RESOURCE USE EFFICIENCY AMONG GINGER FARMERS IN KADUNA STATE, NIGERIA BY

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ABSTRACT

Efficiency is a very important factor for productivity growth. In an economy where resources are scarce and opportunities to use new technologies are limited, resource use studies indicate the potential possibility to raise productivity by improving efficiency without necessarily developing new technologies or increasing the resource base. The resource use was estimated in order to identify the potential increase in production with minimum cost for farm inputs. The study determined the technical, allocative and economic efficiencies of ginger farmers in Kaduna State, Nigeria. A multi-stage sampling technique was employed to select 240 ginger farmers. Data were analyzed using the stochastic parametric technique. Findings show that technical efficiency indices range from 25.47 to 94.33%, with a mean of 64.98%; allocative efficiency varied from 10.28 to 98.72%, with a mean of 40.68%; and economic efficiency varied from 2.62 to 93.12%, with a mean of 26.43%. These widely varying indices of efficiency indicate great potential to achieve productivity growth through improved efficiency, using existing technologies and the available resource base in the study area. Analysis of the estimated coefficients indicated that age and education positively relate to technical efficiency while education and extension contact correlate with allocative efficiency positively. The results obtained show some increasing returns to scale in ginger production. Finally, the findings prove that further productivity gains linked to the improvement of efficiencies may still be realized in ginger production

Keywords: efficiency, ginger, productivity growth, resource use, returns to scale, stochastic production frontier

INTRODUCTION

Ginger is a tropical species native to South East Asia. It originated from India from where it was introduced to Africa and Caribbean. It is now cultivated throughout the humid tropics. Ginger is an herbaceous perennial plant known as *Zingier officinal*, which belongs to the order *Scitamineae* and the family *Zingriberaceae*.The English term ‘ginger’ originated from Sanskrit word ‘Sringavera’. Botanically known as ‘*Zingiber officinale*’, it is the most popular hot spice in the world (Abubacker, 2009). Ginger is an herb but is often known as a spice, with a strong distinct flavor that can increase the production of saliva. It is grown for its pungently aromatic underground stem or rhizome which is an important export crop valued for its powder, oil and oleoresin, all of which have food and medicinal value (Eze and Agbo, 2011). This ginger root is traditionally used with sweet foods in almost all parts of the world.

Nigeria is among the major producers and exporters of ginger in the world. Area under ginger cultivation in the world was 429,481 hectares in 2007. The largest area under ginger cultivation is in Nigeria, which is about 55% of the total area under ginger cultivation in the world (Abubacker, 2009). Although, it is grown in six states of Nigeria namely: Kaduna, Nasarawa, Benue, Plateau, Niger and Gombe. Kaduna state is the main producing zone with over 95% of the country's total production (Okafor, 2002). Nigeria's production in 2006 which was put at134,000 metric tonnes increased to 140,000 metric tonnes in 2008 (FAO, 2009), which is 4.3% increase. Out of this production, an average of 10% is locally consumed as fresh ginger, while 90% is dried and 20 percent of this is consumed locally for various uses while the remaining is exported (Ojeme, 2007).

In spite of the great potentials of ginger farming in the study area, factors such as low technical knowledge on the part of ginger farmers and the high cost of production inputs have constrained its contribution to increased food supply, export and poverty reduction. Furthermore, the efficiency or inefficiency of utilization of available resources for farming has remained an unanswered question in the quest for increased export of ginger production in the country in general. An efficient method of production is that which utilizes the least quantity of resources in order to produce a given quantity of output. A production process that uses more physical resources than an alternative method in producing a unit of output is thus said to be technically inefficient. However, since economic efficiency embodies both technical and allocative efficiencies, once the issues of technical inefficiency have been removed, the question of choosing between the set of technically efficient alternative methods of production, allocative efficiency, comes to fore, thereby, resulting to stabilized economic efficiency. Nchare (2009) defined technical efficiency as the ability to derive the greatest amount of output possible from a fixed quantity of inputs. Allocative efficiency is the ratio between total costs of producing a unit of output using actual factor proportions in a technically efficient manner, and total costs of producing a unit of output using optimal factor proportions in a technically efficient manner (Inoni, 2007). Economic efficiency is the product of technical and allocative efficiencies (Bifarin *et al.,* 2010).

