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Efficiency of Cassava Production Enterprise among Root and Tuber Expansion Programme (RTEP) Beneficiaries and Non-Beneficiaries in Abia State, Nigeria

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Abstract
The study estimates the technical, allocative and economic efficiency of cassava production enterprise among RTEP beneficiaries and non-beneficiaries in Abia State, Nigeria. The study employed a combination of multi-stage purposive and random sampling techniques to select 120 respondents for the research. A stochastic frontier production function was used to estimate efficiency levels and identify factors influencing efficiency. The result for technical efficiency for RTEP beneficiaries revealed significant positive impacts of planting material, farm size, and agrochemicals on cassava output while RTEP non-beneficiaries show a positive relationship between labour and agrochemicals with output and technical efficiency. The inefficiency model for non-beneficiaries highlights age as a factor contributing to technical inefficiency, while experience and extension contact enhance efficiency. The allocative efficiency result shows that age, education, and farming experience significantly impact the allocative efficiency of RTEP beneficiaries. For non-beneficiaries, extension visits and farming experience play crucial roles in allocative efficiency. Economic efficiency analysis indicates that planting material, rent on land, and agrochemical costs are significant determinants for RTEP beneficiaries. For non-beneficiaries, rent on land and labour costs significantly contribute to total production costs. Age, education, and household size affect the cost efficiency of both beneficiaries and non-beneficiaries. Based on the findings and conclusion of this study, it is therefore recommended that efforts should be directed towards encouraging RTEP non-beneficiaries to partake in subsequent agricultural programmes through adequate awareness creation and sensitization programmes by government, non-governmental organizations and extension agents, as this enhances productivity and efficiency of farmers.
Keywords: Efficiency, Enterprise, Beneficiaries, and Production

Introduction

Cassava stands out as a strategic crop with the potential to drive rural development, alleviate poverty, stimulate economic growth, and ultimately enhance food security (FAO (2018). Given these considerations, key stakeholders have consistently played a significant role in contributing to discussions and initiatives aimed at advancing the cassava sub-sector in Nigeria. The majority of cassava farmers operate on small land plots that are neither suitable nor economically viable for mechanized agriculture. Despite these challenges, cassava remains a rapidly expanding staple food crop in countries where it is widely consumed. It has gained popularity among farmers, and industrial demand for cassava has been consistently increasing (Food and Agricultural Organisation FAO, 2018). Globally, cassava has experienced annual growth rates exceeding 3% (FAO, 2018). According to FAO (2018) statistics, global cassava production reached approximately 278 million tonnes in 2018, with Africa contributing about 56% of the total production, totalling around 170 million tonnes. During the same period, Nigeria alone produced about 60 million tonnes (FAOSTAT, 2019).

RTEP was one of the governmental programmes that were carried out to assist in improving agricultural yield-enhancing technologies and productivity in root and tubers and processing to attain food security in the country. RTEP was established in July 2001 with a plan to synergize the gains attained under the Cassava Multiplication Programme (CMP), and a goal to raise income, alleviate poverty and improve the food security of small-scale farmers and processors of cocoyam, cassava, sweet and Irish potato and yam, within the project area (RTEP, 2010; Ibrahim & Onuk, 2010; Obisesan & Omonona, 2013; Matanmi, Afolabi, Komolafe & Adefalu, 2017).

According to (Lovell, 1993), the term efficiency refers to the comparison between the real or observed values of input(s) and output(s) with the optimal values of input(s) and maximal output(s) used in a particular production process. Efficiency is achieved by minimizing the resources required for producing a given output. Efficiency is considered technical, if optimal values are defined in terms of the maximum level of output, given the level of input, in terms of the production frontier. In other words, technical efficiency is achieved by producing at the production frontier. If the optimal values are based on the selection of the mix of inputs, such that a given level of output is produced at the lowest possible cost, given the respective input prices, then the term efficiency can be referred to as allocative efficiency (Lovell, 1993). The role of efficiency in increasing agricultural output has been widely recognized in both developed and developing countries of the world (Trans *et al*., 1993; Shehu and Mshelia, 2007; Giroh and Adebayo, 2009). The objective of this study is to estimate the technical, allocative and economic efficiency of cassava production among the beneficiaries and non-beneficiaries in Abia State of Nigeria.

