area. This was followed by random sampling of six maize producing communities in the municipality. Thereafter, simple random sampling was applied to select thirty respondents per community to provide a total of 180 respondents. The respondents were interviewed using a semi-structured questionnaire with the interviews conducted in the local dialect since most of the respondents could not read and write. One respondent was dropped from the analysis due to incomplete information. The data covered activities for the 2018/2019 cropping season.

Efficiency concepts and measurement

Efficiency measurement was introduced by **Farrell (1957**) and described by **Kumar and Gulati (2010)** as a measure of operational excellence in the resource utilization process. Closely related to efficiency is productivity. Productivity in its simplest form is determined by dividing the output realised by the total physical inputs or resources (land, labour, seed, etc.) utilised in production. In other words, productivity is simply efficiency in production **(Syverson, 2011)**. Single-factor productivity also measures or reflects units of output produced per unit of a particular input. A firm is said to be inefficient when it does not attain to the potential maximum output.

A firm in the production process is likely to experience some components of productive efficiency, namely: technical, allocative and economic efficiencies. Discrepancies in output between farmers can be explained by the differences in efficiency. Thus, the production frontier describes the highest attainable output given the minimum inputs needed to obtain a particular output. In other words, for each input mix the production frontier depicts the maximum attainable output. Technical inefficiency denotes failure of the farmer or firm to attain the frontier level of output, given the level of inputs **(Kumbhakar, 1994**). Consequently, inefficiency arises when the observed output lies below the frontier. Allocative efficiency is a firm or farmer's ability to use inputs in their optimal way, given their respective prices **(Uri, 2001)**. If a farmer fails in allocating inputs at minimized cost, given the relative input prices, then there is allocative inefficiency or resource misallocation. The implication is that, misallocating resources will result in increased cost of production and hence decreased profit. Again, if the marginal rate of technical substitution between any two inputs is not equal to the resulting proportion of factor prices, a firm or farmer is said to be allocatively inefficient. This could be due to sluggish adjustment to price changes and regulatory challenges **(Atkinson and Cornwell, 1994)**. In the production process, a firm may be technically efficient but allocatively inefficient, allocatively efficient but technically inefficient, both technically and allocatively efficient, and at worse, technically and allocatively inefficient. Economic efficiency seeks to pool technical and allocative efficiencies to depict the ability of a firm or farmer to produce at possible minimum cost, given input price and a set of inputs. Consequently, achieving technical or allocative efficiency is only a necessary but not a sufficient condition for economic efficiency. A firm or farmer must at the same time achieve both technical and allocative efficiencies if it is to achieve economic efficiency.

Stochastic profit frontier model

The stochastic profit frontier function is modelled based on **Battese and Coelli (1995)** as Equation (1).

$$\pi_i = f(P_i, Z_i)\, exp(e_i)\,; \quad e_i = v_i - u_i \qquad (1)$$

where π_i is normalized profit, P_i is normalized input price, Z_i denotes the level of a fixed inputs, and e_i represents the composed error term. v_i is random errors beyond the producer's control while u_i denotes factors within the farmer's control.

The inefficiency effects (u_i) is modelled as Equation (2).

$$u_i = \delta_0 + \sum_{k=1}^{n} \delta_k W_{di} + \varepsilon_i \qquad (2)$$

where W_{di} represents the factors associated with inefficiency, ε_i is random error and δ_0 and δ_k are unknown parameters. Profit efficiency is obtained as the ratio of the observed profit to the frontier profit **(Aigner *et al.*, 1977**; **Meeusen and Van den Broeck, 1977)** (Equation 3 – Equation 6).

$$\pi_e = \frac{\pi_i}{\pi_{max}} \qquad (3)$$

$$\pi_e = \frac{f(P_{ij}, X_{ij}, \beta_i).exp(v_i - u_i)}{f(P_{ij}, X_{ij}, \beta_i).exp(v_i)} \quad (4)$$

$$\pi_e = exp(-u_i) \quad (5)$$

$$\text{Profit inefficiency} = 1 - \pi_e \quad (6)$$

where π_e is profit efficiency, π_i is observed profit, and π_{max} is the frontier profit.