However, a farm using a technically efficient input combination may not be producing optimally depending on the prevailing factor prices. Thus, the allocatively efficient level of production is where the farm operates at the least-cost combination of inputs (Inoni, 2007). In fact, the presence of shortfalls in efficiencies means that output can be increased without requiring additional conventional inputs or new technologies given the current prices for inputs. If this is the case, then empirical measures of efficiency are necessary in order to determine the magnitude of the gain that could be obtained by improving performance in production with a given technology. Given the foregoing scenario, the study intends to determine resource-use efficiency and identify its determinants among ginger producers in Kaduna State, using production function approach. A determination of resource use efficiency in ginger production will facilitate investment decision-making in the farming business, as well as give an indication of optimal input combinations necessary to obtain maximum returns from the scarce resources employed.

Theoretical Framework

The concept of efficiency is concerned with the relative performance of the processes used in transforming given inputs into outputs. Economic theory identifies at least three major types of efficiency. These include: technical, allocative and economic efficiencies. Technical efficiency as defined by Heady (1982) is the measure of a firm's success in producing maximum output from a given set of inputs. Allocative efficiency refers to the choice of an optimum combination of inputs consistent with the relative factor prices. Economic efficiency is the product of technical and allocative efficiencies. Efficiency is a very important factor of productivity growth, especially in developing agricultural economies where resources are meager and opportunities for developing and adopting better technologies are dwindling (Bifarin *et al.*, 2010). Such economies can benefit greatly by determining the extent to which it is possible to raise productivity or increase efficiency, at the existing resource base or technology. For efficient production, non-physical inputs, such as experience, information and age, might influence the ability of a producer to use the available technology efficiently. Each type of inefficiency is costly to a firm or production unit (e.g., a farm household) in the sense that, each inefficiency cause a reduction in profit below the maximum value attainable under full efficiency (Bifarin *et al.*, 2010).

The most popular methods of measuring efficiency, are parametric (the stochastic frontier method) and the non-parametric (Data Envelopment Analysis) which assumes the presence of inefficiency effects in the production system. Coelli (1995) made a comparison of the two methods and asserted that the main strengths of the stochastic frontier approach are its ability to deal with stochastic noise and the incorporation of statistical hypothesis tests pertaining to production structure and the degree of inefficiency. Therefore, the frontier production function differs from the Ordinary Least Square estimation in the structure of the error term. Bravo-Ureta and Pinheiro (1997), Ajibefun and Abdulkadri (1999), Sharma *et al*. (1999) and Ajibefun *et al*. (2002) have used the stochastic parametric model to estimate efficiencies in agricultural production in their studies.

In addition to determining the efficiency levels, for policy formulation purposes, it is also useful to identify the sources of these inefficiencies. The stochastic frontier production function proposed has firm effects that are assumed to be distributed as truncated normal random variables and, also, are permitted to vary systematically with time. The model may be expressed as:

$$Y_{it} = \beta_o + \sum_{j=1}^{k} \beta_j X_{jit} + (V_{it} - U_{it}) \qquad ,i=1,...,N,\ t=1,...,T \text{ - - - - - - - - - - } (1)$$

where:

Y_{it} denotes (the logarithm of) the production of the *i-th* firm in the *t-th* time period;

X_k represents the *k-th* (transformations of the) input quantities;

β_k stands for the output elasticity with respect to the *k-th* input;

V_{it} is a random variable which is assumed to be iid $N(0,\sigma_V^2)$, and distributed independently of the U_{it} which has the specification:

$$U_{it} = U_i\ \eta_{it} = U_i exp(-\eta(t-T_i)) \text{ - } (2)$$

where:

U_i is a non-negative random variable which is assumed to account for technical inefficiency in production and are assumed to be iid as truncations at zero of the $N(\mu,\sigma_\mu^2)$ distribution and η is a parameter to be estimated.

