

# **EFFICIENT MANAGEMENT OF RESOURCE UTILIZATION IN CASSAVA PRODUCTION IN A FRIENDLY POLICY ENVIRONMENT: IMPLICATIONS FOR CASSAVA PRODUCTION IN NIGERIA**

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## **Abstract**

This study examined efficient farm management in a friendly policy environment and its implications for agricultural production in Nigeria using the cassava industry as a case study. Data were collected from randomly sampled 360 cassava farmers in Benue State. In-depth analysis of data collected was done using the stochastic frontier production function model. The result of the stochastic frontier production model indicated that government policy which favoured increased input use in cassava production in Nigeria resulted to more than proportionate increase in cassava output in Nigeria. The policy packages on cassava resulted to efficient utilization of production resources in cassava production in Nigeria, and hence profit maximization by the farmers. Technical efficiency in cassava production in Nigeria could be increased by 24% through better use of available resources given the current state of technology – via farmer-specific factors, which included access to improved cassava varieties, access to improved cassava processing technology, access to available cassava markets, access to improved extension services and agricultural credits. Moreover, 98% of the variations in input among the farms were due to differences in technical efficiency occasioned by differences in the relative access of cassava farmers to the cassava policy packages.

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**Keywords:** efficient farm management, friendly policy environment, agricultural production, cassava industry, Nigeria

## **1.0 Introduction**

### **1.1 Background of the Study**

Following the radical reorientation of agricultural policy during the SAP years, beginning in the mid-1980s, cassava emerged as an important crop in the national effort to replace imported foods with domestic production. In 1984, the National Coordinated Research on Cassava Project (NCRCP) was set up to coordinate the on-farm adaptive research on cassava by the NAFPP, ADP, research institutes, and universities. In 1985, the ADPs were established in cassava-producing states to carry out on-farm evaluation of new technologies including the TMS varieties, construct roads for input delivery and output evacuation, provide extension services to farmers, as well as multiply and distribute the TMS stem cuttings and seeds of other crops.

According to Abdullahi (2003), the policy direction encouraged cassava development leading to a new orientation in research-extension-farmers linkage, especially in the IFAD-assisted Cassava Multiplication Programme (CMP); and subsequently in the Roots and Tubers Expansion Programme (RTEP) (Dambatta, 2004). Under the Roots and Tubers Expansion Programme, the cultivation of cassava, yams, sweet potatoes, Irish potatoes and cocoyam would be enhanced through the introduction of improved seedlings, relevant chemicals, better farming techniques and other wider forms of extension services (IFAD, 1999; Dambatta, 2004; PME, 2004). The Federal Government of Nigeria signed a loan agreement for the sum of US \$23 million with IFAD, Rome, in July 2001 and the loan disbursement to agencies had commenced (FRN, 2000; Dambatta, 2004; PME, 2004).

In view of the growing favourable policy intervention of government in the cassava sub-sector in Nigeria, it has become necessary to evaluate government agricultural policies' effects on resource-use in cassava production. For Nigeria, raising productivity per area of land is the key to effectively addressing the challenges of achieving food security. This is pertinent as most cultivable land has already been brought under cultivation. More so, in areas where wide expanse of cultivable land is still available, physical and technological constraints prevent large-scale conversion of potentially cultivable land (Ajibefun, 2002).

However, policy that can enhance resource-use efficiency of the farmers in farm production is pertinent to effectively raising productivity, and hence addressing the challenges of achieving food security in Nigeria. From available literature, a number studies have been carried out on resource-use efficiency of farmers in farm production in Nigeria (for example, Ajibefun, 2002; Lawal, 2002; Ajibefun and Daramola, 2003; Ater, 2003). However, only very little empirical literature exists on the policy options for raising farmers' resource-

use efficiency in agricultural production in Nigeria. This paper, therefore, provides a useful empirical guide on the policy options for raising farmers' resource-use efficiency in agricultural production using the cassava industry in Nigeria as a case study.

## **1.2 Objective of the Study**

The broad objective of the study is to examine efficient farm management in a friendly policy environment and its implication for agricultural production using the cassava industry in Nigeria as a case study. The specific objectives of the study are to:

- i. determine the effect of the policy packages on resource-use in cassava production in Nigeria;
- ii. analyze the effect of resource-use on the cassava output of the cassava farmers in Nigeria; and
- iii. assess the technical efficiency of the cassava farmers in Nigeria.

## **1.3 Statement of Hypotheses**

The following null hypotheses were stated and tested:

- i. Resource-use of the cassava farmers in Nigeria has no significant effect on their cassava output;
- ii. The government policy packages on cassava have no significant effect on the efficiency of resource-use of the cassava farmers in Nigeria;
- iii. inefficiency effects among the cassava farmers are not a linear function of the government policy packages on cassava;
- iv. The Stochastic frontier production function is not an adequate representation of the model for the farm data collected on the cassava farmers in Nigeria; and
- v. Cassava farmers in Nigeria are not technically inefficient.