Methodology

The research took place in Abia State, Nigeria. Abia State is situated in the South-east geo-political zone of Nigeria, with coordinates between longitude 70°231' and 80°021'E and latitude 50°471' and 60°121'N. According to current census statistics, the state's population remains at 2,845,380, with approximately 95% of the population identifying as Christians (Population Statistics, 2018). The target populations of the study comprised the areas that where Root and Tuber Crop Expansion Programme covered in the State. The study employed a combination of multi-stage purposive and random sampling techniques to select 120 respondents for the research. The first stage was the random selection of the three agricultural zones in Abia State, namely Umuahia, Ohafia, and Aba agricultural zones. The Second Stage was the purposive selection of one local government from each agricultural zone, resulting in the selection of Umuahia North, Isiukwuato, and Osisioma Ngwa. The third stage was the random selection of four communities from each of the selected local governments, totalling twelve (12) communities. Finally, a purposive selection of ten farmers from each chosen community led to a total of 120 respondents. This sample comprised 60 beneficiaries and 60 non-beneficiaries of the programme. The primary data were collected through structured questionnaires and interview schedules administered to both beneficiaries and non-beneficiaries of the programme. Stochastic frontier production functions (Technical, Economic and Allocative efficiency) were used to analyze the data collected for this study.

Data Analysis

For this study, the specific models that were estimated are:

A stochastic frontier production function is defined by …… (1)

Where Yi is the output of the i-th farm, Xi is the vector of input quantities used by the i-th farm, β is a vector of unknown parameters to be estimated, f( ) represents an appropriate function (e.g. Cobb Douglas, translog, etc). The term Vi is a symmetric error, which accounts for random variations in output due to factors beyond the control of the farmer e.g. weather, disease outbreaks, measurement errors, etc. The term Ui is a non-negative random variable representing inefficiency in production relative to the stochastic frontier. The random error Vi is assumed to be independently and identically distributed as N(o, σv 2) random variables independent of the Uis which are assumed to be non-negative truncation of the N(o,σu 2) distribution (i.e. half normal distribution) or have exponential distribution.

Technical efficiency (TE) = Yi/Yi* = f (Xi;β) exp (Vi-Ui) / f (Xi,β) exp (Vi) = exp (-Ui)….(2)

Where Yi is the observed output and Yi* is the frontier output. The parameters of the stochastic frontier production function are estimated using the maximum likelihood method.

Technical Efficiency

The technical efficiency of an individual farmer is defined in terms of the ratio of the observed output to the corresponding frontier output given the available technology [11].

Technical efficiency (TE) Yi/Yi*
= *f* (Xi, β) exp (Vi)/ *f* (Xi, β) exp (Vi) = exp (-Uj) ….. (3)

Where
Yi = observed output
Yi* = frontier output:

$$\text{Ln } Q = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + Vi - Ui \ldots (4)$$

The technical efficiency of an individual farmer is defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology.

(b) The Empirical Model: For this study, the production technology of Cassava farmers in Abia State, Nigeria is assumed to be specified by the Translog frontier production function defined as follows

$$InQ = bo+b_1InX_1+b_2InX_2+b_3InX_3+b_4InX_4+b_5InX_5+V_iU_i \quad ..... (5)$$

Where Q is output of cassava in kg., X1 is farm size in hectares, X2 is labour input in mandays, X_3 is fertilizer input in kg, X_4 is bundles of cassava planted in kg, X5 is capital input in naira made up of depreciation charges on farm tools and equipment interest on borrowed capital and rent on land, b_0, b_1, b_2 ….. b_5 are regression parameters to be estimated while Vi and Ui are as defined earlier. In addition, Ui is assumed in this study to follow a half-normal distribution as is done in most frontier production literature.

