Greener Journal of Agricultural Sciences
Vol. 11(4), pp. 228-236, 2021
ISSN: 2276-7770

https://gjournals.org/GJAS

Determinants of Technical Efficiency in Rice Production on the Weta Irrigation Scheme in the Volta Region, Ghana

Francis Kastro Kavi

Tutor, Science Department, Saint Catherine Senior High School, Sogakofe, Ghana.

ARTICLE INFO

Article No.: *110921119*
Type**:** *Research*
Full Text: ***HTML, EPUB***

Accepted: *13/11/2021*
Published: *28/11/2021*

****Corresponding Author***
Francis K. Kavi
E-mail: *kastro8k@ yahoo.com*

Keywords: *rice production, technical efficiency, stochastic, maximum likelihood estimates, socioeconomic*

ABSTRACT

The study investigated the determinants of technical efficiency in rice production on the Weta Irrigation Scheme in the Ketu North District of the Volta Region of Ghana during the 2014/2015 cropping season. A two-stage sampling procedure was used to select a sample of 290 rice farmers from a population of 1,024. Primary data, collected from 285 respondents using structured interview schedule, were used for the study. A translog stochastic frontier production function which incorporates a model for inefficiency effects, using the Maximum Likelihood Method was employed in the analysis of the data. Results indicated that the mean technical efficiency index was estimated at 70.7 per cent which implies that the rice farmers were not fully technically efficient. Thus there was the opportunity to increase the output of rice in the study area by 29.3 per cent via efficient reallocation of available resources. Also, the socio-economic characteristics of rice farmers which were significant determinants of technical efficiency in the study area were age, sex, farming experience and membership of a farmer based organization. The study recommended among others that the Ministry of Food and Agriculture should intensify training of farmers on how to improve upon their production activities through the efficient combination of inputs by establishing demonstration farms within the vicinity of farmers. Furthermore, the study recommended the organization of rice farmers in the study area into groups since group membership positively influenced their efficiency.

INTRODUCTION

Rice is considered as the second most important grain food staple in Ghana, next to maize, and its consumption keeps increasing as a result of population growth, urbanization and change in consumer habits [Ministry of Food and Agriculture (MoFA, 2009)].. The total rice consumption in Ghana in 2005 amounted to about 500,000 tonnes and this is equivalent to per capita consumption of 22 kilograms per annum. According to MoFA, per capita consumption of rice per annum is estimated to increase to 63 kilograms by 2018 as a result of rapid population growth and urbanization.

Rice is also the most imported cereal in the country accounting for 58 per cent of cereal imports (CARD, 2010) accounting for 5 per cent of total agricultural imports in Ghana over the period 2005-2009. Ghana largely depends on imported rice to make up for the deficit in rice supply. On the average, annual rice import in Ghana is about 400,000 tonnes (MoFA, 2009). It is therefore important for stakeholders in the food and agriculture sector to ensure increased and sustained domestic production of good quality rice for food security, import substitution and savings in foreign exchange.

Domestic rice production satisfies around 30 to 40 per cent of demand with a corresponding average rice import bill of US $450 million annually (MoFA, 2010). The massive dependency on rice imports has always been a concern for policy makers, especially after food prices soared in 2008. However, import duties and other taxes as well as interventions to boost productivity and quality of local rice do not seem to produce any substantial impact on Ghana's import bill.

In May, 2008, Ghana was one of the first countries within the Coalition for Africa Rice and Development to launch its National Rice Development Strategy (NRDS) for the decade 2009 – 2018. The main objective of the NRDS is to double domestic production by 2018, implying a 10 per cent annual growth rate and enhance quality to stimulate demand for domestically produced rice. These increases will most likely come from utilizing potential irrigable lands and valley bottoms with water supply, promoting rice production, and increasing the productivity of existing growers.

