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EFFECTS OF PRODUCTION PARAMETERS ON RICE OUTPUT IN THE KETU NORTH DISTRICT OF THE VOLTA REGION, GHANA

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Abstract

This article investigated the effects of production parameters on thecultivation of rice in the Ketu North District of Ghana. Out of 1,024 farmers, 290 rice farmers were chosen to take part in the study using a two-stage sampling procedure. A structured interview schedule was used to collect primary data from 285 respondents resulting in a response rate of 93%. A translog stochastic frontier production function with a model for inefficiency effects was employed in data analysis, using the Maximum Likelihood Method.Land area under cultivation, fertilizer input, irrigation cost, and equipment were identified as the major input factors that significantly influenced yield of rice in the Ketu North District. Also, results indicated 0.642 returns to scale; which implies that an aggregate increase in inputs results in a less than proportionate increase in the yield of rice in the study area. This indicates a decreasing returns to scale. The findings of this study would guide governments and civil society organisations to understand where public investments can best be directed to boost rice production in Ghana. Increased rice output would raise farmers' income and improve their livelihood security. Also, increased output of rice will help reduce rice imports to save foreign exchange and strengthen the local currency. Finally, the findings of this study would fill the gaps in literature and contribute to knowledge.

Key words: *irrigation scheme, return to scale, production, stochastic frontier analysis*

INTRODUCTION

In Ghana, rice comes next to maize as an important cereal grain staple food and its consumption has risen over the years as a result of increase in population, growth in cities, and consumer habit change [1, 26, 20, 10, 18, 8]. Rice production in Ghana satisfies about 30 to 40 percent of domestic demand with an accompanying rice import bill of $400million annually [23,14,12]. The over reliance on rice imports has been a challenge for policymakers, especially after a significant hike in food prices in 2008. The government's flagship programme, Planting for Food and Jobs continue to yield results [19]. Under the estimate for Planting for Food and Jobs (PFJ), the overall land area under rice cultivation in Ghana was to be increased from 239,340 ha to 260,000 ha by 2020 [24, 13]. Furthermore, 30,000 ha of the current area under rice cultivation in Ghana was occupied by Planting for Food and Jobs in 2017, there were official plans to increase coverage to 124,628 ha in 2018 and then to 198,380 ha in 2019. If the results displayed in 2017 remained consistent throughout the programme, a major increase in rice output is anticipated.

Similarly, the continued expansion of the area under irrigation is expected to increase the per hectare output of rice. While poor farm mechanisation and improper post-harvest facilities have posed a challenge to most smallholder rice farmers in the country, government's effort to modernise and enhance production is expected to alleviate these issues. Since the demand for rice is expected to increase in subsequent years, it will be necessary to sustain rice production gains achieved between 2013 and 2017 to turn Ghana into a sustainable, food-secure rice-producing country. This can be achieved through the enhancement of the efficiency of rice farmers.The inability of domestic rice producers to meet local demand is as a result of rice farmers' production inefficiency [15]. Performance at the farm level is achievable in two distinct ways: either by increasing output with a given set of inputs or by reducing costs to produce a prescribed amount of output [21]. The previous concept is called technical efficiency which is a yard stick for a firm's ability to produce the highest possible output from a given set of inputs under the existing level of technology. Rice is a widely produced food crop and its cultivation serves as a source of livelihood for a lot of people in the Ketu North District. Yet, not much research has been carried out to determine the productivity of rice farmers; especially farmers cultivating rice on the irrigation scheme at Weta. The aforesaid reasons inform this research to be conducted to investigate the effects of some inputs on rice yield. This would impact government policy decisions. Generally, the study aims at evaluating the effects of production inputs on the yield of rice in the Ketu North District.

The specific objectives are: to estimate the effects of production inputs on the yield of rice in the study area and to work out the production output elasticities. The undermentioned research questions guide the study: 1. How do production inputs impact the yield of rice in the district? 2. What are the output elasticities in rice production? The following hypothesis will be tested:H_0: Production inputs haveno substantial impact on the yield of rice. H_1: Production inputs have substantial impact on the yield of rice. The scope of the study is delimitedted to investigating the effects of production parameters on the yield of rice on the Irrigation Scheme only. It did not include other rice farmers outside the irrigation scheme. Also, it focused on only the effects of production inputs on output; excluding the effects of socioeconomic factors. Most of the respondents involved in this study were illiterates or had only primary education and hence could not keep accurate production records. Also, as a result of the high illiteracy rate, all the items on the structured interview schedule had to be translated into the local language of the respondents. Production technology was also held constant. All the above could negatively affect the validity of the data collected as well as the accuracy of the results obtained.