Economic efficiency

(b) The Empirical Model: In this study, the stochastic frontier translog cost function will be estimated for cassava using the Maximum Likelihood method.

The model is specified as follows:

$$Ln\,Ci = \alpha_0 + \alpha_1 LnW_1 + \alpha_2 LnW_2 + \alpha_3 LnW_3 + \alpha_4 LnW_4 + \alpha_5 LnW_5 + Vi - Ui \quad .... (6)$$

Where LnCi represents the total input cost of the i-th farm, W_1 is average daily wage rate per manday, W_2 is price of fertilizer per kg, W_3 is land rent in naira per hectare, W_4 is price of planting materials in naira per kg, W_5 is capital input in naira made up of depreciation charges on farm tools and equipment, interest on borrowed capital and rent on land, Y is output of cassava in kg adjusted for statistical noise, α_0 α_1 α_2 ….. α_{27} are regression parameters to be estimated while *u*i and *v*i are as defined earlier.

Allocative efficiency

The combinations of equations (3) and (4) are used to obtain the allocative efficiency (AE) index following Farell (1957)

$$AE = EE / TE = (Xie.\,P) / (Xi.\,P) \quad ...... (7)$$

Results and Discussion

The maximum likelihood estimate of the technical efficiency of cassava production among RTEP beneficiaries and non-beneficiaries is shown in Table 1. The maximum likelihood estimate of technical efficiency in cassava production among RTEP beneficiaries and non-beneficiaries is presented in Table 1. For RTEP beneficiaries, the sigma square (σ2) estimate of 50.4% is statistically significant at the 1% level, affirming the goodness of fit and correctness of distributional assumptions. The gamma parameter (γ) of 0.720 indicates that 72.0% of the total variation in cassava output results from technical inefficiency differences, highlighting the significance of unexplained variations. However, planting material was the most important resource in cassava production as this was positively signed and significant at a 1% level with a coefficient of 0.264. This implies that an increase in the use of planting material will bring about an increase in the output and technical efficiency of RTEP beneficiaries. The result agrees with the findings of Ebe *et al.* (2018) who noted that agricultural productivity can be increased through planting materials. The coefficient of the farm size (0.031) was positively signed and significant at 10%. This implies that the output and technical efficiency of RTEP beneficiaries increases with an increase in farm size. The coefficient of the agrochemicals (2.190) was positively signed and significant at 5%. This implies that the output and technical efficiency of RTEP beneficiaries increases with an increase in the use of agrochemicals. These findings collaborate with Esiobu (2019) who reported that the output and technical efficiency of cassava producers in Imo State, Nigeria increases with an increase in farm size and the use of planting materials like improved cassava cuttings, and agrochemicals among others.

The inefficiency model results for beneficiaries of the RTEP revealed significant implications for their technical efficiency. The negative signs of the estimated coefficients, interpreted in the context that a negative sign enhances technical efficiency, align with established principles (Egbodion and Aguelle, 2017). Notably, age, experience, and educational level exhibited negative and significant coefficients for RTEP beneficiaries, in line with the anticipated outcomes. The negative coefficients and significance of age (-0.721), experience (-2.186), and educational level (0.860) suggest that matured RTEP beneficiaries in the study area were productive, with these variables contributing to increased technical efficiency. The explanation lies in the maturity associated with age, indicating that mature beneficiaries efficiently utilized their resources to enhance productivity. Additionally, greater farming experience positioned beneficiaries to adeptly address challenges in cassava production, as experienced farmers possess enhanced knowledge of climatic conditions, resource allocation, and market dynamics, fostering efficient and profitable enterprises. Furthermore, higher educational levels among RTEP beneficiaries were linked to increased technical efficiency, as individuals with more years of education were more responsive to improved technologies such as advanced cassava-cutting methods, fertilizer application, and pesticide use. This aligns with Esiobu's (2019) findings, emphasizing that age, experience, and education collectively contribute to the efficiency of cassava farmers in Imo State, Nigeria.