The inability of local rice production to meet domestic demand can be attributed to the inability of the rice farmers to obtain maximum output from the resources committed to the enterprise (Kolawole, 2009). According to Rahman, Mia and Bhuiyan (2012), farm level performance can be attained in two alternate ways: either by maximizing output with the given set of inputs or by minimizing production cost to produce a prescribed level of output. The former concept is known as technical efficiency which is a measure of a farm firm's ability to produce maximum output from a given set of inputs under certain production technology. It is a relative concept in so far as the performance of each production unit is usually compared to a standard. The standard may be used on farm-specific estimates of best practice techniques (Herdt & Mandac, 1981) but more usually by relating farm output to population parameters based on production function analysis (Timmer, 1971).

A technically efficient farm operates on its frontier production function. Given the relationship of inputs in a particular production function, the farm is technically efficient if it produces on its production function to obtain the maximum possible output, which is feasible under the current technology. Put differently, a farm is considered to be technically efficient if it operates at a point on an isoquant rather than interior to the isoquant.

Technical efficiency in agriculture production is an important element in the pursuit of output growth. A high level of technical efficiency implies that output is being maximized given the available technology. In this situation, output growth will be achieved through the introduction of new technology that will shift the production frontier outward. A low level of technical efficiency, on the other hand, indicates that output growth can be achieved given current inputs and available technology. Therefore, it is important to determine the degree of technical efficiency among farmers, and if low technical efficiency is found, to investigate the factors that will increase efficiency.

In an economy where resources are scarce and opportunities for new technologies are lacking, further increase in output can best be brought about through improvement in the productivity of the crop. In this context, technical efficiency in the production of a crop is of paramount importance.

Measurement of technical efficiency (TE) provides useful information on competitiveness of farms and potential to improve productivity, with the existing resources and level of technology (Abdulai &Tietje, 2007). Moreover, investigating factors that influence technical efficiency offers important insights on key variables that might be worthy of consideration in policy-making, in order to ensure optimal resource utilisation.

Several studies have been conducted on rice production in Ghana. However, most of these studies on rice focused on other areas rather than the technical efficiency of production. Examples are: "Impact of improved varieties on the yield of rice producing households in Ghana" (Wiredu, et al., 2010); "Cooking characteristics and variations in nutrient content of some new scented rice varieties in Ghana"(Diako et al., 2011), "Rice price trends in Ghana" (Amanor-Boadi, 2012) and "Patterns of adoption of improved rice technologies in Ghana''(Ragasa et al., (2013).

Even though some studies have been conducted on technical efficiency in rice production in Ghana, most of these studies are concentrated in Northern Ghana; especially on the Tono Irrigation Scheme, for example Technical efficiency in rice production at the Tono irrigation scheme in Northern Ghana (Donkoh, Ayambila & Abdulai, 2012).

Besides, in the Ketu North District rice is a major food crop and its production serves as a source of employment for many years. Yet, not much study has been conducted to determine the technical efficiency of rice farmers.

The aforementioned reasons informed a study to be conducted to determine the technical efficiency in rice production on the Weta irrigation scheme in the Ketu North District of the Volta Region of Ghana. This would fill the knowledge gap and inform policy decisions.

Objectives of the study

Generally, the study seeks to measure the technical efficiency in rice production in the Ketu North District of the Volta Region. The specific objectives include**:**

1. To estimate the level of technical efficiency of rice farmers in the district.
2. To analyse the determinants of technical efficiency.

Research questions

The following research questions have been developed to guide the study.
1. What are the levels of technical efficiency in rice production in the district?
2. What are the determinants of technical efficiency?

Hypotheses

The study seeks to test the following hypotheses:

1. H_0: Rice farmers are not fully technically efficient.
   H_1: Rice farmers are fully technically efficient.
2. H_0: The socio-economic characteristics of rice farmers have no significant influence on technical efficiency.
   H_1: The socio-economic characteristics of rice farmers significantly influence technical efficiency.

