

## Technical Efficiencies of TMS Cassava Varieties by Farmers in Ebonyi State, Nigeria

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### Abstract

*Technical efficiency of TMS cassava varieties by farmers in Ebonyi State, Nigeria was studied. One hundred and twenty respondents were selected using multi-stage random sampling techniques. Primary data for the study was collected using a well-structured questionnaire and complimented with interview scheduled. Percentage responses and Cobb Douglas stochastic frontier production function were used to address the objectives of the study. The results of the socioeconomic characteristics showed that 79.16 % of the farmers were married, the mean age of farmers was 42.50 years and most of them (25%) and (75%) were male and married respectively. The mean education was 6.2 years with only 10% that does not have formal education. Also, 73.34% of the farmers had above 10 years of farming experience. The average farm size and household size stood at 1.45 hectares and 6.7 members respectively. As well, 63.3% of the farmers were members of cooperatives, while 36.7% were not. As well, 66.7% of the farmers had access to credit, while 33.33% does not. Furthermore, the determinant factors to technical efficiency in TMS cassava varieties production were level of education, household size and farm size. The need to enhance farmers' access to educational programmes, land and extension services were proffered.*

**Keyword:** Technical efficiency, TMS Cassava Varieties, Farmers, Stochastic Frontier, Cobb Douglas.

## 1.0 Introduction

The important of Agriculture in fostering economic growth in most developing countries in sub-Saharan Africa is well documented (Food Agricultural Organization (FAO), 2017; Okoronkwo,

*et al.*, 2017; Kaine and Ume *et al.*, 2018). In this region according to FAO, (2015) and Kaine *et al.*, (2015), agriculture is sources of the food security, poverty alleviation and foreign exchange earnings. In Nigeria, for instance, agriculture contributes about 12 per cent of the nation's Gross Domestic Product (GDP), 23 per cent of foreign exchange, and 65 per cent of the total employment in the rural areas and 42 per cent of industrial raw materials (Kaine & Chukwuma, 2017; Onunka *et al.*, 2020). In South East, South- South, South West and Middle belt farming systems, crop production dominates agricultural production with cassava production standing preeminence among smallholder farmers. Cassava is capable of generating desired economic growth through generation of employment and income, alleviating poverty, improve food security, livestock feed formation and as potentials for agro-based industrialization (Ibekwe *et al.*, 2012; FAO. 2015). Nigeria is the adjudged the world largest producer of cassava with output of about 60 million tonnes in 2019 (FAO, 2020).

This production exploit could largely be linked to the collaboration among International Institute for Tropical Agriculture (IITA) and the National Root Crop Research Institute (NRCRI) and Federal government of Nigeria, the collaboration resulted in development of the Tropical Manioc Selection (TMS) variety (FAO, 2020). This variety of cassava, though subsists under different cultivars or clones (TMS 50395, 63397, 30555, 4(2)1425, TMS 419, 30572 etc) with TMS 30555 and 30572 being most common in the study area (NRCRI, 2017, Ume *et al.*, 2016a). TMS cassava varieties generally has exceptional features of being resistant to mosaic disease, tolerant to Cassava Spider mite, low in cyanide content, drought resistant, early maturing, and high yielding (Oparinde *et al.*, 2016; IITA, 2013).

Despite all the interventions by the Federal Government of Nigeria and Development Agencies, notably "Presidential Initiative for Cassava" implemented by the Nigerian government, the "Integrated Cassava Project" of the International Institute of Tropical Agriculture (IITA) and the "Cassava Plus Project" of the International Fertilizer Development Center (IFDC) (Osun *et al.*, 2014), cassava production is still grossly inadequate as exemplified by the wide gap between demand and supply of its products (Central Bank of Nigeria (CBN), 2016; Ume, *et al.*, 2020). This could be linked to myriads of problems faced by smallholder farmers, the farming population in many countries in sub-Saharan Africa, Nigeria inclusive, included smallholder farmers characterized by limited land frontier, diseases and parasites infestations, poor soil fertility, low capital base, poor extension services outreach (CBN, 2016; IITA, 2020; Onunka *et al.*, 2020), their production sensitive to climatic variation as it is mainly rain fed, small size due to existing ownership and inheritance system, poor soil fertility, poor knowledge of efficient use of inputs and proper crops husbandry methods (Ibekwe *et al.*, 2012, Ume *et al.*, 2016b; NRCRI, 2017; FAO 2020). The consequences of the aforesaid limitations are aggravation of poverty and food insecurity to the farmers and consumers alike poor agricultural mechanization due to land fragmentation and poor adoption of improved agricultural innovations (Asogwa, "*et al.*," 2011; Nkegbe, 2012).