Concerning RTEP non-beneficiaries, the estimate of sigma square (σ^2) of 59.1% was statistically significant at a 1% level and therefore, shows the goodness of fit and correctness of the distributional assumptions of the composite error. The estimated gamma parameter (γ) of 0.570 indicates that 57.0% of the total variation in cassava output was due to differences in their technical inefficiency. It also indicates that the unexplained variations in output are the major sources of random errors. It also confirms the presence of the one-sided error component in the model and hence, the use of the Ordinary Least Square (OLS) in estimating the function, becomes inadequate in representing the data. The positive and significant coefficient of labour (0.051) among RTEP non-beneficiaries indicates that an increase in the size of the labour force contributes to higher output levels. This aligns with the importance of labour emphasized by Okeke and Emaziye (2017), especially in developing countries where large household sizes enhance labour availability for farming activities. Additionally, the positively signed and significant coefficient of agrochemicals (1.130) suggests that the use of agrochemicals contributes to increased output and technical efficiency among RTEP non-beneficiaries. The inefficiency model for RTEP non-beneficiaries revealed that age (-1.111) had a positive and significant impact on technical inefficiency; this implies that technical inefficiency among RTEP non-beneficiaries increases with age, suggesting that older farmers tended to be more risk-averse or risk-neutral, potentially hindering the adoption of improved production techniques. Conversely, experience (-0.106) and extension contact (1.220) had negative coefficients and were significant, indicating that more experienced and extension-contact farmers were productive, with these three variables enhancing their technical efficiency. This implies that matured and experienced RTEP non-beneficiaries efficiently utilized resources, overcoming cassava production challenges. Farmers with extended contact with extension services were more likely to adopt improved technologies, contributing to increased efficiency in resource allocation and agricultural production. These findings align with Ochi *et al*. (2016) results, highlighting the positive relationship between extension contact and the relative efficiency of cassava farmers.

The Allocative efficiency of cassava production among the beneficiaries and non-beneficiaries is shown in Table 2. The results of estimates of allocative efficiency of RTEP beneficiaries and RTEP non-beneficiaries presented for RTEP beneficiaries show a sigma square value of 71%, significant at 1% was recorded, indicating the goodness of fit and correctness of the specified assumption of the composite error terms distribution. The gamma ($\gamma = 0.63$) shows that 63% of the variability in the total output of cassava produced by RTEP beneficiaries in the study area resulted from the existence of allocative efficiency. The coefficient for age was negatively signed and significant at a 1% probability level, this implies that an increase in age will result in allocative inefficiency because most of the respondents were aged and would tend to misallocate their resources. The coefficient for education was negative and it was significant at a 1% probability level. This implies that farmers, the majority of whom are aged rely on their long years of experience to allocate their resources efficiently for cassava production. Most of the farmers (30%) had primary school education which implies that education is not costless but requires investment. Finally, the coefficient for farming experience was negative and it was significant at a 10% probability level. This implies that farmers with small farm holdings are allocatively efficient. Concerning RTEP non-beneficiaries, a sigma square value of 27%, significant at 1% was recorded, indicating the goodness of fit and correctness of the specified assumption of the composite error terms distribution. The gamma ($\gamma = 0.54$) shows that 54% of the variability in the total output of cassava produced by RTEP non-beneficiaries in the study area resulted from the existence of allocative efficiency. The coefficient for extension visits was positive and it was significant at a 1% probability level. This implies that an increase in extension visits will lead farmers to allocate their resources efficiently. The coefficient for farming experience was also negative and it was significant at a 1% probability level. This implies that cassava farmers with small farm holdings are allocatively efficient.