METHODOLOGY

Research design

The study employed cross-sectional survey research design to measure the technical efficiency of rice farmers. In this design, a sample of the population was selected from which data were collected to answer research questions of interest. It is called cross-sectional because the information that were gathered about the phenomenon represent what existed at only one point in time. A cross-sectional study is one that produces a 'snapshot' of a population at a particular point in time. The single 'snapshot' of the cross-sectional study provides researchers with data for either a retrospective or a prospective enquiry (Louis, Lawrence & Keith, 2007). This research design is appropriate as it makes inference about the effect of one or more explanatory variables on the dependent variable by recording observations and measurements on a number of variables at the same point in time (Gay, 1992).

Population

Amedahe (2002) defines population as the target group about which the researcher is interested in gaining information and drawing conclusions. The target population was all rice farmers in the Ketu North District of the Volta Region. The accessible population for the study included all the 1,024 rice farmers on the Weta irrigation scheme in the Ketu North District.

Sample size and sampling technique

Hummelbrunner, Rak and Gray (1996) explain sampling as selecting a portion of the population that is most representative of the population. The study employed a two-stage sampling technique to select the participants for the study. The rice farmers on the Weta Irrigation Scheme were grouped into 11 sections by the Irrigation Development Authority. Considering each section as a cluster, six sections were selected at random at the first stage. At the second stage, a total of 290 rice farmers were chosen from the six sections using proportionate random sampling technique to form the sample for the study. A sampling frame was obtained from the Irrigation Development Authority. The computer software programme known as excel was then used to generate a list of randomly selected numbers within a specified range. Rice farmers with those randomly selected numbers were then identified and interviewed. This sample size was determined using the sample size determination table produced by Krejcie and Morgan (1970). However, out of the 290, only 285 rice farmers were reached, giving a response rate of 98.3 per cent.

Instrumentation

The structured interview schedule was developed by the researcher and used to collect data relating to technical efficiency in rice production from the respondents (farmers). It contained both open-ended and close ended questions. A structured interview is an interview in which the specific questions to be asked and the order of the questions are predetermined and set by the researcher. It is based on a strict procedure and a highly structured interview guide which is no different from a questionnaire. The structured interview is, in reality, a questionnaire read by the interviewer as prescribed by the researcher. The rigid structure determines the operations of this research instrument and allows no freedom to make adjustments to any of its elements such as content, wording or order of questions (Amedahe, 2002).

Data were collected on socio-economic characteristic of farmers, input and output quantities and the constraints faced by rice farmers. The structured interview schedule comprised four sections; namely, A, B,C and D. Section A covered the farm and farmer-specific characteristics such as the age of the farmer, sex of farmer, household size, educational level, marital status, off-farm work, farming experience and years of formal education. Section B of the interview schedule dealt with the production activities of the farmer such as methods of weed control, access to technical training, access to credit, access to agricultural extension services and number of times of producing rice in a cropping year. Section C of the interview schedule provided information on the inputs used and the output obtained by the farmer. These included information on land, labour, materials used for planting, fertilizer, equipment, chemical use and output obtained. The last section, D covered the constraints that farmers face in the production of rice in the district. This included input, production, and marketing constraints.

Pre-testing of instrument

The instrument was pre-tested before it was used for data collection. The pre-test was undertaken in November, 2014 using 30 respondents who cultivated rice in the South Tongu District. This helped to check the adequacy of response categories, ambiguity and respondents' interpretation of certain questions, thereby making it possible for adjustments to be made where necessary. Inaccuracies identified during the pre-testing were corrected before the actual data collection took place.

The reliability of the instrument was established using the Cronbach's alpha reliability coefficient. The reliability coefficient was estimated at 0.75. According to Cohen, Manion and Morrison (2007), the widely acceptable minimum standard of internal consistency is 0.70. Therefore, the reliability coefficient of 0.75 is interpreted as high; implying that the individual items or sets of items on the instrument would produce results consistent with the overall instrument.