Based on the above premise, measurement of technical efficiency of farmers especially cassava farmers is imperative in the study area, Ebonyi State from the standpoint of agricultural development, since the State is known as among other States cassava food baskets of the South east in particular and Nigeria in general. This research would facilitate in gathering essential information as relates to the prevailing inefficiencies in the crop production and in aiding in rational policies making as concerns to management decision, resource allocation and

institutional development in order to increase cassava productivity through enhanced efficiency (Ojokoto *et al.*, 2015; Kadumba & Ume, 2012). Hence, the need for this study is imperative as there is dearth of published information on the subject matter under discuss to the best knowledge of the researcher. In effort to achieve the topic of discuss, the following specific objectives were addressed, included to describe the socioeconomic characteristics of the respondents and estimate the technical efficiency of the respondents in the study area.

## 1.1. Literature Review

### 1.1 Reviews on TMS Cassava Varieties

Cassava is Africa's second most important food staple in terms of calories consumed per capita and a major source of calories for roughly two out of every five African (Isitor, *et al.*; 2017, FAO, 2018). Globally, Nigeria is the largest cassava producer, accounting for about one-fifth (21%) of total production worldwide. The demand for cassava and its constituents is high in the domestic economy (Kolapso *et al.*, 2020). The Nigeria estimates for cassava production output for year 2018 stands at 59.5 million metric tonnes (Ume *et al.*, 2020; FAO, 2020). The growing importance of the crop for food security and potentials for agro-based industrialization, has necessitated several collaborations between the government and international organizations in development of among others several improved varieties of the crop. The development and introduction of improved cassava varieties has long been recognized as one of the key strategies for transforming the cassava industry and for enhancing the wellbeing of Nigeria's rural populace (Kadiri *et al.*, 2015; Oyewole & Eforuoku, 2019).

In early 1980s, numerous cassava varietal technology were developed by International Institute for Tropical Agriculture (IITA), National Root Crop Research Institute(NRCRI) in collaboration with government of Federal Republic Nigeria, Tropical Manihot Series (TMS) was prominence not only because of disease-resistant and high-yielding but (IITA, 2013; Girei *et al.*, 2015; Kolapso *et al.*, 2020). This variety of cassava, although exists under different cultivars (TMS 50395, 63397, 30555, 4(2)1425, and 30572 TMS 01/1371, TMS 01/1412, TMS 01/1368, TMS 07/593, TMS 07/539,) was introduced with singular characteristics of being resistant to cassava bacterial blight (CBB), cassava mosaic virus disease (CMD), cassava anthracnose disease (CAD), cassava mealybug (CMB) and cassava green mite, low in cyanide content, drought resistant, early maturing, and high yielding (NRCRI 2017). However, because of problem of identification and among others, TMS 30572, TMS 30555, and TMS 30211 were selected by the IITA and disseminated all over Nigeria in the 1980s (NRCRI, 2015; Otekunrin & Sawicka, 2019). The TMS 30572 variety was the most popular, especially among Nigeria farmers who process it into gari sale to urban markets (NRCRI, 2015, Nnadozie *et al.*, 2015). Also, in collaboration with Harvest Plus, IITA and NRCRI recently released six new bio-fortified yellow cassava varieties that are conventionally bred to have high beta-carotene content. The varieties were TMS 01/1371, TMS 01/1412, TMS 01/1368, TMS 07/593, TMS 07/539, NR 07/0220 with aim of addressing vitamin A deficiency in Nigeria (IITA, 2013; Ume *et al.*, 2020).

## 1.2 Efficiency

Efficiency is the relative performance of the processes employed in transforming given inputs into outputs (Maligina *et al.*, 2015). To Hazarika & Subramanian; (1998) efficiency is 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 could be attained by minimizing the resources necessary for producing a given output. Farrell (1957) identified three types of efficiency; allocative, technical and economic. Allocative efficiency refers to the choice of the best combination of inputs consistent with the relative factor prices. That is, it is the ability of a firm to use inputs in optimal proportions, given their respective prices (Mbanasor & Obiora, 2005; Yenibabit *et al.*, 2019). Technical efficiency according to Carlson, (1968) is the ability of firms to employ the 'best practice' in an industry, so that no more than the necessary amount of a given sets of inputs is used in producing the best level of output. Technical efficiency is the ability to minimize input use in the production of an output vector, or the ability to obtain maximum output from an input vector (Kumbhakar *et al.*, 2001). To Olayide & Heady (1982) technical efficiency is the ability of a firm to produce a given level of output with minimum quantity of inputs under a given technology. The technical efficiency of individual farmers according to Ogundari, (2014) and Asogwa *et al.*, (2011) refers to the ratio of observed output to the corresponding frontier's output, conditional on the level of input used by the farmers. Efficiency can as such be seen as a vital determining factor of productivity growth of an individual farmer. An important assumption underlying efficiency concept is that firms operate on the outer bound of production function (i.e., on their efficiency frontier). The product of technical and allocative efficiencies yields economic efficiency.