The Economic efficiency of cassava production among the RTEP beneficiaries and RTEP non-beneficiaries is shown in Table 3. The results of estimates of the economic efficiency of RTEP beneficiaries and RTEP non-beneficiaries are presented in Table 3. Concerning RTEP beneficiaries, a sigma square value of 80.1%, significant at 1% was recorded, indicating the goodness of fit and correctness of the specified assumption of the composite error terms distribution. The gamma ($\gamma = 0.67$) shows that 67% of the variability in the total output of cassava produced by RTEP beneficiaries in the study area resulted from the existence of economic inefficiency. The estimated parameter of the cost function revealed that the coefficients of cost of planting materials (0.041), rent on land (0.082) and agrochemical cost (0.103) were statistically significant at 10% and 1% levels of probability respectively. This indicates that these variables mostly determine the total cost of production for RTEP beneficiaries. Thus, an increase in these inputs may lead to an increase in the total cost of cassava production among RTEP beneficiaries. In the inefficiency cost model, the coefficient of age was statistically significant (1%) and negatively related to the cost efficiency of RTEP beneficiaries. This implies that older farmers tend to be more cost-efficient than younger farmers. Education is statistically significant (5%) and negatively related to the cost efficiency of RTEP beneficiaries implying that educated respondents are likely to make cost decisions that will lead to cost efficiency compared to others who had little or no education. This is in line with the work of Taphe, Agbo and Okorji, (2015). Extension contact was negative and significant at 1%. This means that an increase in extension visits to RTEP beneficiaries will reduce cost inefficiency in their cassava production enterprise. This is plausible because information about the price of production resources is usually passed to the farmers in the course of the visit by extension agents. Also, household size was negative and statistically significant at 10%, indicating that RTEP beneficiaries with relatively larger household sizes are likely to use more family labour to reduce the high cost of hired labour thereby enhancing cost efficiency. This finding is in tandem with Nwahia *et al.* (2020) who reported that cost of planting materials and rent on land added to the total cost of production of RTEP beneficiaries in Ebonyi State.

For RTEP non-beneficiaries, a sigma square value of 61.1%, significant at the 1% level, indicated a good fit and the correctness of the specified assumption regarding the distribution of composite error terms. The gamma ($\gamma = 0.730$) suggested that 73.00% of the variability in total cassava output among RTEP non-beneficiaries resulted from economic inefficiency. The estimated parameters of the cost function revealed that the coefficients of rent on land (0.444) and labour cost (0.023) were statistically significant at the 1% level, indicating that these variables play a crucial role in determining the total cost of production for RTEP non-beneficiaries. Consequently, an increase in these inputs may lead to a higher total cost of cassava production among RTEP non-beneficiaries. In the inefficiency cost model, the coefficient of age was statistically significant (1%) and negatively related to the cost efficiency of RTEP non-beneficiaries. This suggests that older farmers tend to be more cost-efficient than younger farmers. Education was also statistically significant (1%) and negatively related to the cost efficiency of RTEP non-beneficiaries, implying that educated respondents are more likely to make cost-effective decisions compared to those with little or no education. Additionally, household size was statistically significant at 1% and negatively related to cost efficiency among RTEP non-beneficiaries, indicating that those with relatively larger household sizes are likely to use more family labour, reducing the need for hired labour and enhancing cost efficiency.

The frequency distribution of technical, allocative and economic efficiency of cassava production among the RTEP beneficiaries and RTEP non-beneficiaries are shown in Table 4. Table 4 shows the frequency distribution for technical, allocative, and economic efficiency of cassava production among RTEP beneficiaries and RTEP non-beneficiaries. For RTEP beneficiaries, the mean technical efficiency was 0.687, indicating that, on average, an RTEP beneficiary operates at 31.3% less efficiency than the maximum possible level due to technical inefficiency. Achieving the technical efficiency level of the most efficient counterpart could result in a 21.4% cost saving. Conversely, the most technically inefficient farmers could realize a cost saving of 62.1%. In terms of allocative efficiency, the mean was 0.742, suggesting that, on average, observed costs were 25.8% less than the optimum minimum cost, indicating room for improvement. Achieving the allocative efficiency level of the most efficient counterpart could lead to a 20.1% cost saving, while the most allocative inefficient farmers could achieve a cost saving of 80.5%. The estimated mean economic efficiency was 0.576, implying that, on average, an RTEP beneficiary in the study area operates at 42.4% less efficiency than the most efficient counterpart. Achieving the economic efficiency level of the most efficient counterpart could result in a 40.1% cost saving. Conversely, the most economically inefficient farmers could realize a substantial cost saving of 91.3%.