Data collection procedure

Data were collected by the researcher and two field assistants during the 2014/2015 cropping season. The selection of the field assistants took into consideration their level of education and their ability to speak the local language of the farmers. A visit was paid to the study area by the researcher with an introductory letter from the Department of Agricultural Economics and Extension, University of Cape Coast to inform the District Director of Agriculture, the Irrigation Scheme Manager, the Sectional Heads and the rice farmers about the study a month ahead of the data collection date. A two-day training programme was organised to equip the field assistants with interviewing skills and to explain to them the various items on the instrument. A second visit was paid to the study area to agree on the date and duration for data collection with the rice farmers and their Sectional Heads a week before data collection began. Data collection was done for a period of two months.

Data analysis

Descriptive statistics, including the mean, frequencies, charts and standard deviation were used to describe the socio-economic characteristics of farmers. The stochastic production frontier analysis, a parametric approach in measuring technical efficiency was employed in this study. The transcendental logarithmic (translog) form of production function was then fitted to the production function to estimate technical efficiency level of rice farmers and the determinants of technical efficiency simultaneously (Research questions one and two). Data were analysed using the SPSS version 21 and the R programming software.

Specification of the models

The explicit translog stochastic frontier production function used in this study is given in equation (vii):

$$\ln Y_i = \beta_0 + \sum_{i=1}^{8}\beta_i \ln x_i + \frac{1}{2}\sum_{i=1}^{8}\sum_{j=1}^{8}\beta_{ij}\ln x_i \ln x_j + \left(v_i - u_i\right) \qquad \text{(vii)}$$

Where; Y_i is the output of rice (kilograms) produced in 2014/2015 cropping season 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 inefficiency model of the stochastic frontier function is given by:

$$u_i = \delta_0 + \sum_{i=1}^{9}\delta_i Z_i \qquad \text{(viii)}$$

$$u_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 \qquad \text{(iv)}$$

Where,

u_i denotes farm specific inefficiency

δ denotes a set of parameters to be estimated

Z_1 denotes farmers' educational level (years of schooling)

Z_2 denotes age of the farmer (years)

Z_3 denotes sex of the farmer (dummy variable, 1 = male, 0 = female)

Z_4 denotes access to extension services (dummy variable; if yes = 1, no = 0)

Z_5 denotes off-farm work (dummy variable; if yes =1, no = 0)
Z_6 denotes access to credit (dummy variable; if yes =1, no =0)
Z_7 denotes household size (number)
Z_8 denotes farming experience (number of years of rice production)
Z_9 denotes membership of farmer based organisation (dummy variable, if yes =1, no =0)

The translog function was adopted in order to estimate the level of technical efficiency in a way consistent with the theory of production function after preliminary testing for the most suitable functional forms of the model under the data set available using the generalised likelihood ratio test(Griffiths, Hill & Judge, 1993). The generalised likelihood- ratio test statistic is of the form:

$$LR = -2\left[ln\left\{L\left(H_0\right)\right\} - ln\left\{L\left(H_1\right)\right\}\right] \quad \text{(x)}$$

where, $L(H_0)$ and $L(H_1)$ are values of the likelihood function under the null and alternative hypotheses respectively. Asymptotically, the test statistic has a Chi-square distribution with the degree of freedom equal to the difference in the number of parameters between the models. Here, the null tested was that the Translog functional form does not represent the data more adequately than the Cobb-Douglas. The results of the likelihood ratio test presented in Table 1 show a p-value of 0.05676 which is statistically significant at the 10 per cent significance level indicating the rejection of the Cobb-Douglas functional form in favour of the more flexible translog. Thus the null hypothesis was rejected.