## **2.0 Theoretical Framework**

As a study on agricultural policy and resource-use in the cassava industry, the theoretical foundation of this study was based on the relationship between cassava output (productivity), resource-use efficiency and government agricultural development policy packages on cassava. The more friendly the agricultural policy on cassava, the more efficient (productive) the cassava farmers would tend to be in resource-use, and the more output that would be obtained and hence more income that will be realized (all things being equal) and consequently less poverty for the farmers. Therefore, very favourable agricultural policy on

cassava would make cassava farmers to be highly productive and efficient in the use of resources in cassava production and hence they are most likely to obtain higher output, and consequently higher incomes and therefore less poverty for them. This would lead to further development of the cassava sub-sector and Nigerian agriculture as a whole.

According to Ajibefun and Daramola (2003), increasing growth in the agricultural sector (of the economy) is the most efficient means of alleviating poverty and generating long-term sustainable development among the farming households in Nigeria. Resources must be used much more efficiently, with more attention paid to eliminating waste. This will lead to an increase in productivity and incomes. The success in achieving broad-based economic growth will depend largely on the ability to efficiently utilize the available resources.

On the other hand, the farm level efficiency of the farmer can be constrained by limited access to production resources. Reddy *et al.* (2004) observed that greater efficiencies in the use of resources are associated with the large farms than the small farms. They pointed out that the smallness of holdings deters the use of mechanization and does not allow the use of modern inputs due to lack of purchasing power in the hands of small farmers. This is the reason for the assertion of Desli *et al.* (2002) that in reality, small scale producers are not always efficient. According to Desli *et al.* (2002), two otherwise identical firms never produce the same output, and costs and profit are not the same. This difference in output, cost, and profit can be explained in terms of efficiency, and some unforeseen exogenous shocks.

Policies on cassava are captured through links to agricultural innovations in the cassava sub-sector arising from the government agricultural development policies focused on cassava. Thus, the farm level efficiency of the farmer can be influenced by the government agricultural development policy (which influences access to production resources) and other exogenous shocks. Hence, the input expansion (input supply) policy of the government in the cassava sub-sector (which increases the availability of production resources to farmers) can lead to efficient use of resources in cassava production and brings about improvement in the profitability of cassava production. This is because the cassava farmers through the input expansion policy of government would be able to expand their resource-use in production and hence be able to move production level from the inefficient production phase of increasing return to scale to the efficient production phase of decreasing return to scale where profit can be fully maximized.

### **3.0 Methodology**

#### **3.1 The Study Area**

Benue State derives its name from River Benue, the second largest River in Nigeria. The State, created in 1976, is located in the middle Belt region of Nigeria, approximately between latitudes  $6\frac{1}{2}^{\circ}$  and  $8\frac{1}{2}^{\circ}$  N and longitude  $7\frac{1}{2}^{\circ}$  and  $10^{\circ}$  E.

The State shares boundaries with five states namely, Nasarawa to the North, Taraba to the East, Cross River to the South-East, Enugu to the South- West, and Kogi to the West. The Southern part of the State also shares boundary with the Republic of Cameroon. The State is also bordered on the North by 280 km River Benue, and is traversed by 202 km of River Katsina-Ala in the inland areas.

The State has a total land area of about 30,955 square kilometers and administratively it is divided into 23 Local Government Areas. Benue State has an estimated population of 2,780,398, and is made up of 413,159 farm families (National Population Commission, 1991b; Crop Area and Yield Survey, 1998).

Benue State has a tropical climate, which manifests two distinct seasons. The rainy season is from April to October while the dry season is from November to March. Annual average rainfall varies from 1750 mm in the Southern part of the State to 1250 mm in the North. In the mountain region of Kashimbia area average rainfall rises up to 400 mm. The hot season comes in mid April with temperatures between  $32^{\circ}$  C and  $38^{\circ}$  C with high humidity. The State stretches across the transition belt between the forest and savanna vegetations. Much of the area consists of undulating hills or grassy open space on the North and derived Savanna in the South.

Benue State is referred to as the Food Basket of Nigeria because of the abundance of its agricultural resources. About 80% of the State population is estimated to be directly involved in semi-subsistence agriculture. The State is a major producer of food and cash crops like cassava, yams, rice, benniseed and maize. Others include sweet potato, millet and a wide range of other crops like soyabeans, sugar cane, oil palm, mango, citrus and bananas.