The study adopted the Cobb-Douglas functional form for the analysis. The empirical Cobb-Douglas stochastic profit frontier model can be expressed as Equation (7).

$$ln\pi_i = \beta_0 + \beta_1 lnx_{1i} + \beta_2 lnx_{2i} + \beta_3 lnx_{3i} + \beta_4 lnx_{4i} + \beta_5 lnx_{5i} + \beta_5 lnx_{6i} + \beta_5 lnx_{7i} + v_i - u_i \quad (7)$$

The x_i variables include both conventional inputs and fixed production inputs used in the cultivation of rice. The variables included unit price of seed, labour, fertilizer, herbicide, ploughing cost per acre as well as the size of land and amount of capital used in production.

The inefficiency model is given as Equation (8).

$$u_i = \delta_o + \delta_1 z_{1i} + \delta_2 z_{2i} + \delta_3 z_{3i} + \delta_4 z_{4i} + \delta_5 z_{5i} + \ldots\ldots\ldots + \delta_n z_{ni} \quad (8)$$

The z_i variables include individual, household, farm and institutional factors identified in the literature to affect profit efficiency.

Descriptive statistics of the respondents

The variables used in the study are described in Table 1 which reveals that the farmers are within the economically active age for farming. A youthful farming population is likely to be more willing to explore new technologies to enhance productivity and profitability. It was also revealed that only 25% of the respondents are educated which could be a drawback to information seeking and technology adoption. On the average, the respondents owned farms with an average size of 3.4 acres suggesting that they are small-scale producers. The study further indicated that most (70%) of the respondents belonged to a farmer-based organization. Thus, new technology or innovation aimed at increasing output and profit could be channel through these organizations to farmers. Also, it was found that most (84%) of the farmers owned cattle, which play a useful role in farming in most rural settings, where they are used to cart goods and plough fields to reduce drudgery associated with farming.

Table 1 Descriptive statistics of the variables

Variable	Measurement	Mean	Std. Dev.	Min.	Max.
Profit	Ghana cedi (GH¢)	1196	879.7	90	5000
Maize price	Ghana cedi/kg	0.997	0.018	0.9	1
Labour price	Ghana cedi/man-day	10.61	1.852	7	15
Seed price	Ghana cedi/kg	1.530	0.706	1	3
Fertilizer price	Ghana cedi/kg	1.267	0.710	0	2.4
Herbicide price	Ghana cedi/litre	14.94	9.815	0	25
Ploughing cost	Ghana cedi/acre	72.01	7.505	45	100
Farm capital	Ghana cedi	297.3	180.4	62	1402
Farm size	Acreage	3.402	2.241	0.5	14
Age	Number of years	42.50	11.64	24	77
Education	Number of years	2.229	4.435	0	16
Owned cattle	1 if yes; 0 otherwise	0.838	0.369	0	1
Extension visits	1 if visited; 0 otherwise	0.447	0.499	0	1
Farmer group	1 if member; 0 otherwise	0.704	0.458	0	1
Fertility of soil	1 if fertile; 0 otherwise	0.330	0.471	0	1

Note: 1 Ghana cedi = USD 0.19. Source: Authors' computation, 2020.

RESULTS AND DISCUSSION

Maximum likelihood estimates of the stochastic frontier profit function

The results in Table 2 show the stochastic profit frontier estimates. The dependent variable, profit, and the input variables were all mean-corrected to zero and log-transformed, implying that the first-order coefficients denote the corresponding elasticities. The results show a good fit of the data as indicated by the significance of the variance parameters. The results show that 61% of the variation in profit is associated with factors within the control of farmers.