The last period ($t=T_i$) for firm i contains the base level of inefficiency for that firm ($U_{it} = U_i$). If $\eta > 0$, then the level of inefficiency decreases toward the base level. If $\eta < 0$, then the level of inefficiency increases to the base level, and if $\eta = 0$, then the level of inefficiency remain constant (Jorge and Suárez, 2004). If the firm effects are time invariant, then the technical efficiency is obtained by replacing $\eta_{it} = 1$ and $\eta = 0$.

Battese and Corra (1977) replaced σ_V^2 and σ_μ^2 with $\sigma^2=\sigma_V^2+\sigma_\mu^2$ and $\gamma=\sigma_\mu^2/(\sigma_V^2+\sigma_\mu^2)$ and stated that the parameter, γ, must lie between 0 and 1 (i.e., $0\leq \gamma \leq 1$). Gamma γ, is the total output attained at the frontier which is attributed to technical efficiency. Similarly, 1-γ measures technical inefficiency of the farmers. The predictions of individual firm technical efficiencies from the estimated stochastic production frontiers are defined as:

$$EF_{it} = exp(-U_{it}) = E[exp(-U_{it})/E_i] = \left\{\frac{1-\Phi\left[\eta_{it}\sigma_i^* - (\mu_i^*/\sigma_i^*)\right]}{1-\Phi\left[-\mu_i^*/\sigma_i^*\right]}\right\}\exp\left[-\eta_{it}\mu_i^* + \frac{1}{2}\eta_{it}^2\sigma_i^{*2}\right] \quad ----(3)$$

where:

E_i represents the (T_i x 1) vector of E_{it} 's associated with the time periods observed for the *i* th firm, where $E_{it} = V_{it} - U_{it}$;

$$\mu_i^* = \frac{\mu\sigma_V^2 - \eta_i' E_i \sigma^2}{\sigma_V^2 + \eta_i'\eta_i\sigma^2} \quad -- (4)$$

$$\sigma_i^{*2} = \frac{\sigma_V^2\sigma^2}{\sigma_V^2 + \eta_i'\eta_i\sigma^2} \quad -- (5)$$

where:

η_i represents the (T_i x 1) vector of η_{it} 's associated with the time periods observed for the *i*th firm, and $\Phi(.)$ represents the distribution function for the standard normal random variable.

The Cobb-Douglas functional form was used to estimate the technical efficiency in the stochastic production frontier. The function requires few independent variables. The specific model estimated is in the form:

$$\ln Y = \ln\beta o + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \epsilon \quad ----------------- (6)$$

Where:

Y,βs and *Xi* are as defined earlier

METHOD0LOGY

Study area, Sampling procedure and Data collection

The study is conducted in Kaduna State. The state is located between latitude 09^0 30’N and longitude 08^0 30’E in Northern Guinea Savannah. Kaduna has two seasons, dry (November – April) and rainy (May – October) seasons. Crops such as ginger, cassava, potatoes, sorghum, cowpea, soya bean, cocoyam and maize are cultivated. Multi-stage sampling techniques were used in selecting the study sample. In the first stage, four Local Government Areas: Kachia, Jaba, Jama’a and Zango Kataf were purposively selected randomly based on the intensity of ginger production. Thereafter, 3 ginger farming communities were randomly selected from each Local Government. The last stage had to do with the selection of 20 farming households from each farming community to make a total of 240 respondents. Primary data were collected from December, 2010 to January, 2011 and in April, 2011 through the administration of structured questionnaire and interview. The data focused on socio-economic characteristics of farmers, inputs used, prices of input and output; and quantity of ginger produced.