Nigeria has 3.5 million hectares of cassava land across the country (Eno, 2004). Benue State has a total land area of 310 million hectares, and agricultural land is estimated to be about 180 million hectares or more than 58% of the total land area (BMANR, 2003). At present only about 138 million hectares is used i.e. more than 76% of the cultivable land (BMANR, 2003).

Nigeria is the largest producer of cassava tuber in the World with an estimated production figure of 40 million metric tons of cassava tubers per annum (Eno, 2004) and

Benue State is a leading producer of cassava in Nigeria, accounting for more than 8.87% of the total cassava output in Nigeria (BMANR, 2003). Apart from the ecological support for cassava growth and population, Benue State has mounted deliberate strategies such as distribution of improved varieties to sustain its leading role in cassava production in the country (BMANR, 2003).

While different varieties of cassava can be adequately grown across the State, some Local Government Areas like Logo, Ukum, Katsina-Ala, Gboko, Buruku, Agatu, Otukpo, Okpokwu and Ohimini, as well as Ado, Konshisha and Vandeikya are blessed with additional advantages in terms of ecological adaptation to the production of the crop (BMANR, 2003; PFD, 2004). The Benue State Agricultural Development Programme (ADP), Benue State Agricultural and Rural Development Authority (BNARDA), benefited from IFAD loan, which became effective in 1987 but closed June, 1997 (PME, 1996; PME, 2004). Benue State government took another loan as a follow up from IFAD, the Roots and Tuber Expansion Programme (RTEP), which became loan effective in July, 2001 and disbursement effective July, 2002 (PME, 2004).

### **3.2 Sampling Technique**

It was reliably gathered from BNARDA that there are 4,013 cassava farmers in Benue State. Only 75 percent (3010 cassava farmers) of this population has benefited from the IFAD-assisted cassava multiplication programme (PME, 1996), and Roots and Tubers Expansion Programme (RTEP) (PME, 2004). Since it was impractical and uneconomic to obtain information from the entire population, a sample of the population was used for the study.

There is no simple answer to the question of how large a sample must be to be representative of the population or to provide the desired level of confidence in the results. According to Winner and Dominick (1983), sample size is almost invariably controlled by cost and time. They opined that the general rule is to use as large a sample as possible within the economic constraints of the study. Eboh (1998) pointed out that the factors that make for a feasible sample size are especially related to logistics and resources availability such as funds, competent personnel, time factor, transportation facilities etc. Considering these factors together with the population size of the study area, a sampling proportion of about 12 percent was taken for the study.

Benue State is divided into three agricultural zones namely, Zone A, Zone B and Zone C. Using a combination of purposive and random sampling techniques, a total of nine Local

Government Areas were selected for the study under the guide of ADP workers in BNARDA. Particularly, areas that apparently have benefited from the IFAD-assisted Cassava Multiplication Programme (CMP) and other government policy interventions focused on cassava such as Roots and Tubers Expansion Programme (RTEP) were selected for the study using a purposive sampling technique. From each Zone, three Local Government Areas were selected using randomized sampling design in the first phase multistage sampling design.

From each of the nine selected Local Government Areas in Benue State, two communities that typify the State in terms of cassava production were drawn employing a randomized sampling design. Finally, from each community, households were randomly selected on the basis of the community's population size using an appropriate sampling fraction in order to make the sampling design to be self-weighting thereby avoiding sampling bias (Eboh, 1998). Based on the foregoing, 360 farm households were randomly selected from the communities for the study.

### **3.3 Data Collection**

Data were collected mainly from primary sources. Primary data for the study were generated through the use of a structured questionnaire, copies of which were administered to the 360 cassava farmers selected for the study in the study area. This sample was randomly drawn from the nine Local Government Areas (Logo, Katsina-ala, Ukum, Gboko, Tarka, Buruku, Otukpo, Okpokwu and Ohimini) that were selected for the study.

### **3.4 Validation of Instrument**

Content validity was used to measure the adequacy of the instrument items in this study. Content validity in this context sought to determine the relevance and adequacy of items included in the instruments. Using the Jury Method (Kerlinger, 1973) the entire instrument was subjected to the scrutiny of relevant experts. Each of the experts was requested to independently give his expert opinion on the relevance and adequacy of the items with respect to the objectives of the study. Various items of the data collection instrument were scrutinized in terms of how relevant they are to the study. Furthermore, the data collection instrument was examined against the background of its adequacy in regard to the accomplishment of the objectives of the study.