The technical efficiency which forms the onus of this study could be measured through parametric and non-parametric approaches (Srinivasulu *et al.*, 2015; Kyei *et al.*, 2011; Hazarika & Subramanian, 1998). Basically, non-parametric frontier technique has been fused into the Data Envelopment Analysis (DEA). Non-parametric frontiers do not impose a functional form on the production frontiers and do not make assumptions about the error term. These have used linear programming models to estimate firms' level of efficiency (Kyei *et al.*, 2011, Adetomiwa *et al.*, 2021). Parametric frontier approaches impose a functional form on the production function and make assumptions about the data (Olayide & Heady, 1982). Stochastic production frontier function is the most popular type of parametric function (Onumah *et al.*, 2013; Donkoh, *et al.*;2013).

The Stochastic frontier has atypical features as asserted by Tijani and Bakari (2014), Osun *et al.*, (2014) and Djokolo, (2015) of outlining the limit to a range of potential observed production levels and as well categorizes the extent to which the firm lies above or below the frontier. Second, it assumes that deviations of the observed output from the frontier could be linked to relatively due to random events (measurement errors and statistical noise) and firm specific inefficiency. Third, it makes allowance for stochastic errors due to statistical noise or measurement errors. Fourth, the stochastic frontier production function model has the benefit of letting simultaneous estimation of individual technical efficiency of farmers as well as determinants of technical efficiency. Here, the most commonly used stochastic production frontier functional forms is the Cobb-Douglas, constant elasticity of substitution (Udo. 2005; Onubuogu *et al.*, 2014; Ume *et al.*, 2016b) with Translog production functions less popular in efficiency measurement. Nevertheless, both Translog and Cobb Douglas have their merits and

demerits. For instance, Translog has merits of being rigid as it provides a local and second-order approximation to any function and good in estimating larger number of parameters. Nevertheless, the problem of multicollinearity among the regressors is very common with use of the function (Gani & Omonona, 2009; Iheke, 2006; Osun *et al.*, 2014). Cobb-Douglas on its own is a special form of the translog production function where the coefficients of the squared and interaction terms of input variables of translog frontier are assumed to be zero. Second, its coefficients directly represent the output elasticity of inputs and easy for interpretation and estimation than translog frontier (Coelli and Battese, 1998; Iheke, 2006, and Berhan, 2015).

The important of efficiency studies are well recognized in both developing and developed world (Haider *et al.*, 2011; Tijani & Bakari, 2014, Ogundari, 2014; Djokolo *et al.*, 2015). For this subject matter, efficiency study could aid in formulation of technical policies probable to improve producer efficiency and output, increase income through increased profit and reduction in poverty (Djokolo, 2015).

### 1.3 Empirical Framework of Application of Scholastic Frontier Production Function

Erhabor and Emokoro (2007) used stochastic frontier production Function to assess the comparative economic analysis of the relative technical efficiency of cassava farmers in the three agro-ecological zones of Edo State (Edo North, Central and South) using 156 cassava farmers. These farmers were selected using a multi-stage random sampling technique. The empirical estimates showed that individual technical efficiency values that ranged from 23 to 95%, 43 to 97% and 52 to 98% with a mean of 72, 83 and 91%, for Edo South, Edo North and Edo Central agro-ecological zones, respectively. The determinants of technical inefficiency in the three zones were, farmers level of education, age, farming experience and variety of planting materials used. Gender and family size were however, not found to be significant determinants of the technical inefficiency of cassava farmers in the State. As well, Ume *et al.*, (2017) conducted a study in Ivo Local Government Area of Ebonyi State, Nigeria to estimate costs, returns and technical efficiency of women cassava smallholder farmers using the Cobb-Douglas stochastic frontier production function using one hundred and twenty farmers(120).The results of the study show that level of education, farming experience and extension contact were positive and significantly related to technical efficiency, while credit access had inverse relationship with technical efficiency. The mean, maximum, minimum technical efficiency were 0.56; 0.97 and 0.23 respectively.

Also, Anyanwu *et al.*, (2014) employed stochastic frontier production function approach to analyze technical efficiency and determinants of technical inefficiency among smallholder cassava farmers in Rivers of Nigeria using 94 cassava farmers. The result of the study shows that age, household size and farming experience were the determinants of technical inefficiency among the farmers with mean technical efficiency of the farms of 70%.As well, the production elasticity estimates showed that the farmers were experiencing increasing returns to scale (1.27). Furthermore, Ogunniyi *et al.*, (2013) investigated the technical efficiency of cassava-based cropping in Oyo State of Nigeria. Information for the study were collected from a total of 253 cassava-based farmer using structured questionnaire and complimented with oral interview. Applying the Cobb- Douglas stochastic frontier production function, the study found that farm size was also found to be significant and positive in all the zones except in zone 4 where it was insignificant and negative. A s well, The estimated values of mean technical efficiency, gamma