MATERIALS AND METHODS

The study used a two-stage sampling to pick the participants. The accessible population was 1,024 rice farmers on the Weta irrigation scheme. The rice farmers were put into 11 sections on the scheme. Out of the eleven, six sections were randomly picked at the first stage. Using the proportionate random sampling method, 290 rice farmers were chosen from the six sections at the second stage to constitute the study sample. A list of randomly chosen numbers was generated within a given range. Rice farmers with the randomly chosen numbers were identified and interviewed. The sample size was determined from the sample size determination table of Krejcie& Morgan [17]. Only 285 rice farmers, out of the 290, were however accessed, yielding a response rate of 98.3 percent. A structured interview schedule, containing both open-ended and close-ended questions was used to collect data relating to socio-economic characteristics of rice farmers as well as input and output quantities.

Pre-Testing of Instrument

The instrument was pre-tested prior to data collection. This made it possible for the researchers to confirm the appropriateness of response categories and farmers' understanding of items on the instrument, thus enabling corrections to be made where necessary. The reliability of the instrument was estimated at 0.75, using the Cronbach's alpha reliability coefficient. According to Cohen, Manion and Morrison [7], the minimum standard of internal consistency which is acceptable is 0.70. Therefore, the 0.75reliability coefficient is high; meaning, the individual items or sets of items on the instrument would yield results consistent with the overall instrument.

Data Collection Procedure

Data were gathered by the researchers and three field assistants during the 2021 cropping season. The choice of the field assistants considered their levels of education and their ability to communicate very well in the local language of the farmers. The researchers visited the study area to inform the rice farmers and all other stakeholders, namely; the Ketu North District Director of Agriculture, the Irrigation Scheme Manager and the Sectional Heads about the study, a month earlier than the data collection date. A three-day training workshop was organised to train the field assistants on skills of interviewing and to explain to them, the items on the instrument. A week prior to data collection, the study area was visited the second time to reach an agreement on the date and duration for data collection with the rice farmers and their Sectional Heads. Data was gathered for a period of two months.

Description of Variables

Output: This refers to the overall yield or total product of rice during the cropping season, measured in kilograms per hectare.

Land: It is the total area of the farmland under rice cultivation, this variable was measured in hectares. The amount of land used was expected to have a positive effect on output.

Labour: This includes both family and hired labour, was measured as person-days per hectare of farm from land preparation to harvesting. It was expected that labour will have a positive influence on output.

*Equipment:*The cost of farm tools and machinery involved in the production process. It is measured in Ghana Cedis (GH₵) per hectare. The use of equipment was anticipated to increase output.

Seed: This represents the quantity of rice seeds planted and was measured in kilogram (kg) per hectare. The plant population or output of rice is influenced by the quantity of seeds planted per hectare of land.

Pesticide: The quantity of agrochemicals (fungicides and insecticides) used, and was measured in litres per hectare. Its influence on output could be positive or negative.

Weedicide: This is the quantity of chemicals applied to control weeds before and after planting. It was measured in litres per hectare of farmland. Like pesticides, the use of weedicides can influence output positively or negatively.

*Fertilizer:*The amount of fertilizer applied on rice plots in kilograms per hectare during the cropping season. It was expected that fertilizer would have a positive influence on yield.

Irrigation cost: This was measured as the amount (in Ghana Cedis) spent on irrigation per hectare per cropping season. This was expected to increase output.