### **3.5 Instrument Reliability Test**

An instrument is considered reliable when it consistently produces the same result when applied to the same sample many times. The test-retest method of affirming instrument reliability was employed for this study. It was computed by calculating the correlation coefficient between two distributions of test scores obtained at two different times on the same respondents. The instrument was administered on 20 respondents drawn from two communities in Otukpo Local Government Area viz Otukpo-icho and Adoka at interval of 2 weeks. Product-moment correlation coefficients ( $r$ ) of 0.990, 0.999 and 0.994 were respectively obtained for sections A, B and C of the instrument. The mean of 0.994 indicated high reliability.

### **3.6 Method of Data Analysis**

Descriptive and inferential statistics were adopted for data analysis. The descriptive statistics include frequency distribution, percentages, as well as mean, minimum and maximum. Inferential statistics such as the stochastic frontier production function was used for an in-depth analysis of data gathered for the achievement of the specific objectives. Hypotheses i, ii, iii and iv were tested using the Generalized likelihood-ratio tests while hypothesis v was tested using t-test analysis.

### **3.7 Model specification**

#### **3.7.1 Resource and Policy Linkage Equation**

The policy structure of the model is embedded in equations linking cassava output to resources (inputs) on one hand and cassava output to inefficiency model on the other hand. In the inefficiency model, inefficiency effects is linked with the policy packages on cassava (improved cassava variety, improved cassava processing technology, improved market access and improved extension services).

Policies on cassava are captured through links to agricultural innovations in the cassava sub-sector arising from the government agricultural development policies focused on cassava (which for the purpose of this study, includes the development of improved cassava varieties, the development of improved cassava processing technologies, the development of improved market access and the provision of improved extension services). For this exercise, only four categories of agricultural development policy packages focused on cassava are considered in the model: improved cassava variety, improved cassava processing technology, improved market access and improved extension services.

In this study, it is assumed that the policy packages on cassava have influence on the inefficiency effects of resource-use of the cassava farmers in Benue State. Thus, in this study, Cobb-Douglas stochastic frontier production function is assumed to be the appropriate model for the analysis of the farm data collected on the cassava farmers in Benue State. The model to be estimated is defined by:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + V_i - U_i \dots\dots\dots(1)$$

**Where:**

Ln = natural logarithm to base e

Y = the total cassava output of the farmers (in kilograms)

$\beta_i$  = the unknown parameters associated with the explanatory variables in the production function (i = 0,1,2,3,4,5)

$X_1$  = total cash expenditure on hired labour (in Naira)

$X_2$  = total number of family labour used for production (in man-days)

$X_3$  = total amounts of land under cassava production (in hectares)

$X_4$  = total number of cassava stems used as planting material (in numbers)

$X_5$  = total amounts of fertilizer used for production (in kilograms)

$V_i$  = random errors, which are assumed to be independently and identically distributed as N (0,  $\sigma_v^2$ ), independently distributed of the  $U_i$ .

$U_i$  = non-negative random variables, associated with technical inefficiency of production, which are assumed to be independently distributed, such that  $U_i$  is obtained by truncation (at zero) of the normal distribution with variance,  $\sigma_u^2$  and mean  $\mu_i$  where the mean is defined by:

$$\mu_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \dots\dots\dots(2)$$

**Where:**

$\delta$  is a (5 x 1) vector of unknown parameters to be estimated.

$Z_1$  = Cassava variety planted (a dummy variable). Improved variety = 1, local variety = 0

$Z_2$  = Processing technology available (a dummy variable). Improved processing technology = 1, local processing technology = 0

$Z_3$  = Access to cassava markets (a dummy variable). Good access to markets = 1, Poor access to markets = 0

$Z_4$  = Extension services (a dummy variable). Access to extension services =1, Non – access to extension services = 0

$Z_5$  = Agricultural credit (a dummy variable). Access to agricultural credit =1, Non – access to agricultural credit = 0

The cassava output is expected to be influenced positively by hired labour cost, quantity of family labour, farm size, number of cassava stems used as planting material and quantity of fertilizer.

The cassava variety is expected to have a negative effect on the size of the technical inefficiency effects. This is so because as the farmer switches from planting local cassava variety to planting improved cassava variety, an effective utilization of inputs would be achieved, which in turn, increases the technical efficiency of the farming operations.

The processing technology is expected to have a negative effect on the technical inefficiency. This is because switching from the use of local processing methods to the use of processing machines for processing helps to conserve time and resources which would be transferred to the farming operations, which in turn, would help in the achievement of effective utilization of inputs. This in turn, increases the technical efficiency of the farming operations.

Market access is expected to have a negative effect on the technical inefficiency. This is because a switch from a poor access to markets to a good access to markets would help to conserve time and resources as well as boost morale for farm productions, which in turn, would be transferred to the farming operations. The result of this would be effective utilization of inputs, which in turn, increases the technical efficiency of the farming operations. Access to markets is important policy and institutional variable that positively influence efficiency because it improves farmers' liquidity and the affordability of the inputs required for production.

