DETERMINANT OF TECHNICAL EFFICIENCY OF GROUNDNUT PRODUCTION IN BAUCHI STATE, NIGERIA

Supported by tetfund TERTIARY EDUCATION TRUST FUND

Biye, Salihu Umaru[1]*, A. A. U. Jongur[2], Lawal Haruna[2] & Ya'u Adamu[1]

[1]Department of Agricultural Economics & Extension, Federal University Kashere, PMB 0182, Gombe State, Nigeria

[2]Department of Agricultural Economics & Extension, Modibbo Adama University of Technology, PMB 2076, Yola, Nigeria

*Corresponding author: salihubnumarbiye@yahoo.com

Received: November 30, 2016 **Accepted:** March 23, 2017

Abstract: The study was conducted in Bauchi State, with a view to examining the technical efficiency (TE) of sole groundnut farmers in the state, which invariably has a direct bearing on profitability. It focuses on farmers who plant only groundnut, given that little is known about technical efficiency of sole groundnut in the state. The result reveals that most of farmers were male (70.12%), small scale (cultivating less than 5 ha.), married (82.87%) and were literates (96.37%). Majority of the farmers (61.32 %) were within the range of 35-50 years, with a mean age of 42 years and a standard deviation of 6.5. Sole groundnut farmers in the study area had a mean efficiency 0.75, implying that they were on the average, 75% efficient. Hence, their TEs can still be raised by 25% through improvement in extension services in the state. The minimum TE was 0.37 (37%), while the maximum was 0.97 (97%). Constraints encountered include; poor access to farm credit, Unfavourable prices of groundnut especially at harvest, Poor road network, high cost of labour and problems of pests and diseases. There is the need to restructure the extension services of the ADP through; provision of efficient transport facility, improved condition of service, adequate funding and regular training and retraining of staff for effective service delivery. Government is also advised to reinstate its subsidy policy on inputs especially fertilizers, hybrid seeds and other agrochemicals through the use of national identity card project to reach all the targeted farmers.

Keywords: Bauchi State, determinant, groundnut production, technical efficiency

Introduction

Groundnut, *Arachis hypogea* belongs to the family *Leguminosae*. Groundnut is also known as peanuts, earthnuts, gobbers, pinders, Manila nuts etc. (Beghin*et al.*, 2003). Groundnut in Nigeria, as in other major producing areas is largely a smallholder crop, grown under rain-fed conditions in semi-arid areas. Although it is grown in commercial farms in America and Europe, the developing countries with their small scale production, account for over 95 and 94 per cent of world groundnut area and production respectively (Baba *et al.*, 2013).

According to (Shehu *et al.*, 2010) and Shamsudeen *et al.* (2011) efficiency is concerned with the relative performance of the processes used in transferring given inputs into outputs. Technical efficiency means that natural resources are transformed into goods and services without waste. The maximum amount of physical production is obtained from the given resource inputs. In essence, production is achieved at the lowest possible opportunity cost. Technical efficiency is a prerequisite for allocative or economic efficiency. Economic efficiency is achieved if the highest possible level of satisfaction is obtained from given resources used (Azeez *et al.*, 2013).

Technical efficiency is one component of overall economic efficiency. However, in order to be economically efficient, a firm must first be technically efficient. Profit maximization requires a firm to produce the maximum output given the level of inputs employed (that is, be technically efficient), use the right mix of inputs in light of the relative price of each input (that is, be input allocative efficient) and produce the right mix of outputs given the set of prices (that is, be output allocative efficient) (Kumbhaker and Lovell, 2000). The level of technical efficiency of a particular firm is characterized by the relationship between observed production and some ideal or potential production (Greene, 1993).

United Nations Population Division (UNPD) (1999) revealed that the development of agriculture in Nigeria has not addressed the yearnings of its teeming-population, despite the country's endowment with abundant and diversified range of natural, human and material resources and oil revenue; it has `remained one of the most underdeveloped countries in Africa. The reality is that Nigeria has not been able to attain self-sufficiency in food production, despite increasing land area put into food production annually. The constraint to the rapid growth of food production seems to mainly be that of low crop yields and resource productivity. This is revealed by the actual yields of major food crops, compared with their potential yields (Federal Ministry of Agriculture, 1993).

The objectives of the study were to; (i) describe the socio-economic characteristics of sole groundnut farmers in Bauchi State, (ii) examine the technical efficiency among sole groundnut farmers in Bauchi State, (iii) examine the effects of productive resource inputs on profitability among sole groundnut farmers in Bauchi State, (iv) identify production constraints associated with sole groundnut production in Bauchi State, (v) proffer solution to the problems identified.