Model Specification

The translog functional form was adopted to , to compute output level such that it will be consistent with the theory of production function after preliminary testing for the most appropriate functional form of the model under the available data set using the generalised likelihood ratio test [25]. The null hypothesis tested was that the Translog functional form does not fit the data more than the Cobb-Douglas. The generalised likelihood-ratio test statistic takes the form

$$LR = -2\left[\, In\{L(H_0)\} - In\{L(H_1)\}\right] \;..(1)$$

where:

$L(H_0)$ and $L(H_1)$ are the null and alternative hypotheses values of the likelihood function respectievly.The translog production function is given as:

$$InY_i = \beta_0 + \sum_{i=1}^{8} \beta\, Inx_i + \frac{1}{2}\sum_{i=1}^{8} Inx_i \sum_{j=1}^{8} \beta_{ij}\, Inx_j + (v_i - u_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where:

Y_i is the output of rice (kilograms) produced by the i^{th} farmer; x is a set of eight input categories namely: land area (hectares), labour (person-days), seed (kilograms), weedicides (litres), pesticides (litres), equipment (GH₵), fertiliser (kilograms) and irrigation cost(GH₵);

β denotes the unknown parameters to be estimated; v_i denotes a random error that captures the stochastic effects that are beyond the farmer's control; u_i is the one-sided non-negative error representing inefficiency in production.The Maximum Likelihood Estimation (MLE) method was used to obtain the estimates for equations (2) in this study, using the computer programme,'R' by the simultaneous estimation procedure propounded by Reifschneider &Stevenson [22] and subsequently by Battesse & Coelli [3]. The MLE approach is defined as the value of the parameter that maximises the probabilityof randomly drawing a particular sample of observations [5]. It makes some distributional assumptions about the two error terms. Thus, it helps to model the impact that external factors may have on the distribution of the inefficiencies. The MLE is preferred to other estimators such as the ordinary least squares and the corrected ordinary least squares because it is asymptotic. That is, it has many desirable large sample properties. With the MLE, a value is chosen for β such that the value makes the observations the most likely observations and that there is a high concord between the model and the observations. This makes the method more unique, nearly unbiased with a large sample, and consistent as it brings the estimated parameter very close to the true value of the parameter. Aside the estimate of the β value, the ML estimation also generates the gamma (γ) value. The gamma computes the total variation of observed output from the frontier output. It is expressedthe error associated with inefficiency (σ_u^2) divided by the total variation in the model (σ^2).The total variation of the model is given as the sum of the variance of the error associated with inefficiency (σ_u^2) and the errors associated with the stochastic noise, σ_v^2, that is:

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \quad (3)$$

The gamma estimate is specified as:

$$\gamma = \frac{\sigma_u^2}{\sigma^2} \quad (4)$$

Gamma (γ) takes a value between zero and one, that is, 0<= γ <=1. Variations in the observed output are attributed to inefficiency factors if the gamma value is equal to one. On the other hand, deviation from the frontier output is entirely attributed to statistical noise (random factors) if the gamma value is equal to zero[4, 6]. Therefore, results would be equal to that of the ordinary least square results if the parameter gamma becomes zero whereas the noise term is irrelevant if the value of gamma equals one.

RESULTS AND DISCUSSIONS

The results of the likelihood ratio test shown in Table 1 give a p-value of 0.05676 which is statistically significant at the 10 percent level of significance, implying the rejection of the Cobb-Douglas functional form.

Table 1. Likehood Ratio Test

Model	Log-likelihood value	Degree of freedom	Chi-square	P- value
Cob-Douglas	-18.9452			
Translog	4.4345	33	46.76	0.05676**

** denotes significance at 10%.
Source: Field survey data, 2021

Table 2 gives the summary statistics of farmer-specific characteristics and production variables. As can be seen from Table 2, on average, rice farmers on the irrigation scheme had farming experience of 19 years, with a minimum of 2 years and a maximum of 36years.

The mean years of formal education was 5 years with a minimum of zero and a maximum of 13 years. Also, the mean extension contact was twice a year. This is extremely low; considering the relevance of extension in agriculture.

The low extension contacts mean that not much information gets to the farmers in the form of innovations and technologies. Furthermore, Table 2 also shows that on average, rice farmers on the Weta Irrigation Scheme produced 6,059.9kilograms of rice per hectare with an average of 1.66hectares of land, 275kilograms of seeds , 492.33b kilograms of fertilizer ,21.15litres of weedicide,16.98litres of pesticide, 625person days of labour, GH¢608.50 worth of irrigationfacilities and GH¢40.75 worth of equipment per hectare. The minimum yield of rice was 3,250kilograms/hectare and the maximum was 22,000kilograms/hectare.

The large variation in rice output in the study area can be attributed to variations in their levels of technical efficiency.