Extension services are expected to have a negative effect on the size of the technical inefficiency effects. This is because as the farmers have access to improved extension services, the more knowledge and information they would have about modern farming, and hence, more disposed to adopting improved farm technologies. This would lead to effective utilization of inputs, which in turn, increases the technical efficiency of the farming operations. Extension is important policy and institutional variable that positively influence

efficiency because it provides the incentive and means for farmers to access improved crop technology. Availability of extension services and information about technical aspects of crop technologies play an important role in increasing farm level efficiency. The availability of an extension worker in the community and the usefulness of the extension messages (as perceived by the respondents) both influence technical efficiency.

Agricultural credit is expected to have a negative effect on the size of the technical inefficiency effects. This is because the higher the access to agricultural credit, the larger the fraction of the farmers that qualifies for a farm credit. When low-income farmers can access agricultural credit, they generally can adequately educate their children and start and expand a business. This is because households with access to agricultural credits are able to acquire more productive resources for their farm production.

The model defined by equations (1) and (2) was proposed by Battese and Coelli (1995). The parameters of the model, i.e. the  $\beta$ 's, the  $\delta_s$ , and the variance parameters:

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

$$\text{and } \gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2) \dots\dots\dots (4)$$

are simultaneously estimated using the method of maximum likelihood. The computer programme FRONTIER 4.1 developed by Coelli (1994) that computes the parameter estimates by iteratively maximizing a nonlinear function of the unknown parameters in the model subject to the constraints was used. The value of the  $\gamma$  indicates the relative magnitude of the variance associated with the distribution of inefficiency effects,  $\mu_i$ . If  $\mu_i$  in the stochastic frontier are not present or alternatively, if the variance parameter,  $\gamma$ , associated with the distribution of  $\mu_i$  has value zero, then  $\sigma_u^2$  in (1) – (2) is zero, and the model reduces to a traditional production function with the variables: cassava variety, cassava processing technology, market access, and extension services all included in the production function meaning that inefficiency effects are not stochastic.

The functional form for the stochastic frontier is defined by equation (1). The function is a modified version of a Cobb-Douglas model. It permits different levels of productivity associated with different proportions of hired labour cost, total number of man-days of family labour, farm size, total number of cassava stems used as planting material and total quantity of fertilizer used for production.

### 3.7.2 Generalized Likelihood-ratio Tests

Several generalized likelihood-ratio tests pertaining to stochastic frontier coefficients, inefficiency model, and variance parameters were carried out. The generalized likelihood-ratio test statistic is computed as:

$$\lambda = - 2 \log [(L (H_0) / L (H_1))] \dots\dots\dots (5)$$

where  $L(H_0)$  and  $L(H_1)$  are the likelihood functions evaluated at the restricted and unrestricted maximum-likelihood estimator for the parameters of the model. If the null hypothesis,  $H_0$ , is true then the statistic has approximately chi-squared distribution with parameter equal to the number of restrictions imposed by  $H_0$ . The test statistic ( $\lambda$ ) has a  $\chi^2$  or a mixed  $\chi^2$  distribution with degrees of freedom equal to the difference between the parameters involved in  $H_0$  and  $H_1$ .

### 3.7.3 Efficiency Predictions

The computer program (Frontier 4.1) calculates predictions of individual firm technical efficiencies from estimated stochastic production frontiers. The measure of technical efficiency relative to the production frontier (10) is defined as:

$$EFF_i = E(Y_i^*/U_i, X_i) / E(Y_i^*/U_i, = 0, X_i), \dots\dots\dots(6)$$

where  $Y_i^*$  is the production of the i-th firm, which will be equal to  $Y_i$  when the dependent variable is in original units and will be equal to  $\exp(Y_i)$  when the dependent variable is in logs. In the case of a production frontier,  $EFF_i$  will take a value between zero and one.

## 4.0 Results and Discussion

### 4.1 Maximum Likelihood Estimates

The effect of specific cassava policy packages on the resource-use efficiency of the cassava farmers in Nigeria, the effect of resource-use on the cassava output of the cassava farmers in Nigeria as well as the technical efficiency of the cassava farmers in Nigeria were investigated employing the stochastic frontier production function, using the Maximum Likelihood Estimator (Tables 1).

#### 4.1.1 Output elasticity and return to scale

The elasticity of cassava output with respect to hired labour cost (-0.74), family labour (- 0.48), cassava stems (0.87) and fertilizer (0.69) were less than unity while the elasticity of cassava output with respect to farm size (0.92) was greater than unity (Table 1). This result suggests that while the hired labour cost and family labour (with negative coefficients) were of decreasing function, farm size, cassava stems and fertilizer (with positive coefficients) were of increasing function.