Analytical techniques

The data where subjected to Cobb-Douglas stochastic frontier production and cost functions using the maximum likelihood method, which is specified as follows:

$$Y = X_{it}\beta + E_{it} \quad -- (7)$$

$$\text{where: } E_{it} = V_1 - U_1 \quad --(8)$$

Taking logarithm of both sides, the equation becomes

$$\ln Y = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln((X_2)) + \beta_3 \ln((X_3)) + \beta_4 \ln((X_4)) + V_1 - U_1 \text{------}(9)$$

where:

Y = quantity of ginger produced (100kg/bag);

β_1 = coefficient of the parameter estimated ;

X_1 = farm size (hectare) ;

X_2 = quantity of fertilizer used (kilogram) ;

X_3 = labour (manday) ;

X_4 = planting materials used (kilogram) ; and

$V_1 - U_1$ are as defined earlier

Coelli (1996) expressed the cost function as follows:

$$Y_i = x_i\beta + (V_i + U_i) \qquad ,i=1,...,N, \text{ - } (10)$$

where:

Y_i is the (logarithm of the) cost of production of the i-th firm;

x_i input prices and output of the i-th firm;

β is a vector of unknown parameters;

V_i is the random variables which is assumed to be iid $N(0,\sigma_V^2)$, and independent of the

U_i which is non-negative random variables which is assumed to account for the cost of inefficiency in production, which are often assumed to be iid$|N(0,\sigma_U^2)|$.

Taking logarithm of both sides, the equation becomes

$$\ln Y = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + V_1 + U_1 \quad \text{- - - - - - -} (11)$$

where:

Y = quantity of output (100kg/bag) ;

β_1 = coefficient of the parameter estimated ;

X_1 = amount spend on land (Naira) ;

X_2 = cost of purchasing fertilizer (Naira) ;

X_3 = cost of labour (Naira) ;

X_4 = cost of acquiring planting materials (Naira) ; and

$V_1 + U_1$ are as defined earlier

In this cost function, the U_i now defines how far the firm operates above the cost frontier. If allocative efficiency is assumed, the U_i is closely related to the cost of technical inefficiency.

The inefficiency model based on Battese and Coelli (1995) specification was

$$Ui = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + W_i \quad \text{- -} (12)$$

where:

Z_1 = Age of the farmer (Number of years) ;

Z_2 = Educational level of farmer (years of schooling);

Z_3 = Experience of the farmer (years a farmer has been farming ginger);

Z_4 = Household size (number of people in the farmer's house);

Z_5 = Extension contact (dummy: 1=yes, 0=otherwise); and

W_i = error term.

Returns to Scale

In order to determine the returns to scale, the sum of output elasticities with respect to each resource was computed. Elasticities are estimated because they permit the evaluation of the effect of changes in the amount of an input on the output (Nchare, 2007).According to Olayide and Heady (1982), when

$\Sigma EPi = 1$, we have constant returns to scale;
$\Sigma EPi < 1$, we have decreasing returns to scale;
$\Sigma EPi > 1$, we have increasing returns to scale.and

RESULTS AND DISCUSSION

Table 1 presents the technical efficiency of ginger farmers in the study area. The estimated value of gamma (0.95) which is between zero and one as required, implies that the ginger farmers attained 95 percent technical efficiency level in their production. This value represents the total output made on the frontier production function attributed to technical efficiency (Rahji, 2005). Thus, estimate of technical inefficiency ($U = 1-\gamma$) is 0.05 i.e. five percent. This represents the largest proportional reduction in inputs that can be achieved in the production of ginger without the output being reduced. Generalized likelihood-ratio tests' of null hypotheses, that the inefficiency effects are absent or that they have simpler distributions are rejected because the value exceeds the Chi-square value at 1% significant level, therefore, supporting evidence of the presence of inefficiency effects. The 1 percent significant level of the sigma-square and less than one implies the fitness of the Cobb-Douglas model to the data, revealing the existence of the component error terms

The signs of the coefficients of the stochastic frontier conform to the *a pri*ori expectation, with the exception of the negative estimate of planting materials variable. All the explanatory variables show significant relationship with technical efficiency except planting materials. The positive relationship implies that increase in any of these variables by a unit will lead to an increase in technical efficiency of the farmer vis-à-vis the output. Ogundele and Okoruwa (2006), Omonona (2010) and Battesse and Coelli (1995) recorded similar results in their studies. The negative coefficient and insignificant value of planting materials, underscore the low use of the input as a result of local varieties planted in the area which brings low yield as compared to yield obtained in other countries like India and China. This indicates that the quality of planted materials was more important than the absolute quantity.