For non-beneficiaries, the mean technical efficiency was 0.543, indicating that, on average, an RTEP non-beneficiary operates at 45.7% less efficiency than the maximum possible level due to technical inefficiency. Achieving the technical efficiency level of the most efficient counterpart could result in a 35.3% cost saving, while the most technically inefficient farmers could achieve a cost saving of 77.7%. In terms of allocative efficiency, the mean was 0.441, suggesting that, on average, observed costs were 55.9% less than the optimum minimum cost, indicating room for improvement. Achieving the allocative efficiency level of the most efficient counterpart could lead to a 51.1% cost saving, while the most allocative inefficient farmers could achieve a substantial cost saving of 94.7%. The estimated mean economic efficiency was 0.395, implying that, on average, an RTEP non-beneficiary in the study area operates at 60.5% less efficiency than the most efficient counterpart. Achieving the economic efficiency level of the most efficient counterpart could result in a 55.0% cost saving, while the most economically inefficient farmers could realize a substantial cost saving of 86.2%. It's worth noting that these findings differ from the reported technical efficiency scores for RTEP beneficiaries and non-beneficiaries in other states in Nigeria, such as Nasarawa and Kwara, as documented by Ibrahim and Onuk (2010) and Ayinde *et al*. (2012).

Conclusion

This study has shown that Planting materials, farm size, agrochemicals age, experience and education enhanced the technical efficiency of RTEP beneficiaries in the study area. However, the age of RTEP non-beneficiaries (1.111***) under inefficient factors reduced their technical efficiency. The cost of planting materials, rent on land and labour cost influenced the total cost of production and profit of the respondents. The mean levels of technical, allocative and economic efficiency of RTEP beneficiaries (68.7%, 74.2% and 57.6%) respectively were higher than that of RTEP non-beneficiaries 54.3%, 44.1% and 39.5% respectively. Based on the findings and conclusion of this study, it is therefore recommended that efforts should be directed towards encouraging RTEP non-beneficiaries to partake in subsequent agricultural programmes through adequate awareness creation and sensitization programmes by government, non-governmental organizations and extension agents, as this enhances productivity and efficiency of farmers. Also, Extension services, especially of the ADP should try to enlighten farmers to ensure better and more appropriate application of the modern inputs as well as participation and adoption of agricultural development programmes.

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Table 1: The Maximum Likelihood Estimates of Technical Efficiency of RTEP Beneficiaries and Non-Beneficiaries

Technical Efficiency	Parameters	Beneficiaries Coefficient	T-Ratio	Non-Beneficiaries Coefficient	T-Ratio
Production factors					
Intercepts	b_0	-0.218	8.733^{***}	-1.100	3.311^{***}
Planting materials	b_1	0.264	4.326^{***}	0.506	1.003
Farm size	b_2	0.031	1.700^{*}	2.011	0.852
Labour	b_3	0.086	1.555	0.051	5.721^{***}
Agrochemicals	b_4	2.190	2.000^{**}	0.130	4.070^{***}
Capital	b_5	1.639	0.113	0.187	1.002
Inefficient factors					
Constant	δ_0	1.215	2.115^{**}	0.826	4.325^{***}
Age	δ_1	-0.721	4.118^{***}	1.111	3.991^{***}
Experience	δ_2	-2.186	1.811^{*}	-0.106	2.291^{**}
Education	δ_3	-0.860	6.261^{***}	0.070	0.200
Extension contact	δ_4	0.400	1.118	-1.220	3.501^{***}
Household size	δ_5	2.000	0.900	0.090	0.231
Diagnostic statistics					
Log Likelihood		-281.91		-151.53	
Gamma (γ)		0.720	6.882^{***}	0.570	4.711^{***}
Sigma-squared (δ^2)		0.504	6.504^{***}	0.591	5.307^{***}