However, given that only the coefficients of hired labour cost, cassava stems, fertilizer and farm size were statistically significant, it follows that increasing farm size, the number of cassava stems planted and the quantity of fertilizer used while maintaining the level of hired labour cost would result to increase in the cassava output of the cassava farmers in Benue State. Furthermore, the sum of the coefficients of the significant variables (farm size, hired labour cost, number of cassava stems planted and fertilizer) of the stochastic frontier production model (3.70) was higher than unity. This suggests that a proportionate increase in all the inputs would result to more than proportionate increase in cassava output in Benue State, Nigeria. This implies that expansion of input use in cassava production in Benue State would result to higher cassava output in the State. The implication is that government agricultural policy that encourages increase in input use in cassava production in Benue State would lead to a higher increase in cassava output in the State and Nigeria at large.

Contrary to the *a priori* expectation, the hired labour cost had a negative and significant coefficient. According to Olayide *et al.* (1980), a negative relationship does exist between family labour and hired labour among the resource-poor rural farmers. This is because the consumption of additional hired labour is meant to supplement available family labour such that as the availability of family labour decreases, additional hired labour is needed to make up the shortage of family labour supply in the face of the lean resources of the poor farmers. Due to the high (rising) cost of hired labour, if additional hired labour must be consumed, then additional cost must be incurred. This implies that to maintain the cost of production at the limit of the poor farmers' lean resources when additional hired labour is to be consumed, the resource-poor rural farmers must cut down the level of their cassava production. This explains the negative influence of hired labour on cassava output as observed among the respondents. This finding is in agreement with the observation of Nweke (2004) that farmers who plant improved cassava varieties have sometimes have to suspend planting because they were unable to hire sufficient labour to harvest previously planted cassava fields because of rising wages.

**Table 1: Maximum Likelihood Estimates for the Parameter in the Stochastic Frontier Production Function Model for the Cassava Farmers in Benue State, 2005**

Variable	Parameter	Estimate	T- Ratio
<b>Stochastic Frontier</b>			
Constant	$\beta_0$	1.45	3.52**
Ln (labour cost)	$\beta_1$	-0.74	- 4.56**
Ln (family labour)	$\beta_2$	-0.48	- 1.32
Ln (farm size)	$\beta_3$	0.92	11.67**
Ln (cassava stems)	$\beta_4$	0.87	9.87**
Ln (fertilizer)	$\beta_5$	0.69	6.73**
<b>Inefficiency Frontier Model</b>			
Constant	$\delta_0$	- 1.41	- 11.69**
Cassava variety planted	$\delta_1$	-0.25	- 5.47**
Processing technology	$\delta_2$	-0.34	- 12.73**
Market access	$\delta_3$	-0.19	-2.96**
Extension Services	$\delta_4$	-0.17	-2.89**
Agricultural credit	$\delta_5$	-0.15	-2.46**
<b>Variance Parameters</b>			
Sigma squared	$\sigma^2$	0.22	18.79**
Gamma	$\gamma$	0.98	264.25**
Log Likelihood function		186.9	

**Source:** Field Survey, 2005.

\*\* t-ratio is significant at 1% level.

#### 4.1.2 Inefficiency frontier model

The estimated coefficients of cassava variety planted, processing technology available, market access, extension services and agricultural credit were all negative and significant at 1% level (Table 1). This result suggests that technical inefficiency effects in cassava

production in Benue State, Nigeria declined with the planting of improved cassava varieties, the use of improved cassava processing technology, access to cassava markets, access to extension services and access to agricultural credit. This means that the planting of improved cassava varieties, the use of improved cassava processing technology, access to cassava markets, access to extension services and access to agricultural credit all have positive effects on technical efficiency in cassava production in Nigeria, suggesting that planting of improved cassava varieties, the use of improved cassava processing technology, access to cassava markets, access to extension services and access to agricultural credit are important for achieving effective utilization of inputs in cassava production in Benue State, Nigeria. In other words, cassava farmers that invested relatively more into the use of improved cassava varieties and improved cassava processing technology achieved higher levels of technical efficiency in cassava production in Benue State, Nigeria. Furthermore, cassava farmers that had relatively more access to cassava markets, extension services and agricultural credits achieved higher levels of technical efficiency in cassava production in Benue State, Nigeria.