Table 2 Stochastic frontier estimates of the profit function for maize farmers

Variable	Parameter	Estimate	Std. Error
Constant	β_0	0.949	1.691
Labour price	β_1	0.491**	0.192
Seed price	β_2	– 0.149*	0.080
Fertilizer price	β_3	0.062***	0.011
Herbicide price	β_4	0.012*	0.007
Unit cost of ploughing	β_5	0.350	0.335
Capital	β_6	0.593***	0.161
Farm size	β_7	0.421***	0.126
Variance parameters			
Gamma: $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$	γ	0.606***	0.015
Sigma squared: $\sigma^2 = \sigma_u^2 + \sigma_v^2$	σ^2	0.403***	0.018
Log-likelihood	L	– 92.58	

Note: ***, **, and * denote significance at 1%, 5% and 10% level, respectively. Source: Authors' computation, 2020.

The price of labour is positive and significant at 5%, implying that an increase in the average price of labour services increases farm profit. However, the positive effect of labour in this study is at variance with **Amesimeku and Anang (2021)** in their study in northern Ghana. Seed price was also found to be significant at 10% and negatively correlated with profit, revealing that an increase in seed price results in reduction in farm profit. The negative effect of seed price disagrees with **Amesimeku and Anang (2021)** who reported a positively significant effect of seed price on profit of soybean farmers in Ghana. Fertilizer application was found to be significant at 1%, implying an increase in fertilizer price positively correlates with profit of maize farmers. Price of herbicide was found to be significantly related to profit at 10% while the value of farm capital and cultivated land area were both significantly related to profit 1%. This indicates that an increase in herbicide price, capital and cultivated land area increases farm profit. The positive influence of capital is consistent with the result of **Chikobola (2016)** which indicated a positive effect of farm capital on the profit level of groundnut production in Zambia.

Distribution of profit efficiency scores of maize farmers

The results in Table 3 show the distribution of the profit efficiency scores of the respondents. The producers recorded an average profit efficiency of 71.3%, with a range of 18.2% and 94.2%. This implies that the farmers lose about 28.7% of the profit due to inefficiency. Hence, the farmers could potentially increase profit efficiency by 28.7%.

Table 3 Distribution of profit efficiency scores

Efficiency range	Frequency	Percent
0.00 – 0.10	0	0
0.11 – 0.20	1	0.6
0.21 – 0.30	3	1.7
0.31 – 0.40	8	4.5
0.41 – 0.50	14	7.8
0.51 – 0.60	12	6.7
0.61 – 0.70	30	16.8
0.71 – 0.80	44	24.6
0.81 – 0.90	61	34.1
0.91 – 1.00	6	3.4
Mean	0.713	
Minimum	0.182	
Maximum	0.942	

Source: Authors' computation, 2020.

Most (62.1%) of the farmers had profit efficiency above 70% while very few (14.6%) had profit efficiency up to 50%. Generally, most of the farmers are profit oriented and achieve more than 50% of profit efficiency. This technically allows farmers to be in production, since they are able to meet their average cost of production. On the contrary, farmers' inability to attain 100% profit efficiency could be attributed to limited usage of the available technology for maize production and external shocks such as poor environmental conditions that affect farmers' productivity.

Identifying the sources of profit inefficiency

Table 3 shows the determinants of profit efficiency. Six variables were found to influence profit efficiency either positively or negatively at various significant levels.

Table 4 Determinants of profit inefficiency

Variable	Parameter	Estimate	Std. Error
Constant	α_0	– 3.982**	1.640
Age	α_1	0.036**	0.018
Years of education	α_2	– 0.311*	0.183
Years of education squared	α_3	0.020	0.015
Herd ownership	α_4	1.241**	0.615
Extension visits	α_5	– 0.720*	0.431
Farmer-based association	α_6	0.934*	0.541
Soil fertility status	α_7	– 1.117**	0.481

Note: ***, **, and * indicate significance at 1%, 5% and 10% level, respectively. Source: Authors' computation, 2020.

Age is positive and significant at 5% implying that an increase in age increases profit inefficiency of maize farmers in the Sagnarigu municipality. This finding is in line **Setsoafia *et al.* (2017)** who found that older artisanal fishers in Pru district of Ghana were less profit efficient as opposed to the younger counterparts. Younger farmers may be more adventurous in terms of adopting new technologies thereby improving their efficiency of production.