Table 2. Summary Statistics of Production Parameters and Farmer-Specific Characteristics

Variable	Minimum	Maximum	Mean	Standard deviation
Output (kg/ha)	3,250.00	22,000.00	6,059.85	4,082.75
Land area (ha)	0.80	4.00	1.66	1.77
Fertilizer (kg/ha)	187.50	1,000.00	492.33	163.55
Seed (kg/ha)	75.00	600.00	275.00	101.88
Pesticide (litres/ha)	2.50	40.00	16.98	7.78
Weedicide (litres)/ha	10.00	35.00	21.15	6.38
Labour (person days/ha)	195.00	1,350.00	625.01	282.95
Irrigation cost (GH¢/ha)	150	1240	608.50	236.65
Equipment (Gh¢/ha)	17.50	70.00	40.75	12.05
Farming experience (years)	2.00	36	18.58	1.77
Years of formal education (years)	0.00	13.00	5.58	3.58
Extension contacts (number)	0.00	6.00	2.34	1.77

Source: Field survey data, 2021.

Table 3 indicates the results of MLE for the translog production function parameters. Results indicates that only inputs of land area under cultivation, equipment, fertilizer and irrigation costs were statistically significant at 5 percent. This implies that, among the eight inputs, only land, equipment, fertilizer, and irrigation cost were important factors that had significant effects on rice yield. The other inputs, namely; labour, seed, weedicide, and pesticide were not significant factors that influence the yield of rice.Among the significant inputs, however, only equipment cost has a negative sign. The negative sign on equipment cost implies that an increase in equipment cost would result in a decrease in rice output. In other words, rice output in the district would increase when equipment cost decreases. This finding is contrary to that of Ayalwe et al. [2] that equipment cost contributed positively to rice output in selected rice-growing districts in Ghana. The negative sign could be due to the use of heavy equipment such as tractors and power tillers by the rice farmers on small land holdings. This is because heavy farm equipment such as tractors and tillers could not be utilised efficiently on small landholdings such as 0.8 hectares. Moreover, it was found that most of the farmers had too many equipment relative to the size of their farms. Therefore, this equipment could not be put to optimum use and could result in increasing average cost.Fertilizer input has a positive sign and this implies that an increase in fertilizer quantity in the study area would increase the yield of rice. This finding confirms that of Rahman et al. [21] and Das & Hossain [9] who found fertilizer to be significant with a positive coefficient among marginal, small, and medium-scale rice farmers in Bangladesh. The finding also confirms that of Konja, Mabe&Alhassan [16]. Also, the variable, land is significant with a positive sign. This implies that if the land area under cultivation is increased, rice ouput will also increase significantly.Again, this finding confirms the finding of Konja, Mabe&Alhassan [16] who found an increase in the land area under cultivation (farm size) would cause rice output to increase among rice farmers in the Northern Region of Ghana. Also, irrigation cost was significant with a positive sign. This indicates that an increase in irrigation cost would increase output. This could be explained by the fact that the amount paid for irrigation was proportional to the total land area under rice cultivation in the study area,which contributed positively to output. These findings confirm that of Rahman et al. [21] who discovered land area under cultivation and irrigation cost to be significant and positively contributed to theoutput of rice among marginal, small, medium, and large-scale rice farmers in Bangladesh. Hence, the null hypothesis that input factors have no significant effect on rice output is rejected in favour of the alternative hypothesis.

In the case of the squared values of the input variables, none of them was significant. However, three of them, namely land, fertilizer, and irrigation cost had positive signs while the remaining five inputs had negative signs. The squared values in a translog model show the long-term effects of the input variables on output. For instance, the fact that land and land squared were both positive impliesthat both in the short and long term, an increase in cultivation land would lead to an increase in output.