The implication of the foregoing finding is that the input use expansion policy of the government in the cassava industry (through the provision of improved cassava varieties, improved processing technology as well as improved access of cassava farmers to cassava markets, extension services and agricultural credits) led to an increase in resource use efficiency in cassava production among the cassava farmers in Benue State, Nigeria. This suggests an improvement in the profitability of cassava production enterprise among the cassava farmers in Benue State, Nigeria. This is because the cassava farmers through the input use expansion policy of government in the cassava industry (through the provision of improved cassava varieties, improved processing technology as well as improved access of cassava farmers to cassava markets, extension services and agricultural credits) would be able to move from the inefficient production phase of increasing return to scale to the efficient production phase of decreasing return to scale where their cassava output and hence the profitability of their cassava production enterprise can be fully maximized.

This finding validates claim by Nweke (2004) that cassava production is significantly more profitable with the planting of improved (TMS) cassava varieties and the use of improved (mechanized) cassava processing technologies.

The estimated sigma squared (0.22) was significantly different from zero at 1% level. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. In addition, the magnitude of the variance ratio,  $\gamma$ , was estimated to be high at 0.98, suggesting that the systematic influences that are unexplained by the production

function are the dominant sources of errors. This means that 98% of the variation in input among the farms is due to differences in technical efficiency occasioned by differences in the relative access of cassava farmers to the cassava policy packages of government. Thus, the results of the diagnostic statistics confirm the relevance of stochastic frontier production function, using the Maximum Likelihood Estimator (MLE).

#### 4.2 Generalized Likelihood-ratio Tests

The generalized likelihood-ratio test at 1% level of significance rejects the first null hypothesis that the resource use of the cassava farmers in Nigeria has no significant effect on their cassava output (Table 2), suggesting that the variables in the Cobb-Douglas model are not zero. This means that given the assumption of Cobb-Douglas specification, a Cobb-Douglas production function is an adequate representation of the stochastic frontier function.

**Table 2: Generalized-Likelihood Ratio Tests of Hypotheses Involving The Parameters of the Stochastic Frontier and Inefficiency Model for Cassava Farmers in Nigeria**

S/N	Null Hypothesis	ln (H <sub>0</sub> )	$\lambda$	Degree of Freedom	*Critical Value	Decision
<b>Stochastic Frontier</b>						
1	H <sub>0</sub> : $\beta_{ij} = 0$	- 490.35	25.23	5	15.09	Reject H <sub>0</sub>
<b>Inefficiency Model</b>						
2	H <sub>0</sub> : $\gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4$	- 570.23	76.54	6	16.81	Reject H <sub>0</sub>
3	H <sub>0</sub> : $\delta_1 = \delta_2 = \delta_3 = \delta_4$	- 487.69	78.31	4	13.28	Reject H <sub>0</sub>
4	H <sub>0</sub> : $\gamma = 0$	- 580.82	62.87	2	9.21	Reject H <sub>0</sub>

**Source:** Field Survey, 2005.

\*Critical value is significant at 1% level of significance.

The second null hypothesis which specifies that the cassava policy packages have no significant effect on the resource use efficiency of the cassava farmers is strongly rejected at 1% level of significance (Table 2), suggesting that inefficiency effects are not absent from the

model. The third null hypothesis which specifies that inefficiency effects among the cassava farmers are not a linear function of the cassava policy packages is rejected at 1% level of significance (Table 2), suggesting that the explanatory variables in the model for the inefficiency effects have non-zero coefficients. Thus, it can be concluded that the explanatory variables in the inefficiency effects contribute significantly to the explanation of inefficiency in production among the respondents.

The fourth null hypothesis which specifies that the stochastic frontier production function is not an adequate representation of the model for the farm data collected on the cassava farmers in Nigeria is rejected at 1% level of significance (Tables 2), suggesting that the explanatory variables in the technical inefficiency effects model are stochastic. This implies that the traditional average response function is not an adequate representation for farm production among the respondents, given the specification of the stochastic frontier and inefficiency effects, defined by equations 1 and 2.

#### **4.3 Efficiency Estimates for the Stochastic Frontier**

The result of the t-test in Table 3 shows that the null hypothesis that the cassava farmers in Nigeria are not technically inefficient in the use of resources for production is rejected at 1% level of significance. This result implies that the predicted mean technical efficiency is significantly different from the frontier technical efficiency level, suggesting that an average cassava farmer in the study area has not yet reached their production frontier. This suggests that an average cassava farmer's technical efficiency level in the study area can still be increased beyond the current level when adequately motivated with the appropriate cassava policy packages (favourable policy environment).

**Table 3: Test of No Significant Difference between the Frontier Mean Technical Efficiency Level and the Predicted Technical Efficiency Level of the Cassava Farmers in Nigeria**

<b>Variable</b>	<b>Value</b>
Frontier technical efficiency level	1.00
Mean technical efficiency level	0.89
t-statistics	64.87
Degree of freedom	718
*Critical value	2.33

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Decision	Reject $H_0$
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**Source:** Field Survey, 2005.