parameter and return to scale (RTS) for the study area were 0.542, 0.814 and 0.54 respectively. Also, Isitor *et al.*, (2017) investigate the factors affecting technical efficiency of cassava production among smallholder farmers in Anambra State, Nigeria during the 2013/2014 planting season. Herein, stochastic frontier production function approach was used to estimate the level of production efficiency. The finding of work shows that the technical efficiencies of the farmers were found to be low with an average of 51.5% which implies that average cassava output fell short by 48.5% of the maximum possible level. It is also found that the level of efficiencies is significantly and positively correlated with education and access to credit. More so, Osun *et al.*, (2014) examined resource use efficiency of cassava farmers in order to provide empirical guide to competitive cassava production in Nigeria using stochastic production frontier approach. Technical efficiency scores range from 41.90 to 97.34 percent with an average score of 90.35. The coefficients of age, education, gender, use of herbicides, use of fertilizer and access to extension services are negatively and significantly related to technical inefficiency. While age squared is positively related to inefficiency. About more than 80 percent of the farmers have technical efficiency scores greater than 0.7, which is a strong indication that majority of the farmers are quite efficient at the present level of technology.

## 2.0 Materials and Methods

### 2.1 Study Area

The study was carried out in Ebonyi State of Nigeria. The State is one of the five States in the South East geopolitical zone in Nigeria. It is located between latitude  $5^{\circ}41'$  and  $6^{\circ}50'N$  of Equator and Longitude  $5^{\circ}25'$  and  $7^{\circ}30'E$  of Greenwich Meridian. Its rainfall ranges from 1500 mm-2500 mm per annum, temperature of  $28-48^{\circ}C$  and average relative humidity of 75% (Ume *et al.*, 2021). It is bounded in the North by Benue State, South by Abia State, in the East by Cross River State and in the West by Enugu State. Ebonyi State is made up of 13 local government areas and three Agricultural zones namely North, Central and South. The North agricultural zone consists of four local government areas: Abakaliki, Ebonyi, Izzi and Ohaukwu. The Central Agricultural zone has four Local Government Areas: Ezza North, Ezza South, Ikwo and Ishielu, while the South agricultural zone has five local government areas: Afikpo North, Afikpo South, Ivo, Ohaozara and Onicha (Ume *et al.*, 2014). The inhabitants of the area are Igbos and speak Igbo language. Ebonyi State has very rich loamy soils that are capable of sustaining production of crops and animal, hence agriculture is the mainstay of the people. Among the crops planted there are cassava, yam, sweet potato, rice, maize and tomato. Also, among the domestic animals reared are goat, sheep, local cow, poultry, rabbit, piggery and others (Ume *et al.*, 2020). The inhabitants also engaged on off-farm income such saloon, petty trading, auto-mechanics, civil servants and brick layers.

### 2.2 Sampling Procedure and Sample Size.

In the first stage, two (2) Agricultural zones out of three (3) were purposively selected. The choices was based on the fact that the zones are known for high production of TMS cassava varieties production. The selected zones were Ebonyi Central and South agricultural zones. In the second stage, three (3) Local Government Areas were selected randomly from each of the Agricultural Zones. These brought to a total of six (6) Local Government Areas (LGAs). In the third stage, two (2) communities were randomly selected from each of the six LGAs, totaling twelve (12) communities. Finally, ten(10) TMS cassava farmers were randomly selected from



the list of the farmers provided by the extension agents residing in the area from each of the communities. This brought to a total of one hundred and twenty (120) respondents for detailed study.

### 2.3 Method of Data Collection and Analysis

In this study, primary data were collected using questionnaire and complimented with oral interview. The descriptive statistics were used to achieve objectives i and the stochastic frontier based on Cobb Douglas production specification was used to address objectives ii.

## 2.4 Model Specification

### 2.4.1 Stochastic Frontier Model

This study applied stochastic frontier production function model developed by Aigner, *et al*; (1977) and Meeusen & Van den Broeck (1977) which is stated as follows:

$$Y_i = (X_i, \beta)\epsilon, i = 1, \dots, N \dots\dots\dots(1)$$

where:

$Y_i$  is the total output produced by  $i$ th TMS cassava farmer,  $X_i$  is the vector of inputs used by  $i$ th maize farmer, and  $\beta$  is a coefficients or vector of parameters estimated, wherefore  $\epsilon$  is the stochastic error term, which is decomposed into:

$$[\epsilon = v_i - u_i] \dots\dots\dots(2)$$

where:

$v_i$  is the random constituent of the factors which are outside the control of the TMS cassava farmer, and the exogenous variables that were not included in the model and is assumed to be independently and identically distributed

$v_i$  is normally distributed and independent of  $u_i$ , and

$u_i$  is the random variable that represent technical inefficiency in the production function model which is assumed to be independently distributed, and normally distributed with mean  $u_i$  and variance  $(N(u_i, \sigma^2))$ .