Education was measured as a continues variable and was found to positively influence profit efficiency (or negatively influence profit inefficiency) at 10%. This shows that a yearly increase in one's educational level increases the chances of enhancing profit efficiency. This could be due to the influence of education in exposing farmers to modern technologies through knowledge seeking. Farmers who can read and write are more likely to be aware of productivity-enhancing technologies and their correct application. They are also more likely to take advantage of opportunities that improve the lot of farmers such as participation in formal credit market and training programmes, among others. The finding concurs with **Wongnaa *et al.* (2019**) who observed that education correlated positively with profit efficiency of maize farmers in Ghana.

Farmers' access to agricultural extension was significant and negative in relation to profit inefficiency. This shows that access to extension services reduces profit inefficiency (in other words, it enhances profit efficiency). The result agrees with Amesimeku and **Anang (2021)** as well as **Konja *et al.* (2019)** in separate studies with smallholders in northern Ghana. Extension agents are important in smallholder production because they offer technical advice to farmers which contribute to higher productivity and profitability. Extension agents provide a link between farmers and researchers and their role in educating and training farmers on modern production practices to enhance yield and profitability cannot be overemphasized.

Herd ownership and farmer-based organization membership were also significant and positive in relation to profit inefficiency, implying that profit efficiency decreases with herd ownership and farmer-based organization (FBO) membership, which is contrary to expectation. This is because FBOs are expected to serve as a platform for technology adoption and farmer education, thus belonging to a farmer group is anticipated to enhance producers' knowledge about new technologies and their adoption strategies which could directly or indirectly influence profit efficiency. Thus, the FBOs in this study may not be actively engaged in carrying out their core duties or there may be issues of free-riding by some members, thus reducing their effectiveness.

Soil fertility status was found to negatively influence maize farmers profit inefficiency in the Sagnarigu Municipality. The result implies that producers with fertile land achieve higher profit efficiency relative to producers with infertile land. The reason could be that farmers with fertile soils need fewer external inputs to improve the level of soil fertility thereby reducing production costs and increasing the profitability of farming. Farmers with infertile soils need to apply more external inputs to improve soil fertility which is expected to increase the cost of production and thereby negatively impact on profitability and profit efficiency.

Ranking of constraints faced by maize farmers

Eleven major constraints were identified and ranked as shown in Table 5. The problem with the least mean rank was identified as the most serious constraint and vice versa. Farmers identified financial constraints as the topmost problem affecting their production activities. Smallholder farmers usually find it difficult to access credit from both formal and informal sources. Thus, access to finance remains a critical challenge that confronts Ghanaian smallholder farmers. Smallholders are also generally resource-poor, which affects their access to production inputs. This result is buttressed by findings of **Dimitri and Richman (2000)** and **Garcıa-Gil *et al.* (2000)** which revealed that financing is the main challenge faced by farmers. **Amesimeku and Anang (2021)** reported similar finding in a study in northern Ghana involving smallholder soybean farmers.

Table 5 Ranking of constraints facing maize farmers

Variable	Mean score	Std. Dev.	Rank
Financial constraints	2.40	1.84	1st
High cost of ploughing	3.22	2.42	2nd
Difficulty in acquiring fertilizer	4.22	3.56	3rd
Pest and diseases	4.69	2.34	4th

Poor soils	5.73	1.99	5th
Low yields	6.32	1.93	6th
Cost of chemicals for weed control	6.53	3.67	7th
Lack of ready market	7.18	2.05	8th
Low maize price	7.94	1.58	9th
High cost of seeds	8.63	1.87	10th
Unavailability of improved varieties	9.01	2.16	11th

Source: Authors' computation from field survey, 2020.