Table 1: Likelihood 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**

**-------Significant at 10%
Source: Field survey data, 2015

RESULTS AND DISCUSSION

Description of socioeconomic characteristics of rice farmers

Table 2 presents the summary statistics of farmer-specific characteristics as well as production parameters. It can be observed from Table 6 that on average, rice farmers in the study area had 19 years of farming experience, with a minimum of 2 years and a maximum of 36 years. Table 6 also shows that the mean number of years of formal education was 5 years with a minimum of zero and a maximum of 13 years. Also, the mean extension contacts was twice a year. This is relatively low considering the importance of extension in agriculture. The low extension contacts imply that not much information got to the farmers as far as innovations and technologies are concerned. Table 6 also indicates that on average, rice farmers in the study area produced an output of 6059.9 kilograms of rice per hectare using an average of 1.66 hectares of land, 21.15 litres of weedicide per hectare, 492.33 kilograms of fertilizer per hectare, 16.98 litres of pesticide per hectare, 625 person days of labour per hectare, 275 kilograms of seeds per hectare, GH¢608.50 worth of irrigation facilities per hectare and GH¢40.75 worth of equipment per hectare. The minimum output of rice was 3250 kilograms/hectare and the maximum was 22000 kilograms/hectare. The large variation in output of rice in the study area can be attributed to variations in their levels of technical efficiency.

Table 2: Summary statistics of production parameters and farmer characteristics

Variable	Minimum	Maximum	Mean	Standard deviation
Output(kg)/ha	3250.00	22000.00	6059.85	4082.75
Land area(ha)	0.80	4.00	1.66	1.77
Fertilizer(kg)/ha	187.50	1000.00	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	1350.00	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, 2015.

Frequency distribution of technical efficiency of rice farmers

Table 3 shows the frequency distribution of technical efficiency of rice farmers. The mean level of technical efficiency of rice farmers was 70.7 per cent with a minimum of 29.6 per cent and a maximum of 96.3 per cent. This shows that there was a wide disparity among rice farmers in their level of technical efficiency. This, in turn, indicates that there was an opportunity to improve the existing level of production of rice in the study area through enhancing the level of technical efficiency of rice farmers.

The mean level of technical efficiency further implies that the level of output of rice in the study area could be increased on an average by about 29.3 per cent if appropriate measures are taken to improve the level of efficiency of rice farmers. In other words, there was a possibility of increasing the yield of rice by about 29.3 per cent using the available resources in an efficient manner without introducing a new technology.

The results in the table 3 also show that 45.26 per cent of the respondents operated below the mean level of technical efficiency. Thus the null hypothesis that rice farmers in the Ketu North District are not fully technically efficient is not rejected.

Table 3: Frequency distribution of technical efficiency of rice farmers in the Ketu North District

Technical Efficiency (%)	Frequency	Percentage (%)
<50	26	9.12
50 – 59	44	15.44
60 – 69	59	20.70
70 – 79	61	21.40
80 – 89	63	22.11
>89	32	11.23
Total	**285**	**100**
Mean technical Efficiency		70.7
Minimum		29.6
Maximum		96.3

Source: Field survey data, 2015

Determinants of technical efficiency

The determinants of the technical efficiency are discussed using the estimated (δ) coefficients associated with the inefficiency effects in Table 4. Variables with negative coefficients have negative relationships with inefficiency while those with positive coefficients have positive relationships with inefficiency. The results show that age, sex, farming experience and membership of farmer based organization were the only significant determinants of the level of technical efficiency in the study area. Education, extension contact, off farm occupation, access to credit and household size were not statistically significant. This means that these factors were not important determinants of technical efficiency in the study area. Furthermore, the insignificance of extension visits has not come as a surprise. This is because even though most of the rice farmers had access to extension services in the study area, the mean extension contacts was found to be only twice in a year. This might be due to the low extension agent-farmer ratio in the study area (1:3500) which could make extension services ineffective (MoFA, Ketu North District, 2014). However, the positive sign on extension means that rice farmers who had access to extension services were less technically efficient than those who had no access to extension. This is, however, contrary to the apriori expectation.