Technical efficiency is stated thus:

$$TE = Y_i^*/Y_i \dots\dots\dots(3)$$

$$TE = \frac{\log Y_i = \beta_0 + \sum_{i=1}^6 \beta_i \ln X_i + \dots \beta_n \ln X_n + V - U_i}{\log \beta_0 + \sum_{i=1}^6 \beta_i \ln X_i + \dots \beta_n \ln X_n + V_i} \dots\dots\dots(4)$$

where:

$TE$ = Technical efficiency.  $Y_i$ = Yield of TMS cassava observed.

$Y_i^*$ = Frontiers yield of TMS cassava.

The inefficiency effects suggested by Aigner *et al.*, (1977) and Idris *et al.*, (2015) is stated as thus:

$$ui = zi\delta + wi \dots\dots\dots(5)$$

$$TEi = 1 - \frac{Yi}{Yi^*}$$

Where;

$zi$  is the vector of exogenous or explanatory variables included in the technical inefficiency model,  $\delta$  represent the vector of unknown parameters to be estimated, and  $wi$  refers to unobserved random variables, and are assumed to be identically distributed (Idris; *et al*;,2015).  $TEi$  is technical inefficiency of the  $i$ th small-scale cassava farmer and it ranges from 0 and 1. The variance parameters can be estimated as follows:

$$\delta s_2 = \delta v_2 + \delta_u \text{ and } y = \delta u_2 \delta s_2 \dots\dots\dots(6)$$

where,  $0 \leq \gamma \leq 1$  the value of  $\gamma$  lies between 0 and 1, which represent the level of technical inefficiency?

$\gamma=0$  signifies no technical inefficiency in the production model (Getachew & Bamlak, 2014)

The Stochastic Frontier (Cobb Douglas Production Function) Model is stated thus:

$$Yi = (Xi, \beta) + \epsilon i \dots\dots\dots(7) \quad Y =$$

$$(X_1, X_2, X_3, X_4, X_5, V - Ui) \dots\dots\dots(8)$$

$$\ln Yi = \beta_0 + \sum \beta_i \ln i = 1 \ln Xi + \dots \beta_n \ln Xn + V - Ui \dots\dots\dots(9)$$

The implicit function is stated thus:

$$\ln Yi = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + Vi - Ui \dots\dots(10)$$

where:

$\ln Yi$ = Output of TMS cassava (Kg).

$x_1$  = Farm size (ha),  $x_2$  = Labour (manday),  $x_3$  = Cassava stem cutting (bundles),

$x_4$  = Fertilizer (kg),  $x_5$  = Capital (₦),  $X_6$ ; Depreciation (₦)  $x_1 - x_5$  = independent variables, while  $e_1$  was the error term and  $b_0$  was the coefficient.

The technical inefficiency component of the Stochastic Frontier Model is stated thus:

$$Ui = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 \dots\dots\dots(11)$$

where:

$Ui$  = technical efficiency of the  $i^{\text{th}}$  famer,

$z_1$  = age of the farmer (Years),  $z_2$  = level of education (Years),  $z_3$  = household size (No),  $z_4$  = farming experience (Years),  $z_5$  = farm size (ha),  $z_6$  = extension contact (No),  $\alpha_0$  = constant,  $\alpha_1 - \alpha_7$  = coefficients to be estimated.



### (2.4.1) Elasticity of Production(EOP) and Return to Scale

The elasticity of production is a concept that measures the degree of responsiveness of output to changes in input. It measures the proportionate change in output as result of a unit change in input. The estimates for the parameters of the stochastic frontier production are the direct elasticity's of production for the various inputs, given the Cobb Douglas specification of the model (Hazarika & Subramanian, 1998)

To estimate RTS ( $\nu$ ) = the summation of the coefficient,  $\beta_i$

When  $\nu > 1$  (increasing return to scale);  $\nu < 1$  (decreasing return to scale)

$\nu = 1$  (constant return to scale)