The result of the inefficiency effects model showed that only extension contact has significant effect on the technical efficiency of the farmers. Thus, most of the technical inefficiency is accounted for by other natural, economic and environmental factors that are not captured in the model. These factors could include land quality, disease and pest infestations, government policies, weather and so on. Two of the variables; education and age were correctly signed according to the *a priori* expectation. Their negative coefficient signifies that as farmers grow older their inefficiency reduces thereby increasing technical efficiency. This could be as a result of their accumulative experience in farming. Education facilitates technology adoption. More so, ginger farmers who are more educated tend to be technically efficient than less educated ones. On the other hand, farming experience, household size and extension contact decreases technical efficiency of producers, implying that an addition in these variables decreases technical efficiency. A plausible explanation for this finding is that more experienced farmers might be less receptive to knowledge-intensive technologies hence, they are conservative with their technology. The inverse relationship of household size and technical efficiency could be attributed to diversification of resources to other activities engaged by family members. This means that some of the family members are not fully employed in ginger farming.

Table 1: Technical Efficiency of Ginger Farmers

Variable	Parameter	Coefficient	Standard-Error	T-Ratio
Constant	β_0	0.2606	0.2219	1.1744
Fertilizer	β_1	0.3677	0.1909	1.9261*
Farm Size	β_2	0.7747	0.2972	2.6066**
Labour	β_3	0.1976	0.0555	3.5604**
Planting material	β_4	-0.2563	0.2512	-1.0203
Constant	Z_0	0.1169	0.3226	0.3623
Age	Z_1	-0.1139	0.1402	-0.8121
Education	Z_2	-0.1107	0.1896	-0.5838
Farm Exp	Z_3	0.9767	0.9612	1.0161
Household Size	Z_4	0.1482	0.1809	0.8192
Extension contact	Z_5	0.5464	0.1956	2.7934***
Sigma-squared	σ^2	0.4916	0.1019	4.8243***
Gamma	γ	0.9587	0.1093	8.7483***
Log likelihood function		-44.878		
LR test		27.428		

Source: Computed from frontier 4.1 print-out
*** significant at 1%, ** significant at 5%, * significant at 10% level of significance

Result in table 2 revealed the allocative efficiency of ginger farmers. All the variables included in the model had direct relationship with allocative efficiency, implying that, increment in the expenditure of any of these variables by one percent will increase the output by the corresponding value of the coefficient. Farm size, labour and planting materials are significant at 1% probability level while fertilizer was insignificant. This means that only fertilizer is not vital to the cost expenditure for ginger production, probably because of its erratic supply occasion by continuous fertilizer subsidies. This could be seen from table 4, that some farmers obtained fertilizer as low as 25kilogram (1bag).

Age is significant at 99% statistical confidence interval, and relates positively with allotment inefficiency. Meaning that, older farmers tend to be less efficient in their cost allocation for ginger production than younger farmers. This could stem from the fact that younger farmers are more educated, as such, have financial guiding principles. Education is both negative and significant in allocative inefficiency. More educated farmers are more efficient in the allocation of financial resources for ginger production than less educated ones. Farming experience is inversely related to cost efficiency as well as insignificant, implying that years in the enterprise does not matter in allocating expenditure. Household size and extension contact affect allotment inefficiency negatively. Therefore, as household size increases, allocative inefficiency increases. This could be that because funds can be diverted from farming activities to other non-farm activities. The same situation is applicable to extension contacts.