Among the significant inefficiency sources, only age has a positive sign. This implies that older farmers were less technically efficient than younger farmers. This finding lends support to the finding of Maganga (2012) who found that older farmers were less technically efficient than younger farmers in the production of Irish potato at the Dedza District of Malawi. The finding is also consistent with that of Njeru (2010) who found that older wheat farmers were less technically efficient than younger ones in the Uasin Gishu District of Kenya. This could be explained by the fact that older farmers have the tendency to stick to their old methods of production and are usually unwilling to accept change. This finding is however contrary to the position of Ali, Imad and Yousif (2012) that adequate inputs coupled with long years of farming enable older farmers to produce more efficiently. Furthermore, the finding contradicts that of Etwire, Martey and Dogbe (2013) who found younger soybean farmers in the Saboba and Chereponi Districts of Northern Ghana to be less technically efficient than older ones.

The negative sign on the sex variable means that male farmers were more technically efficient than female farmers in the study area. This finding is consistent with that of Donkoh, Ayambilah and Abdulai (2012) who found male farmers to be more technically efficient than female farmers in the production of rice on the Tono irrigation scheme in the Northern Region of Ghana. This could be explained by the fact that male farmers are wealthier and therefore are able to acquire technologies that are costly (Onunmah &Acquah, 2010). This finding is corroborated by that of Anang, Blackman and Sipilainen (2016).

The negative sign on experience implies that farmers with more years of farming experience are more technically efficient than those with less farming experience. Again, this finding confirms that of Maganga (2012). Farmers with longer years of farming may combine inputs more optimally leading to high technical efficiency than the less experienced farmers.

Finally, the coefficient of the dummy variable for membership of a Farmer-Based Organisation (FBO) is negative and statistically significant at 10 per cent. This implies that rice farmers who belonged to a farmer based organisation were more technically efficient or less technically inefficient than those who did not belong to any farmer based organisation. This finding lends support to that of Awunyo-Vitor, Bakang and Cofie (2012) who found that cowpea farmers who belonged to a farmer based organisation were more technically efficient than those who did not. The finding is further supported by that of Anang, Blackman and Sipilainen (2016) where smallholder rice farmers in Northern Ghana who belonged to farmer based organisations were found to be more efficient than non-members. Membership of a farmer based organization is part of social capital. It also affords farmers the opportunity to share information on modern rice production practices through interactions with other farmers (Awunyo-Vitor, Bakang&Cofie, 2012). The finding is however contrary to that of Kuwornu, Amoah and Seini (2013) who found membership of farmer based organization to positively influence technical inefficiency in maize production in the Eastern Region of Ghana.

The maximum likelihood estimates of the inefficiency model indicate that the socio-economic characteristics of the rice farmers significantly influence technical efficiency in the study area. Thus the null hypothesis that the socioeconomic characteristics of rice farmers has no significant effect on technical efficiency is rejected.

Table 4: Maximum likelihood estimates of the inefficiency model.

Variable	Parameter	Coefficient	Standard Error	Z-Value
Intercept	δ_0	0.0346	0.2723	0.1269
z- Education	δ_1	0.0034	0.0063	0.3623
z- Age	δ_2	0.0115*	0.0047	2.4381
z- Sex	δ_3	-0.1807*	0.0715	-2.5262
z- Extension	δ_4	0.0262	0.0701	0.3733
z- Off farm	δ_5	0.1005	0.0686	1.4662
z – Credit	δ_6	-0.0589	0.1135	-0.5195
z-Household size	δ_7	0.0051	0.0090	0.5637
z- Experience	δ_8	-0.0125*	0.0056	-2.2385
z-FBO membership	δ_9	-0.2119**	0.1224	-1.7326

Significant codes: * ------- Significant at 5%
**------- Significant at 10%
Source: Field survey data, 2015

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, it can be concluded that rice farmers in the study area were not fully technically efficient. With the mean technical efficiency estimated at

70.7 per cent, there was an opportunity for the rice farmers to increase their output by 29.3 per cent through efficient reallocation of the available resources without introducing a new technology. Also, the socio-economic characteristics of rice farmers which were significant determinants of technical efficiency in the study area were age, sex, farming experience and membership of a farmer based organization.