Theoretical Framework

Technical efficiency refers to the ability of a producing unit to obtain maximum (optimal) output from a given amount of inputs. Formally, the level of technical efficiency is measured by the distance of farm production from the optimal production frontier. A firm that sits on the production frontier is said to be technically efficient (Henderson, 2003). Technical efficiency is also defined as the ability of the firm to produce the maximum output from its resources. It tells us the maximum amount of output that can be derived from a given level of inputs. Measures of technical efficiency give an indication of the potential gains in output if inefficiencies in production were to be eliminated (Shamsuden *et al*., 2011).

Farrel (1957) refers to technical efficiency as the achievement of the maximum potential output from given amounts of inputs, taking into account physical production relationships. It can be measured within two main frameworks: input and output-oriented. In an input-oriented framework, technical efficiency gives the potential input reduction that a farm could apply without reducing its output level. In an output-oriented framework, technical efficiency gives information about the potential output increase that a farm could implement without increasing its use of inputs. In the case of constant returns to scale, both orientations give close results. On the contrary, in the case of variable returns to scale (increasing or decreasing) an additional component, scale efficiency, must be taken into

account in the calculation of technical efficiency (Chirwa, 2003).

Technical efficiency is derived from production function which is possible to achieve while realizing sub-optimal profit. Thus, a technically inefficient farmer can be kicked out of the market due to failure to achieve profit. On the other hand, in profit measure, we take care of input costs and output prices.Many productivity studies involve the use of production frontiers that describe the technical relationship between inputs and outputs and thus define the maximum output attainable from a given bundle of inputs and technology (Coelli *et al.*, 1998).

Material and Methods

Multi-stage, purposive and simple random sampling techniques were employed in the selection of the respondents. Hence in the first stage, four local government areas from the northern zone, three from the Western zone and two local government areas from the central were selected. In the second stage, twenty seven, which makes up 40 percent of the villages, were selected from the nine local government areas. In the third stage, fourty two respondents from Misau, seventeen from Dambam, fourteen from Gamawa, eighteen from Jam'are, thirty one from Ningi, fourty from Ganjuwa, twenty seven from Alkaleri, thirty four from Toro and twenty eight from Bauchi local government areas, making a total of two hundred and fifty one (251) sole groundnut farmers in all were randomly selected. The data were subjected to analysis using both descriptive and inferential statistics. The descriptive statistics used consist of simple percentage and frequency distribution to describe the socioeconomic characteristics of the groundnut farmers. Inferential statistics employed include Stochastic Frontier production function which was used in estimating the technical efficiencies. Technical efficiency model is embedded in equations linking groundnut outputs to resources inputs on one hand and groundnut output to inefficiency model on the other hand.

Inefficiency effects is linked to the age of farmers, educational level, farming experience, annual income, household size, extension contact and variety of crop planted. The Stochastic Frontier production function model was used in the analysis of the data. The Stochastic Frontier production is widely used for efficiency analysis due to its simplicity and flexibility coupled with the empirical support it has received from data for various industries and countries (Desai, 1976; Jondrow *et al*., 1982; Coelli *et al.*, 1998; Kumbhaker and Lovell, 2000; Handerson, 2003; Hamidu *et al*., 2011). The Stochastic Frontier Production Function is expressed as:

$$LnY_{ij} = \beta_0 + \beta_1 LnX_{1ij} + \beta_2 LnX_{2ij} + \beta_3 LnX_{3ij} + \beta_4 LnX_{4ij} + \beta_5 LnX_{5ij} + V_{ij} - U_{ij} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The subscripts i and j refer to the ith farmers and jth observation respectively,

Where: Ln =natural logarithm to base e; Y =output (kg).

$\beta_0 - \beta_5$ = parameters associated with the explanatory variables in the production function.

X_1 = farm size (ha), X_2 = quantity of seed (kg), X_3 = family labour (man days)

X_4 = hired labour (man days), X_5=quantity of agrochemicals (litres), X_6=quantity of fertilizer (kg)

$V_{i\,j}$- random errors that are assumed to be independent of the U_i and are normally distributed

U_{ij} - 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 σ_2 and mean U_i where the mean is defined by:

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where: δ is a (7×1) vector of unknown parameters to be estimated, Z_1 is age of farmers.

Z_2 is formal education (formal education=1, no formal education =2), Z_3 is years of farming experience, Z_4 is annual farm income of farmers in Naira (₦), Z_5 is extension contact (number of time or if there is no contact), Z_6 is household size (number of persons in a household).

Z_7 is variety of groundnut used (improved variety = 1, local variety = 0).