## 3.0 Results and Discussion

### 3.1 Socio-Economic Characteristics of the cassava Farmers

Table 1 reveals that 52.5% of the respondents were less than 40 years of age, 47.5% were above 40 years of age. The respondents had mean of 42.5, implying that most of the farmers studied were within the economically active age. Youthful farmers as asserted by Udoh, (2005) are often active, energetic, more productive and progressive, hence more willing to adopt new practices leading to higher efficiencies in crop production. Moreover, 79.2% of the farmers were married, 1.67% were divorced, while 19.17 % were single. Married people according to Asogwa *et al.*, (2011) and Ume *et al.*, (2016a) are often saddled with responsibilities of taking care of household members, thus could be eager to take measures to boost their farm output through efficiency in resource use, for instance. In addition, majority (65%) of the farmers had household size of 6 – 10 people, 30%; 1 -5, while the least (5%) had household size range of 16 – 20. The mean of family size of farming household was 6.7. It is important to state that household heads, especially among peasant farmers in Africa, Southeast Asia and Caribbean use household members as source of cheap labour especially during peak of farming when hired labour is scarce and expensive to procure (Abdulai *et al.*, 2013; Osun *et al.*, 2014). Okoronkwo *et al.*, (2017) reported that smallholder farmers use family labour to increase their farmland in order to rip utmost gains of economic scale. Several studies (Asogwa *et al.*, 2011; Tijani & Bakari, 2014; Ume *et al.*, 2016a) concurred to importance of family labour in adoption of labour-intensive agricultural technologies. Moreover, majority (58.5%) of the farmers cultivated farm size less than 2.01hectares, while 41.5% cultivated above 2.00 hectares. The average hectare of land cultivated by the farmers was 1.45. This inferred that the production of the cassava variety in the study area is still at small scale level. Literatures show that such class of farmers (small holder farmer) is known to be efficient in resource use compared to large scale farmers (Gani & Omonona, 2009; Mal & Aboue, 2013). Furthermore, 26.7% of the respondents had years of farming experience of less than 11, while 73.3% had above 11 years. The average farming experience of the farmers was 7.2, indicating that most of the cassava farmers were not novice in the business. Kaine *et al.*, (2015) reported that the more the number of years of farming experience a farmer acquires, the more efficient in resource use he or she has compares to less experienced farmers. Furthermore, only 44.3% of the respondents had contacts with extension agents, while the greater majority (56.7%) had not. Extension agents aids in boosting farmers' efficiency in resource use through information dissemination as well, through giving technical assistants to farmers in a given technology (Djokolo, 2015). Also, 10 % of the respondents had no formal education, while 90% had access. The farmers had mean educational level of 6.2, indicating that most of the farmers studied had primary education. Education helps to unlock the

natural talents and inherent enterprising qualities of the farmer, hence increasing their technical efficiency (Kehinde *et al.*, 2011). The result is presented in Table 1 below

**Table 1: Socioeconomics Characteristics of the Respondents**

Socio-economic Variables	Frequency	Percentage
<b>Age</b>		
20 – 29	23	19.2
30 – 39	40	33.3
40 – 49	32	26.7
50 – 59	14	11.7
50 – 59	14	11.7
60 and Above	11	9.2
Mean	42.5	
Total	120	100
<b>Household Size</b>		
1-5	36	30
6-10	78	65
11-15	6	5
Mean	6.7	
Total	120	100
<b>Farm Size(Hectares)</b>		
0.01-1.00	40	33.3
1.01 – 2.00	30	25
2.01 – 3.00	18	15
3.01 – 4.00	15	12.5
4.01 – 5.00	12	10
> 5.00	5	4.2
Mean	1.45	
Total	120	100
<b>Farming Experience (Years)</b>		
1 – 5	10	8.33
6 – 10	22	18.33
11 – 15	40	33.34
16 – 20	30	25
21 and above	18	15
Mean	7.2	
Total	120	100
<b>Extension Services (Dummy)</b>		
Access	52	44.3
No Access	68	56.7
Total	120	100
<b>Educational Level</b>		
0	12	10
1-7	50	41.67
7-12	40	33.33
13-18	18	15
Mean	6.2	
Total	120	100

*Source; Field Survey, 2020*

### 3.2 Estimation of Technical Efficiency

The technical efficiency of cassava farmers was analyzed using Cobb Douglas functional forms of stochastic frontier production. Table 2 shows the Cobb Douglas production functions result.

**Table 2: Maximum Likelihood Estimation of the Cobb Douglas Stochastic Production Function**

Production Factor	Parameter	Coefficient	Standard Error	t-value
Constant	$\beta_0$	8.164	1.924	4.243***
Farm size	$\beta_1$	1.608	1.725	0.932
Cassava Cutting	$\beta_2$	0.764	0.247	3.093***
Labour input	$\beta_3$	4.337	1.376	3.152***
Fertilizer used	$\beta_4$	0.908	0.218	4.165***
Depreciation	$\beta_5$	-0.231	0.222	-0.961
<b>Efficiency factor</b>				
Constant	$\sigma_0$	0.668	0.048	13.917***
Age	$\sigma_1$	-0.0408	0.285	-1.720
Educational level	$\sigma_2$	0.972	0.263	3.696***
Household size	$\sigma_3$	0.418	0.207	2.019**
Farming experience	$\sigma_4$	0.844	0.430	1.923
Farm size	$\sigma_5$	0.039	0.012	3.25**
Extension services	$\sigma_6$	-0.423	0.877	-1.482*
Credit access	$\sigma_7$	-0.512	0.452	-1.133
Membership of organization	$\sigma_8$	0.517	0.602	0.859
Marital status	$\sigma_9$	0.774	0.855	0.905
<b>Diagnostic statistic</b>				
Total variance	$(\sigma^2)$	1.4437	0.3021	4.779***
Variance ratio		0.9825	0.0025	393.000***
Likelihood ratio test		325.1171		
Log-likelihood	463.74			