From the conclusions drawn, the study recommends that the Ministry of Food and Agriculture should intensify training of farmers on how to improve upon their production activities through the efficient combination of inputs by establishing demonstration farms within the vicinity of farmers since the farmers were not fully efficient in production. More Agricultural Extension Agents should be employed by the Ministry of Food and Agriculture to facilitate the training of farmers. Also, since male farmers were more technically efficient than female farmers in the study area, the Ministry of Food and Agriculture should formulate policies targeted at empowering male farmers by improving their access to agricultural inputs, especially, land, fertilizer and irrigation facilities to increase their efficiency in rice production. Furthermore, the study recommends that .in order to improve efficiency in rice production on the Weta Irrigation Scheme, farmers need to organise themselves into groups since group membership positively influenced their efficiency.

REFERENCES

Abdulai, A., &Tietje, H. (2007). Estimating technical efficiency under unobserved heterogeneity with stochastic frontier models: Application to northern German dairy farms. *European Review of Agricultural Economics,34*(3), 393–416.

Alarima, C.I., Adamu,C.O. Masunaga, T.,&Wakatsuki, T. (2011). Constraints to sawah rice production system in Nigeria. *Journal of Human Ecology, 36*(2), 121-130

Ali, A. A., Imad, E. E., &Yousif, A. K. (2012). Economic efficiency of wheat and faba bean production for small scale farmers in the Northern State of Sudan. *The journal of Animal and Plant sciences, 22*(1)

Amanor-Boadu, V. (2012). *Rice price trends in Ghana (2006–2011).*METSS-Ghana Research and Issue Paper Series 02-2012.Accra.

Amedahe, F. K. (2002). *Notes on educational research*. Unpublished lecture notes. University of Cape Coast. Cape Coast.

Anang, B.T., Blackman, S, & Sipilainen, T. (2016). Technical Efficiency and its determinants in smallholder rice production in Northern Ghaana. *The journal of Developing Arears*, 50(2), 311-328

Awunyo-Vitor, D.,Bakang, J., &Cofie, S. (2013). Estimation of farm level technical efficiency of small scale cowpea production in Ghana. *American-Eurasian Journal of Agriculture & Environmental Sciences, 13* (8), 1080-1087

Bempomaa, B. (2014). *Technical efficiency in maize production in Ejura-Sekyedumase District of the Ashanti Region*. Unpublished master's thesis. University of Cape Coast. Cape Coast.

Cohen, L., Manion, L., & Morrison, K. (2007). Research methods in education. (6th Ed.). Routledge: London

Diako, C. E.,Sakyi-Dawson, B., Bediako-Amoa, F. K. S., & Manful J. T. (2010). Consumer perceptions, knowledge and preferences for aromatic rice types in Ghana*. Nature and Science, 8* (12), 12–19

Diako, C. E., Sakyi-Dawson, B., Bediako-Amoa, F. K. S., &Manful, J.T. (2011). Cooking characteristics and variations in nutrient content of some new scented rice varieties in Ghana. Annals**.** *Food science and Technology, 12* (1), 39–44.

Donkoh, S.A., Ayambila, S., & Abdulai, S. (2012). *Technical efficiency of rice production at the Tono irrigation scheme in Northern Ghana.* Unpublished master's thesis. University of Development Studies. Tamale.

Ellis, F. (1993). *Peasant Economics: Farm households and agrarian development*. (2ndEd.). Wye studies in Agricultural and Rural Development. Cambridge University Press: London.

Etwire, P. M., Martey, E., & Dogbe, W. (2013). Technical efficiency of soybean farms and its determinants in Saboba and Chereponi Districts of Northern Ghana: A stochastic frontier approach. *Sustainable Agriculture Research*, *4*, 106-116.

Gay, L. R. (1992). *Research methods for business management.*Macmillan and Co. : New York.

Griffiths, W.E.,Hill, R. C., & Judge, G.G. (1993). Learning and practicing econometrics. Wiley: New York

Herdt, R.W. & Mandac, A. M. (1981). Modern technology and economic efficiency of Philippines rice farmers. *Economic Development and Cultural Change*, 29,375-399.