Results and Discussion

The results on the socio-economic characteristics of the respondents are presented in Table 1. The result shows that most of the respondents (61.32 %) were within the age ranges of 31-50 years, while only 5.18% of them were 20 years and below. The maximum age was 65 years and the minimum age is 22 years while their mean age was 42 years with a standard deviation of 6.5 an indication of significant variation in age of the respondents who are relatively young and physically active. This has a direct effect on the ability of the respondents to seek and comprehend improved production practices relative to older respondents Consequently, influencing their tendency of recording higher efficiency among farmers. This is in line with Battese and Coelli (1995); Otitoju and Arene (2010) who found a positive relationship between farmer's age and inefficiency, thus express concern that aging population have negative impact on the farmers' efficiency as well as profitability.

Male farmers constitute the majority (70.12%) while only few (29.88%) of them were female, which implies that there are more male farmers than female farmers engaged in groundnut farming in the study area. Otitoju and Arene (2010) also found that male significantly aid in security and wellbeing of the family; planning agriculture and many other aspects of rural life. Most (82.87%) of the groundnut farmers in the study area were married, while 10.76% and 5.58% of the respondents were single and widows/widowers respectively. However, less than 1% of the respondents were divorcees. 37% of them had attended secondary school, 31.08% tertiary education and 15.05 % primary education, while 12.35% had Quranic education. However, only 3.59% had not attained any form of education.

Table 1: Socioeconomic characteristics of the Respondents

Variable	%	Mean	SD	Min.	Max.
Age (years)					
≤ 20	13	5.18	42.42	22	65
21 – 30	37	14.74			
31-40	72	28.69			
41-50	82	32.67			
51 – 60	41	16.33			
≥ 61	6	2.39			
Total	**251**	**100**			
Gender					
Male	176	70.12			
Female	75	29.88			
Total	**251**	**100**			
Marital status					
Single	27	10.76			
Married	207	82.87			
Widower	14	5.58			
Divorcee	2	0.79			
Total	**251**	**100**			
Educational level					
Uneducated	9	3.59			
Quranic education	31	12.35			
Primary education	40	15.94			
Secondary education	93	37.05			
Tertiary education	78	31.08			
Total	**251**	**100**			

Source: Field Survey, 2015

Table 2 shows that all the variables carry the expected positive signs and were also found to be significant except for family and hired labours which were not significant. This Implies that increase in the use of any of the variables such as farm size, quantity of seed, agrochemicals and fertilizers would bring about increase in output of groundnut in the study area. The elasticity estimates (β_1 - β_6) of the explanatory variables were all positive, indicating that they are important determinants of the output. The sum of the elasticity is 1.96 indicating increasing returns to scale, meaning that the efficiency of resource use has not attained an optimum level (below the production frontier). Thus increase in input allocation *ceteris paribus* would result into more than proportionate increase in output of groundnut in the area.

Farm size was significant at 1%. It is one of the most important factors of groundnut production. The elasticity coefficient of farm size (X_1) was 0.274 indicating that the effect of farm size on groundnut production in the area is inelastic. This further depict that a unit change in farm size would bring about 27.4% increases in the total output of groundnut in the area. The resultant effect of lower farm size is that it leads to fragmented land holding thereby making it difficult for expansion and possible use of most technologies, consequently lowering their efficiency. Quantity of seed is significant at 5%, implying that it was also an important factor in groundnut production. Seed used had an elasticity coefficient of 0.188, which means that a unit increase in the quantity of seed used would bring about 18.81% rises in the quantity of output produced.

Agrochemicals were also found to be significant at 5%, while inorganicanic faertilizers on the other hand is significant at 10%. These inputs play a significant role in raising productivity and rational allocation of the inputs which can lead to higher technical efficieny of groundnut production in the area. The elasticity of production of agrochemical was 0.1485, implying that a unit increase in the quantity of agrochemical in groundnut production in the area would bring about 14.85% rise in the quantity of output that would be produced.

Inorganic fertilizers were also found to be an important factor of production, as it is significant at 10%. The elasticity coefficient of inorganic fertilizers was 0.0809, implying that a unit increase in the quantity of inorganic fertilizers applied would lead to an extra 8.09% rise in the quantity of output produced. This is in agreement with Ajeigbe *et al.* (2014) who established a positive relationship between inorganic fertilizer and efficiency.

Table 2: Maximum likelihood estimates of the stochastic frontier production function