Table 2: Allocative Efficiency of Ginger farmers

Variable	Parameter	Coefficient	Standard-Error	t-ratio
Constant	β_0	0.3189	0.2865	0.1113
Fertilizer	β_1	0.3478	0.2210	1.5737
Farm Size	β_2	0.1074	0.4038	2.6591***
Labour	β_3	0.1577	0.0192	8.2135***
Planting material	β_4	0.4801	0.0312	15.387***
Constant	Z_0	0.5245	0.2771	1.8928*
Age	Z_1	0.3332	0.0426	7.8197***
Education	Z_2	-0.1962	0.0379	-5.8047***
Farm Exp	Z_3	0.5449	0.9840	0.5537
Household Size	Z_4	-0.1099	0.1680	-0.6539
Extension contact	Z_5	-0.7662	0.2664	-2.8761***
Sigma-squared	σ^2	0.7195	0.0999	7.2022***
Gamma	γ	0.5769	0.0939	6.1438***
Log likelihood function		-46.8388		
LR test		16.2754		

Source: Computed from frontier 4.1c print-out

*** significant at 1%, ** significant at 5%, * significant at 10% level of significance

The value of gamma 0.5769 shows that 57.69% of the changes in allocation of finances in the farm are accountable by the inefficiency variables captured in the model. Therefore, a change can still occur in the production of ginger using available finances. Sigma-square of 0.7195 indicate the existence of the error terms in the model which makes the Cobb-Douglas production function suitable for the model. Generalized likelihood-ratio tests' of null hypotheses, that the inefficiency effects are absent from the model; that the inefficiency effects are not stochastic and are not a linear function of the inefficiency variables included in the model are strongly rejected because the likelihood function exceeds the Chi-square value at 1% level of significance.

The technical efficiency (TE) score indicates the percentage production of a farmer in contrast to the potential output for a given input level. The scores reveal how much proportion is being produced by a particular farmer subject to the use of the given level of input. Technical efficiency scores range from 0 to 1, where a technical efficiency score close to 1 means the farmer is more technically efficient than other farmers. In the model, the average technical efficiency is 64.979% (Table 3). This implies that, in the short run, there is scope for increasing ginger productivity by about 35.021% by adopting the technology and techniques used by the best ginger farmer.

The results derived from the econometric estimation indicate that farmers in the study area are economically different from each other. 80% of the farmers are operating at 40% and below economically. Technical efficiency (TE) indices range from 25.467% to 94.327%. This means that if the average farmer in the sample was to achieve the technical efficiency level of its most efficient counterpart, then the average farmer could realize a 31.113% cost savings (i.e., 1 − [64.979/94.327]). A similar calculation for the most technically inefficient farmer in the study area reveals cost savings of 73.00% (i.e., 1 − [25.467/94.327]). Bravo-Ureta and Pinheiro (1997) obtained cost savings of 18% for the average farmer and 50% for the most inefficient farmer.

The mean allocative efficiency of the sample for ginger production is 40.682%, with a low of 10.276% and a high of 98. 722%. The combined effect of technical and allocative factors shows that the average economic efficiency level of the farmers is 26.435%, with a low of 2.617% and a high of 93.121%. These figures indicate that if the average farmers in the sample were to reach the economic efficiency level of its most efficient counterpart, then the average farmer could experience a cost savings of 71.61%, which is 1 − [26.435/93.121]. The same computation for the most economically inefficient farmer suggests a gain in economic efficiency of 97.19%, which is 1 − [2.617/93.121]. Bravo-Ureta and Evenson (1994) in their study in Paraguay on Cotton production recorded a mean economic efficiency of 40%. The modal class obtained is 0.91-1.0 for technical efficiency and 0.11-0.20 for allocative and economic efficiencies. In sum, it is evident from these results that economic efficiency could be improved substantially, and that allocative inefficiency constitutes a more serious problem than technical inefficiency.