Sources: Field Survey, 2021; ***, **, * represents significance level of 1%, 5% and 10% respectively

Table 2: The allocative efficiency of beneficiaries and non-beneficiaries

Allocative Efficiency	Parameters	Beneficiaries Coefficient	Beneficiaries T-Ratio	Non-Beneficiaries Coefficient	Non-Beneficiaries T-Ratio
Intercepts	α_0	1.023	4.021***	-1.210	5.192***
Age	α_1	-1.239	6.178***	-1.027	0.003
Education	α_2	-1.098	6.040***	-1.192	0.192
Extension Visit	α_3	-0.510	1.098	1.271	2.802**
Farm experience	α_4	-0.021	1.809*	-1.103	8.120***
Household Size	α_5	-0.251	0.209	-1.203	1.012
Diagnostic statistics					
Log Likelihood		-0.817		-0.145	
Variance ratio (γ)		0.630	4.186***	0.542	7.191***
Total variance (σ^2)		0.713	7.187***	0.274	5.192***
LR Tests		0.016		0.100	

Sources: Field Survey, 2021

Table 3: Estimate of stochastic frontier cost function (Economic efficiency) of RTEP beneficiaries and RTEP non-beneficiaries

Economic Efficiency	Parameters	Beneficiaries Coefficient	Beneficiaries t-ratio	Non-Beneficiaries Coefficient	Non-Beneficiaries t-ratio
Production factors					
Intercepts	α_0	10.882	9.711***	-4.109	3.311***
Price of planting materials	α_1	-0.615	3.006***	0.512	0.003
Farm size	α_2	0.118	1.800*	1.080	9.700***
Price of Labour	α_4	-0.720	2.011**	2.000	0.802
Price of agrochemicals	α_5	-0.331	3.700***	-0.903	6.300***
Capital	α_6	0.639	1.715*	0.025	4.842***
Inefficient factors					
Constant	δ_0	4.041	8.507***	2.716	6.664***
Age	δ_1	-0.043	-6.001***	-0.310	-5.001***
Experience	δ_2	1.707	0.100	0.303	0.991
Education	δ_3	-0.007	2.120**	0.009	-7.404***
Extension contact	δ_4	-0.400	7.651***	0.721	0.008
Household size	δ_5	-0.013	1.928*	1.011	-3.001***
Diagnostic statistics					
Log Likelihood		**-86.24**		**-100.57**	
Gamma (γ)		**0.667**	**4.431*** **	**0.730**	**4.717*** **
Sigma-squared (δ_1)		**0.800**	**6.511*** **	**0.61111**	**7.001*** **

Sources: Field Survey, 2021; ***, **, * represents significance level of 1%, 5% and 10% respectively

Table 4: Frequency distribution of respondents according to efficiency level

Beneficiaries	Technical efficiency		Allocative efficiency		Economic efficiency	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
0.00 – 0.20	0	0.0	4	6.67	8	13.33
0.21 – 0.40	4	6.67	8	13.33	12	20.00
0.41 – 0.60	17	28.33	11	18.33	17	28.33
0.61 – 0.80	18	30.00	15	25.00	8	13.34
0.81 – 1.00	21	35.00	22	36.67	15	25.00
Total	60	100	60	100	60	100
Mean	0.687		0.742		0.576	
Min	0.331		0.181		0.084	
Max	0.874		0.928		0.961	
Non-Beneficiaries						
0.00 – 0.20	0	0.00	8	13.33	11	18.33
0.21 – 0.40p	14	23.33	13	21.67	16	26.67
0.41 – 0.60	25	41.67	18	30.00	12	20.00
0.61 – 0.80	14	23.33	10	16.67	13	21.67
0.81 – 1.00	7	11.67	11	18.33	8	13.33
Total	60	100	60	100	60	100
Mean	0.543		0.441		0.395	
Min	0.187		0.048		0.121	
Max	0.839		0.901		0.877	

Sources: Field Survey, 2021