**Source: Field Survey, 2020**

**Note:** \*\*\*, \*\*, \* indicate statistically significant at 1.0, 5.0, and 10.0 percent respectively.

Table 2 shows the results of maximum likelihood estimate of the Cobb-Douglas production function shows that the diagnostic statistics had coefficients that were all statistically significant at 1.0 alpha level. The coefficient of total variance ( $\sigma^2$ ) was 1.4437, while the variance ratio was 0.9825. This could imply that 98.3% in the variation in output among the TMS cassava farms was due to the differences in technical efficiency. The log likelihood function was 463.74. The results indicated that the three significant variables in this model were cassava stem cuttings, quantity of fertilizer used and labour input. The coefficient of cassava stem cuttings (0.764) was positive and inelastic. This implies that increasing the cassava stem cuttings by one kilogram will bring about 76.4% increases in output of the cassava farmers in the area. Equally, the quantity of fertilizer used by farmer (0.908) had direct correlation with technical efficiency. The implication is that increasing the quantity of fertilizer used will increase output by 90.8%. The positive sign of the coefficient of fertilizer disagreed with the works of Kolapo *et al.*, (2020). They cited high

cost of fertilizer at farm level as a limiting factor to its use by most poor resourced farmers. Fertilizer encourages production intensification, intensifies productivity per unit land and could consequently curtail pursuit for more land expansion. The use of fertilizer could boost net-income from cassava farming (FAO 2020). Also, for labour input, the coefficient was positive and inelastic. The result shows that an additional increase to the total number of labourers used in the cassava production by a labourer, increased technical efficiency of the respondents by 43.7%. Ume *et al.*, (2020) found a negative relationship between labour and technical efficiency. They remarked that paucity of farm lands in their study area, explained the need for reduction in labour use.

As expected, the coefficient of household size was positive and statistically significant at 5% as shown in Table 2. A unit increase in the number of household size of the smallholder improved cassava farmer could led to 0.41.2% increase in the level of technical inefficiency. The implication is that as the farmer's number of household members increases, their inefficiency in improved cassava production also decreases. In contrary, Yenibahit *et al.*, (2019) found indirect relation between family size and technical efficiency. The negative sign identity of coefficient of household size could suggests that farmers with small family sizes tend to be more technically efficient than those with larger farm sizes. This may perhaps be as result of the fact that as large household size has attainment of food security as their major precedence, the likelihood of some of the household members engaging in non-farm activities to the detriment of cassava production cannot be ruled out completely. This could lead to lesser technical efficiency (Djokolo, 2015). Additionally, the use of large number of family labour on small sized farm according to Kehinde *et al.*, (2012) would result in over-utilization and hence inefficiency.

Moreover, the result in the Table 2 indicates that the number of years spent in schooling was significant at 1% and showed a direct relation with technical inefficiency. This means that an increase in the number of years of farmers' schooling, the higher the odds of decreasing the technical inefficiency (TE) level in improved cassava production. Educational attainment has a positive sign, suggesting that an increase in years of formal education reduces the likelihood or probability of a cassava farmer to be technically efficient. This implies that inefficiency increases with increase in educational attainments (Gani & Omonona, 2009). Furthermore, formal education enhances farmers' efficiency through according to Kehinde, "*et al.*"(2012) providing reading and writing skills, exposure to practices that could enhance production outcomes, able to read instructions on farm supplies (such as fertilizer, pesticides and among others) and opportunity to read extension bulletins. However, the finding of Yenibehit *et al.*, (2019) showed negative relationship between education and technical inefficiency in their study. The preference of most educated people for 'white collar' job to farming could be responsible for the negative sign identity of the variable (Djokolo, 2015; Tesfaye *et al.*, 2015).

Additionally, access to extension services was negatively and statistically significant at 10%. The coefficient of access to extension services was -0.483 and the negative sign signifies decrease in inefficiency. This means that access to extension services increases technical efficiency among the farmers. The poor extension outreach to farmers and wide extension agents-farmers ratio could be related to the negative sign of the coefficient of extension services as shown in Table 2. The negative sign of the coefficient of the variable concurred with the findings of Edet & Nsikak, (2007) and Malinga, *et al.*, (2015), however contrary to the submission of Kyei *et al.*,

(2011) and Adetomiwa, *et al.*; (2021). They opined that farmers' access to extension services will lead to ease of accessibility to information on agricultural innovations and technical assistants, thus increasing their (farmers') efficiency (allocative and technical efficiencies) and enhanced farm outputs.