\*Critical value is significant at 1% level of significance.

Majority of the respondents (59.72%) operated closer to the production frontier (Table 4). This is attributable to access to cassava policy packages (improved cassava varieties, improved cassava processing technology, improved market access, improved extension services and improved access to agricultural credits), which enabled the farmers to achieve high level of technical efficiency in cassava production. Furthermore, 0.83% of the respondents produced on the production frontier, suggesting that they were fully efficient in their production. The full efficiency of these few farmers can be attributed to their relatively more effective utilization of cassava production resources occasioned by their relatively higher access to the cassava policy packages. The implication is that the input use expansion policy of the government (through the packaging of improved cassava varieties, improved cassava processing technology, improved market access, improved extension services and improved access to agricultural credits) enhanced the resource use efficiency of the cassava farmers in Nigeria, thereby bringing majority of them (59.72%) closer to their production frontier; and a few (0.83%) to their production frontier proper where output and hence profit can be fully maximized all things being equal.

**Table 4: Distribution of Cassava Farmers in Benue State by Technical Efficiency Estimates**

Technical Efficiency	Frequency	Percentage
0.31 < 0.50	6	1.67
0.50 < 0.70	26	7.22
0.70 < 0.90	110	30.56
0.90 < 1.00	215	59.72
1.00	3	0.83
<b>Total</b>	<b>360</b>	<b>100.0</b>
<b>Mean efficiency =</b>	0.78	
<b>Minimum efficiency =</b>	0.31	
<b>Maximum efficiency =</b>	1.00	

**Source:** Field Survey, 2005.

Furthermore, the result of the study showed that technical efficiency varied widely among farms ranging between 31% and 100% and a mean technical efficiency of 78% (Table 4), suggesting that technical efficiency in cassava production in Benue State could be increased by 24% through better use of available resources, given the current state of technology. This can be achieved through improved access to cassava policy packages, which include access to improved cassava varieties, access to improved cassava processing technology, access to improved cassava markets, access to improved extension services and access to agricultural credits. This finding validates the observation of Olayide *et al.* (1980) that small-scale farmers in the rural areas are very efficient in their farm production when adequately motivated with the favourable policy environment. The policy implication of this finding is that government policy that favours the supply of production resources to cassava farmers in Nigeria for the purpose of increasing cassava production would not lead to wasteful use of the resources by the farmers provided the policy environment is friendly.

## **5.0 Conclusion and Recommendations**

### **5.1 Conclusion**

The result of the stochastic frontier production model indicated that government policy that favours input use expansion in cassava production in Nigeria would lead to higher increase in cassava output in Nigeria. Besides, the input use expansion policy of government in the cassava sub-sector through the packaging of improved cassava varieties, improved cassava processing technology, as well as stimulating improved access cassava farmers to cassava markets, extension services and agricultural credit led to efficient utilization of resources in cassava production in Nigeria, and hence profit maximization by the farmers. Many of the respondents produced closer to their production frontier while some produced on their production frontier. Technical efficiency in cassava production in Nigeria could be increased by 24% through better use of available resources given the current state of technology – via improved access to cassava policy packages, which include access to improved cassava varieties, access to improved cassava processing technology, access to available cassava markets, access to improved extension services and agricultural credits. Moreover, 98% of the variations in input among the farms were due to differences in technical efficiency occasioned by differences in their relative access to the cassava policy packages. Furthermore, the study showed that government policy that favours the supply of production resources to cassava farmers in Benue State for the purpose of increasing cassava production in the State would not lead to wasteful utilization of the resources by the farmers.

## 5.2 Recommendations

- (i). Policies that would guarantee provision of adequate modern production resources to the cassava farmers are strongly advocated. This will ensure that the cassava farmers have access to sufficient production resources that would enable them to increase their resource utilization thereby expanding their cassava production, through further expansion of hectarage under cassava production.
- (ii). Technical efficiency in cassava production in Benue State should be increased through better use of available resources, given the current state of technology, through policies that would guarantee the provision of improved cassava planting material, improved cassava processing technology, improved extension services and improved access to available cassava markets and agricultural credits.
- (iii). Policies that encourage input expansion in the cassava industry should be sufficiently reinforced to bring about much larger increase in cassava production and, hence maximization of profit of the cassava farmers in Benue State, and Nigeria at large. This will ensure that the cassava exportation bid of the Federal Government of Nigeria is sustained while also guaranteeing cassava availability for domestic consumption in Nigeria.
- (iv). Policies that would favour the supply of cassava production resources to cassava farmers in Benue state is strongly recommended since the resources will be efficiently utilized by the farmers (provided the policy environment is friendly) for the purpose of increasing cassava production in the State and Nigeria at large.

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