Table 3. MLE for the Translog Frontier Production Function Parameters

Variable	Parameter	Coefficient	Standard error	Z – value
Intercept	β_0	0.3745***	0.01147	3.2651
ln(mland)	β_1	0.4421**	0.2267	1.9501
ln(mlabour)	β_2	- 0.0509	0.0735	- 0.6928
ln(mseed)	β_3	- 0.0320	0.0824	- 0.0185
ln(mweedicide)	β_4	- 0.0014	0.0771	-0.0185
ln(mpesticide)	β_5	-0.0915	0.0704	- 1.2986
ln(mequipment)	β_6	- 0.1415**	0.0804	-1.7592
In(mfertilizer)	β_7	0.1460**	0.0796	1.8343
ln(mirrigation)	β_8	0.3722**	0.2158	1.7248
½ [In(mland)] ^{2}	β_9	4.0325	2.5886	1.5578
½ [ln(mlabour)]^2	β_{10}	-0.4927	0.3277	-1.3774
½ [ln(mseed)] ^{2}	β_{11}	-0.4819	0.4463	-1.0797
½[ln(mweedicide)]^2	β_{12}	-0.5294	0.4882	-1.0846
½ [lnmpesticide)] ^{2}	β_{13}	-0.1739	0.1390	-1.2424
½[ln(mequipment)]^2	β_{14}	-0.8909	0.5639	-1.2424
½ [ln(mfertilizer)] ^{2}	β_{15}	0.2037	0.4236	0.4810
½ [ln(mirrigation)]^2	β_{16}	-2.2893	1.7236	-1.3282
ln(mland)*ln(mlabour)	β_{17}	-0.6767	0.7013	-0.9649
ln(mland)*ln(mseed)	β_{18}	-1.4844*	0.6942	-2.1383
ln(mland)*ln(mweedicide)	β_{19}	0.0178	0.8931	0.0199
ln(mland)*ln(mpesticide)	β_{20}	0.2296	0.3181	0.7218
ln(mland)*ln(mequipment)	β_{21}	0.9574	0.9948	0.9624
ln(mland)*ln(mfertilizer)	β_{22}	-0.4546	0.7729	-0.5881
ln(mland)*ln(mirrigation)	β_{23}	-2.8567	1.7729	-1.6098
ln(mlabour)*ln(mseed)	β_{24}	0.4329	0.2725	1.5885
ln(mlabour)*ln(mweedicide)	β_{25}	0.1598	0.3252	0.4915
ln(mlabour)*ln(mpesticide)	β_{26}	-0.0202	0.2059	-0.0983
ln(mlabour)*ln(mequipment)	β_{27}	-0.2544	0.3709	-0.6858
ln(mlabour)*ln(mfertilizer)	β_{28}	-0.0283	0.3723	-0.0761
ln(mlabour)*ln(mirrigation)	β_{29}	0.4979	0.6004	0.8293
ln(mseed) *ln(mweedicide)	β_{30}	-0.5679**	0.3155	-1.7998
ln(mseed)*ln(mpesticide)	β_{31}	0.1011	0.1643	0.6155
ln(mseed)* ln(mirrigation)	β_{34}	1.5351*	0.6115	2.5104
ln(mweedicide)*ln(mpesticide)	β_{35}	-0.0239	0.2084	0.1148
ln(mweedicide)*ln(mequipment)	β_{36}	0.6058**	0.3686	1.6473
ln(mweedicide)*ln(mfertilizer)	β_{37}	0.2742	0.3086	0.8889
ln(mweedicide)*ln(mirrigation)	β_{38}	0.0224	0.7602	0.0295
ln(mequipment)*ln(mfertilizer)	β_{39}	0.1992	0.3035	0.6564
ln(mequipment)*ln(mirrigation)	β_{40}	-1.3375**	0.7098	-1.8844
ln(mfertilizer)*ln(mirrigation)	β_{41}	0.1897	0.6354	0.2986
Variance parameters Sigma squared Gamma Log likelihood value	 σ^2 = γ = =	 0.0973*** 0.9191*** 4.4345		

***, **, *indicates significance at 1%, 5%, 10% respectively.

Source: Field survey data, 2021.

This finding is contrary to that of Donkoh, Ayambila&Abdulai [11] who found that a continuous increase in land area under cultivation would lead to a decrease in the output of rice on the Tono irrigation scheme both in the short and long term.

Also, an increase in fertilizer and irrigation cost would result in an increase in output both in the short and long term since the square of these variables are positive. Also, a negative sign on labour and labour squared shows that outputdeceases in both short and long runs when labour is increased. Similarly, an increase in seed rate, weedicide, pesticide, and equipment cost would lead to a decrease in output.

The interaction terms explain the substitutability or complementarity of the variables. A parameter with a positive sign implies that the two variables are complementary, while a parameter with a negative sign means that the two variables are substitutes. From Table 3, the statistically significant parameters with a positive sign are the interactions between seed and irrigation cost at 5 percent, and weedicide and equipment at 10 percent. Those with negative signs are land and seed at 5 percent; seed and weedicide at 10 percent and equipment and irrigation at 10 percent. The positive sign on the interactions between seed and irrigation cost implies that seed was complementary to irrigation therefore the two inputs would be more productive when used together. Weedicide use was also complementary to equipment usage.The implication is that a combination of the two inputs jointly contribute positively to output.