As well, in line with *a priori* expectation, the coefficient of farm size was statistically significant at 5% and positively influenced the level of technical efficiency in improved cassava production. The positive relationship between farm size and technical efficiency could be deduced from the fact that the larger the farm size, the higher the level of output maximization, thereby, reducing the difference between the frontier output and the observed output (Adbai & Owusu, 2014).

### 3.2.1 Technical Efficiency Indices of Cassava Farmers

The frequency distribution of technical efficiency of farmers engaged in the improved cassava production is presented in Table 3

**Table 3: Distribution of Technical Efficiency Index**

Technical Efficiency Index	Frequency	Percentage
0.00 – 0.20	15	12.5
0.21 – 0.40	11	9.17
0.41 – 0.60	30	25.00
0.61 – 0.80	55	45.83
0.81 - 1.00	9	7.5
Maximum Technical Efficiency	0.95	
Minimum technical efficiency	0.23	
Mean technical efficiency	0.56	
Mean of the best 10	43.4	
Mean of the worst 10	75.8	

**Source: Computed from Field Survey, 2020**

Table 3 indicates that the improved cassava farmers had mean efficiency of 56%, which implies that there was a large scope for increasing cassava production by 44%, by adopting the techniques and technology employed by the best practice cassava farmers. According to Udoh, (2005) and Osun *et al.*, (2014), farmers who had efficiency values above the mean score were frontier farmers, while those who had values below it were non-frontier farmers. As such, the percentage of the frontier farmers was 59.76 percent, while non-frontier cassava producers represented 38.39 percent. The implication of the result was that the average cassava farmer required 41.1% cost saving to attain the status of the most efficient cassava farmer as sampled best ten category, while the least performing farmer needed 75.8% cost saving to become the most efficient cassava producer among the worst 10 sampled farmers.

### 3.2.2 Elasticity of Production ( $E_P$ ) and Return to Scale

The elasticity of production is a concept that measures the degree of responsiveness of output to changes in input. It measures the proportionate change in output as result of a unit change in input (Mbanasor & Obiora, 2005). The estimates for the parameters of the stochastic frontier production are the direct elasticity of production for the various inputs, given in the Cobb

Douglas specification of the model (Hazarika & Subramanian, 1999). The sum of the production elasticity is presented in Table 4.

**Table 4: Elasticity of Production and Return to Scale**

Inputs	Elasticity
Farm size	1.648
Planting material	0.704
Labour	4.238
Fertilizer	0.900
Depreciation	-0.441
Sum of elasticity	7.049

**Source: Computed from Table 10**

Table 4 shows that the inputs of farm size (1.648), fertilizer (0.900) and planting material (0.704) had the highest elasticity of production. This implied that they contributed most to farm returns when compared to the other inputs such as labour (-4.238) and depreciation (-0.441). For instance, given the result in this Table, a change in the size of farm land by 1 unit brought about a change in the same direction of 1.648 units in the output of cassava farmers. In the same way, a change of 1 unit in the capital employment brought a change in opposite direction of -0.441 in the output of cassava. The sum of production elasticity was 7.049, indicating an increasing return to scale. The implication is that the sampled farmers in the study area were in stage I of the production phase of production function. In this stage of production, addition of extra unit of input could result in more increase in output compare to the preceding output as result of input added. Hence, the cassava farmers in the study area were under-utilizing their farm inputs, therefore needed an overall increase in the level of their current input employment to achieve technical efficiency.

#### 4.0 Conclusion and Recommendation

Based on the study, the following conclusions were deduced; results of the socioeconomic characteristics showed that majority of the respondents were females, youthful, married, educated, moderate household size, experienced and had access to credit. Furthermore, the determinant factors to technical efficiency of TMS cassava varieties were level of education, household size and farm size..

Based on the findings, the following recommendations were proffered

- (i) The positive influence of education on farmer's efficiency has been noted, in this direction, there is need to strengthen the current policies on education such as the universal basic education, adult education and nomadic education. Furthermore, policies aimed at improving farmer's access to education through aggressive awareness campaign and mass mobilization are needed. (i)Extension agent should help in training the cassava farmers on improved production management and to enable them to use the available resources efficiently.
- (ii) Farm size was found to have positive influence on efficiency. It becomes imperative that the land use Act of 1990 be reviewed to eliminate difficulties associated with land acquisition for agricultural purposes for genuine farmers.

- (iii) Farmers with large household size should be encouraged to be actively involved in adoption of technologies since large household size would provide the much needed labour requirements in cassava production activities at low cost, compared to hired labour.

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