The next constraint in terms of importance to the respondents is high cost of ploughing. Usually, farmers depend on commercial tractor operators who live within their communities or nearby villages. However, due to the limited number of such operators, the demand for tractor services always outstrips the supply, driving up prices. The provision of mechanization centres at the community level is necessary to promote access to tractor services. The study's finding resonates with **Amesimeku and Anang (2021**) who reported high cost of ploughing as the second most important constraint among soybean farmers in northern Ghana.

Farmers identified difficulty in acquiring fertilizer as a major constraint in maize production. Maize is a heavy feeder when it comes to fertilizers and the soils in northern Ghana are generally low in fertility. Lack of access to chemical fertilizer is therefore a major challenge to farmers whose livelihoods depend on crop production. Hence, measures are required to improve farmers' access to chemical fertilizer. This could be done by ensuring efficiency and transparency in the distribution of subsidized fertilizer under the Planting for Food and Jobs (PFJs) initiative of the Government of Ghana. There is also the need to provide incentives and an effective regulative framework to ensure that private input dealers supply farmers with chemical fertilizer and other production inputs at their door steps and at approved prices.

Issues of pests and diseases have become critical in recent times as a result of the emergence of the fall army worm and other pests that devastate the farms of farmers in Ghana. This drives up the cost of chemical pest control which affects profitability of farming. Poor soils were reported as the fifth constraint; poorer soils lead to higher input use with less return. This is closely related to low yields, which was reported as the sixth constraint. Other constraints included the cost of chemical control of weeds, lack of ready market for farm produce, low produce price, high cost of seeds and the unavailability of improved varieties. Adoption of improved seeds is below expectation as many smallholders still cultivate traditional varieties. It is often argued that farmers choose traditional varieties as a risk management tool, since these traditional varieties are better adapted to the local environment and require fewer external inputs, although they give fewer yields. Thus, resource-poor farmers who lack access to credit are more likely to choose local varieties that give minimum yield with minimum external inputs. The challenge is to facilitate smallholders' access to input subsidies to promote adoption of improved varieties to enhance farm yields and profitability.

CONCLUSION AND RECOMMENDATIONS

The study assessed profit efficiency of small-scale maize producers in Sagnarigu municipal of Ghana using stochastic profit function approach. The results indicated that 29% of the potential profit was lost as a result of production inefficiency of farmers. Educational attainment and access to agricultural extension decreased the level of profit inefficiency while age, herd ownership and farmer group membership increased profit inefficiency level. The study also identified several challenges confronting the maize farmers. The most critical challenges reported by farmers included financial constraints, high cost of ploughing and difficulty in acquiring chemical fertilizer.

As a means to improve profit efficiency of producers, the authors recommend that access to agricultural extension services to farmers should be improved. This is because farmers learn from extension agents and acquire knowledge and relevant information that help them to optimize yield and achieve higher efficiency.

Furthermore, expanding access to education in rural areas is another important measure required to increase the profit efficiency of smallholder farmers. Education improves the human capital which improves knowledge of yield-enhancing technologies. Education also improves smallholders' access to information leading to improved farm performance.

Farmers' most pressing constraint was financial, hence increasing access to credit is essential to enhance farm performance. Credit is necessary to purchase farm inputs and ensures timely farm operations. This is critical because smallholder farming is usually time-bound due to the dependence on rainfall for production. Failure to carry out major farm operations timeously could lead to severe crop failure. Also, farmers identified high cost of ploughing as the second most critical constraint. Hence, improving access to agricultural mechanization services is required to improve smallholder farming. Tractorization improves soil preparation and enhances soil aeration, while it also facilitates timely farm operations.

The respondents identified poor soils as one of the constraints to maize production. This was buttressed by the efficiency analysis which indicated that farmers with poorer soils experienced lower profit efficiency. Thus, training of farmers in soil fertility management is needed to enhance profit efficiency of farmers. This could be achieved by incorporating soil fertility management as a critical part of extension service delivery to farmers.

Competing interest
None to declare

Acknowledgments
The authors are very grateful to the farmers who took part in the survey voluntarily and provided the researchers with valuable information to carry out the study.

Funding
The authors self-financed the study.

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