Conversely, seed substituted for land and weedicide while equipment and irrigation costs were substitutes. The implications are that interactions between these pairs of inputs gave less productive results when used together.

Diagnostic Statistics

Table 3 indicates that the estimate of sigma-squared (σ^2) value of 0.097, is statistically significant at 0.1 percent. This indicates a good fit and the accuracy of the specified distributional assumption of the composite error term. The gamma value (γ) measures inefficiency in the variance parameter and assumes a value of zero to one. From Table 3, the computed gamma was approximately 0.92 or 92 percent. This means that 92 percent of the variations in rice output were due to inefficiency of the rice farmers. The results of the diagnostic statistics therefore, confirm the relevance of the stochastic parametric production function and the MLE Method.

Elasticity of Output

Determining the elasticity is important for the estimation of the responsiveness of output to input. Table 4 gives the output of the translog production function. It can be observed from Table 4 that theinput elasticity of land area under cultivation was 0.44. This means that a 1 percent increase in land area under cultivation would increase yield of rice by 0.44 percent. Also, a 1 percent increase in the quantity of fertilizer would increase output by 0.14 percent and a 1 percent increase in irrigation cost would increase output by 0.37 percent. However, coefficients of elasticity of labour, seed, weedicide, pesticide and equipment were negative. The implications are that a 1 percent increase in labourand quantity of seed planted would decrease output by 0.05 and 0.03 percent respectivelty.A percentage increase in the quantity of weedicide would decrease output by 0.001 percent; a 1 percent increase in the quantity of pesticide and cost of equipment would decrease output by 0.09 and 0.14 percent. Moreover, all the inputs used in the production of rice in the study area were found to be inelastic; a 1 percent increase in each input resulted in less than proportionate increase in output.

Table 4. Elasticity of output and return-to-scale

Input variable	Elasticity	Return-To-Scale (RTS)
ln(mland)	0.442	0.642
ln(mlabour)	-0.051	
ln(mseed)	-0.032	
ln(mweedicide)	-0.001	
ln(mpesticide)	-0.092	
ln(mequipment)	-0.142	
In(mfertilizer)	0.146	
ln(mirrigation)	0.372	

Source: Field survey data, 2021.

Furthermore, the return-to-scale indicated in Table 4 is 0.642. The return-to-scale of the technology is given by the sum of the elasticities of all the inputs. If all inputs are varied by the same proportion, the return-to-scale shows the percentage by which output would increase. The return-to-scale of 0.642 is less than one and indicates a decreasing return

to scale. The implication is that if all inputs are proportionally increased by 1 percent, rice yield would increase by only 0.642percent. It is a decreasing return to scale
because the relative increase in output is less than the relative increase in the aggregate input quantity. This suggests that farmers were producing at the irrational stage of production.

Policy Implications

1. Land tenure reforms to increase land area under cultivation would increase output.
2. Fertilizer subsidy policy of government, together with creation of an enabling environment for individuals to make fertilizer available to farmers would increase fertilizer use leading to a rise in output.
3. Government policy that provides irrigation facilities, makes water available for all year round production, increasing output.

CONCLUSIONS

The significant input factors affecting the output of rice in the study area were land area under cultivation, fertilizer input, irrigation cost and equipment. Among these, only equipment affected rice output negatively while land area under cultivation, fertilizer, and irrigation cost positively influenced output. Also, the returns to scale was estimated at 0.642, implying that the rice farmers were producing at decreasing returns-to-scale, that is, a one percent increase in all inputs yielded less than a proportionate increase in output**.** Based on the findings,the study recommends that the land area under irrigation should be expanded and the Irrigation Authority should provide adequate irrigation facilities to scale up farmers' land holdings on the irrigation scheme to increase output. In addition, the Ministry of Food and Agriculture shouldadopt appropriate measures such as introducing a fertilizer subsidy that will ensure the availability of fertilizers at affordable rates to farmers. This would increase fertilizer use resulting in increased yield. Furthermore, farmers should be educated on the optimum use of equipment to increase output.

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