Table 3: Distribution of technical, Allocative and Economic Efficiencies

	Technical		**Allocative**		**Economic**	
Class	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
0.00-0.10	0	0	0	0	46	19.167
0.11-0.20	0	0	74	30.833	81	33.75
0.21-0.30	26	10.833	34	14.167	34	14.167
0.31-0.40	29	12.083	29	12.083	31	12.917
0.41-0.50	17	7.083	19	7.916	12	5
0.51-0.60	24	10	22	9.167	14	5.833
0.61-0.70	41	17.083	19	7.917	10	4.167
0.71-0.80	17	7.083	24	10	12	5
0.81-0.90	22	9.167	7	2.917	0	0
0.91-1.0	64	26.667	12	5	0	0
	240	100	240	100	240	100
Minimum	0.25467		0.10276		0.02617	
Maximum	0.94327		0.98722		0.93121	
Mean efficiency	0.64979		0.40682		0.26435	

Source: Computed from frontier 4.1c print-out

Table 4: Distribution of Technical Efficiency Score

Variable	**Minimum**	**Maximum**	**Mean**
Fertilizer (25kg/bags)	1	90	16.33
Farm size (Ha)	0.025	23	2.226
Labour (Man day)	80.545	345	195.75
Planting Mat (kg)	25	250	89
Age (years)	18	89	44.04
Education (years)	0	19	11.265
Experience (years)	2	50	17.82
Household size (Number)	3	47	15

Source: field survey, 2011

Returns to Scale

The elasticity values obtained indicate the relative importance of every factor used in production. From table 1, it can be observed that farm size, fertilizer, labour and planting materials are in their order of importance in ginger production. The scale coefficient is 1.08. This value is greater than one, indicating increasing returns to scale in ginger production. The implication of this result is that a proportional increase of all the factors of production will leads to a more than proportional increase in production. This result further reveals that ginger farmers can benefit from the economies of scale linked to increasing returns in order to boost production. Similar result was obtained by Ajibefun *et al*. (1996). The non-negative and greater than one value of the sum of elasticities imply that producers are operating in stage one of the production process, which is usually considered as the irrational stage of production (Olukosi and Ogungbile, 1989). Hence, they are inefficient in the utilization of their resources for ginger production.

SUMMARY AND CONCLUSION AND RECOMMEBNDATIONS

The objective of this study was to determine the resource use efficiency of ginger producers in Kaduna State, Nigeria. To achieve this objective, the Cobb-Douglas stochastic frontier production function is estimated using the maximum likelihood method. The inefficiency effects are specified to be functions of the age, educational level, experience of the farmer, household size and extension contact.

The mean efficiencies index is estimated at 64.979%, 40.682% and 26.435V for technical, allocative and economic efficienies respectively. 42.32% of the farmers have technical efficiency indexes above 0.70 with the minimum of 25.467% and maximum of 94.327%. The modal class of allocative and economic efficiencies was 0.11-0.20 with 57.08% and 80.00% operating at 40 and below for allocative and economic efficiencies respectively. This signifies that ginger farmers are very low economically. Allocative efficiency was 10.276% low and 98.722% high while economic efficiency was as low as 2.617% and 93.121% high. Furthermore, the estimated value of the variance parameter, γ, for the technical efficiency is not only close to one, but also significantly different from zero while that of allocative efficiency is 57.69. These results show the existence of inefficiencies in ginger production. Generally, ginger farmers can increase their outputs provided they operate along their efficient frontier. Consequently, if all farmers efficiently use the available resources, the resulting increase in output can offset the fall in product export, thereby, increasing the export earnings from the crop as well as the farmers' income. Furthermore, the result of the technical inefficiency effects model shows that the extension contact is very significant in the production of ginger, whereas age and educational level have negative influence on the farmers' technical inefficiency. On the other hand, education and extension contact are the most important variables in allotment of fund for ginger production while age is significant; and household is inversely related to allocation efficiency. The returns to scale were found to be in increasing returns, therefore, if more inputs are devoted to ginger production, greater output will be realized, thereby, improving income of the farmers.

Based on the results of the research, the following policy measures would improve the efficiency of production of ginger in the study area. Given the importance of planting materials on crop output, measures that improve quality and accessibility of improved planting materials to farmers will be beneficial. Contact between the farmers and research institutes with improved planting varieties should be enhanced Provision of subsidy on farming tools would also have a positive effect on the output of the crop. However, given that the traditional tools are not technically efficient, efforts at educating the farmers on production tools, methods and financial management with specific target on younger farmers would not be amiss.

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