Hummelbrunner, S.A., Rak, L.J., & Gray, J. (1996). *Contemporary business statistics with Canadian applications. (2nd Ed.).*Prentice Hall, Canada Inc.: Ontario

Kendall, M. G., & Smith, B. B. (1939). The problem of rankings. *Annals of Mathematical Statistics*, *10*(3), 275-287

Kolawole, O. (2009). Technical, allocative and economic efficiency in upland rice production system in Nigeria: A frontier function approach. *Food production in a developing economy, 1,* 273-279.

Krejcie, R.V.,& Morgan, D.W. (1970). Determining sample size for research activities. *Educational & psychological measurement, 30,* 607-610.

Kuwornu, J. K., Amoah, E., & Seini, W. (2013). Technical efficiency analysis of maize farmers in the Eastern Region of Ghana. *Journal of Social and Development Sciences*, *4*(2),84-99.

Lau, L. J. (1986). *Functional forms in econometric model building.* Elsevier Science Publishers : New York.

Louis, C., Lawrence, M.,& Keith, M. (2007).*Research methods in education.* Routledge Publishers: New York.

Maganga, A. M. (2012). Technical efficiency and its determinants in Irish potato production: Evidence from Dedza District, Central Malawi. *African Journal of Agricultural Research*, *7*(12), 1794-1799.

Ministry of Food and Agriculture (2009). *Evaluation of the Ghana rice campaign:* A marketing campaign implemented by Engineers without Borders and the Ghana Ministry of Food and Agriculture to stimulate the rice value chain, April, 2009.

Ministry of Food and Agriculture (2010). *Agriculture in Ghana: Facts and figures.*SRID: Accra.

Ministry of Food and Agriculture, Ketu North District (2014). *District Agriculture Profile.* District Agriculture Development Unit:Dzodze.

Musiime, O. Tenywa, M. M., Majaliwa, M.J. G., Lufafa, A. Nanfumba, D., Wasige, J., Woomer, P. L. & Kyondha, M.(2005). Constraints to rice production in Bugiri district. *African Crop Science Conference Proceedings, 7,* 1495-1499

Njeru, J. (2010).Factors influencing technical efficiencies among selected wheat farmers in Uasin Gishu District, Kenya. *African Economic Consortium Research Paper, 206*

Natural Resources Institute, NRI. (2013). *Contrasting rice value chains: A benchmarking study of rice in Ghana, Senegal and Thailand, draft report.* Natural Resources Institute, University of Greenwich: Greenwich, UK.

Onumah, E. E., & Acquah, H. D. (2010). Frontier analysis of aquaculture farms in the southern sector of Ghana. *World Applied Sciences Journal, 9*(7), 826-835.

Ragasa, C., Dankyi, A., Acheampong, P., Wiredu, A. N., Chapoto, A., Asamoah, M., &Tripp, R (2013). *Patterns of adoption of improved rice technologies in Ghana*. GSSP Working Paper, IFPRI, Accra, Ghana.

Rahman, K.M.M., Mia, M.I.A.,&Bhuiyan, M.K. J. (2012). A stochastic frontier approach to model technical efficiency of rice farmers in Bangladesh: An empirical analysis.*A scientific Journal of Krishi Foundation, 10*(2), 9-19

Timmer, C. P. (1971). Using a probabilistic frontier production function to measure technical efficiency. *Journal of PoliticalEconomy*, 79, 776-794.

Wiredu, A.N., Gyasi, K.O., Marfo, K.A.,Asuming-Brempong, S., Haleegoah, J. Asuming-Boakye, A.,&Nsiah, B.F. (2010). *Impact of improved varieties on the yield of rice producing households in Ghana*. Council for Scientific and Industrial Research – Savanna Agricultural Research Institute, Tamale.

Cite this Article: Kavi FK (2021). Determinants of Technical Efficiency in Rice Production on the Weta Irrigation Scheme in the Volta Region, Ghana. *Greener Journal of Agricultural Sciences* 11(4): 228-236.