Variable	Parameter	Coefficient	Standard error	t-ratio
Production factors				
Constant	β_0	1.2138	0.0128	94.7786***
Farm size (X_1)	β_1	0.2739	0.0869	3.1535***
Quantity of seed (X_2)	β_2	0.1881	0.0782	2.4065**
Family labour (X_3)	β_3	0.0190	0.0491	0.3875
Hired labour (X_4)	β_4	0.0330	0.0139	0.2381
Agrochemicals (X_5)	β_5	0.1485	0.0724	2.0523**
Fertilizers (x_6)	β_6	0.0809	0.0412	1.9669*
Inefficiency Effects				
Age (z_1)	δ_1	-0.3797	0.0569	-6.6786***
Formal education (z_2)	δ_2	-0.3132	0.0166	-18.9056***
Farming experience (z_3)	δ_3	0.0161	0.0177	0.9088
Farm income (z_4)	δ_4	-0.2093	0.9803	-2.1352**
Extension contact (z_5)	δ_5	-0.0073	0.0100	-0.7273
Household size (z_6)	δ_6	-0.0145	0.0274	-0.5290
Variety of seed (z_7)	δ_7	0.0091	0.0079	1.1482
Diagnosticstatistics				
Log Likelihood ratio	LR	28.21*		
Sigma squared	σ^2	0.1036	0.00586	17.7230***
Gamma	(γ)	0.8874	0.1287	6.8946***

Source: Computer output from Frontier 4.1

***Significant at 1% level; **Significant at 5% level; * Significant at 10%

The inefficiency model revealed that age (Z_1), years of formal education (Z_2) and farm income (Z_4) were significant. Age (Z_1) of the groundnut farmers and years of formal education (Z_2) were both significant at 1% and also carry the expected negative signs, implying that the variables are highly important determinants of technical efficiency in groundnut production in the area. The coefficient of age (δ_1) being -0.3797 implies that 37.97% reduction in technical inefficiency of groundnut farmers in the area *ceteris paribus* can be attributed to age of the farmer. This implies that age of the groundnut farmer is positively related to technical efficiency of groundnut production in the area.

Farming experience has a coefficient of -0.3132 on the technical inefficiency model, implying that 31.32% reduction in inefficiency of groundnut farmers in the study area can be due to years of farming experience of the farmers. In another words, farming experience of groundnut farmers in the area increases their technical efficiency by 31.32%. This is because physical strength is required in farming which is mostly associated with adults than with children. Hence, as the farmer's age increases before getting to old age, both technical efficiency and farming experience increases. This is in conformity with the findings by Biye (2016), Otitoju and Arene (2010), Adeyemo *et al.* (2010) and Ebong *et al.* (2009) who observed that age and years of farming experience improve efficiency as a result of "practice makes perfect".

Farm income was also found to be an important variable, as it is significant at 5%. Farm income (Z_4) has a coefficient of -0.2093 indicating that farm income reduces technical efficiency of groundnut farmers in the study area *ceteris paribus* by 20.93%. Sigma squared (σ^2) is statistically significant at 1% level, indicating good fit and the correctness of the distributional form assumed for the composite error term in the model. The variance ratio gamma, (γ) was found to be 0.89 and is statistically significant at 1% level, implying that 89% of the variation in output of groundnut among the farmers was due to their differences in technical efficiencies. Furthermore, all the input coefficients were less than one, implying that input allocation is in stage II of the production function. Similarly, the sum of all the input

elasticity is 0.74 indicating that groundnut production in the area is inelastic and is in stage II of the production function, which is termed as the rational stage of production.

The inefficiency parameters were all negative except those of farming experience (Z_3) and variety of seed used. Thus the parameters which carry the expected signs have met the *apriori* expectations, meaning that the variables increase efficiency in groundnut production.

Conclusion

Sole groundnut farming in Bauchi State is dominated by male small scale farmers cultivating an average of 3 ha, funded through their personal savings and were mostly literate to some extent. The farmers were themselves efficient in groundnut production in lieu of their vast experience and literacy level. Farmers are encouraged to expand their farm size and also form cooperative associations so that they can interact with each other on problems of mutual interest, benefit incentives put forward through government programs and political parties.

There is the need to restructure the extension services of the ADP through; provision of efficient transport facility, improved condition of service, adequate funding and regular training and retraining of staff for effective service delivery.Government is also advised to reinstate its subsidy policy on inputs especially fertilizers, hybrid seeds and other agrochemicals through the use of national identity card project to reach all the targeted farmers in order to eradicate the deep rooted corruption in the disbursement of the subsidized inputs rather than removing it.

References

Adeyemo R, Oke JTO & Akinola AA 2010. Economic Efficiency of Small Scale Farmers in Ogun State, Nigeria. *Tropicultura*, 28(2): 125-133.

Ajeigbe HA, Waliyar F, Echekwu CA, Ayuba K, Motagi BN, Eniayeju D & Inuwa A 2014. A farmer's guide to groundnut production in Nigeria. Patancheru 502 324, Telangana, India: *International Crops Research Institute for the Semi-Arid Tropics*, p. 36.

Azeez FA, Famuyide OO, Nosiru MO, Bello GT, Clement NA & Amoo MO 2013. Technical efficiency of *Moringaoleifera* production in Isokan Local Government Area of Osun State, Nigeria. *Discourse J. Agric & Food Sci.*, 1(2): 78-84. www.resjournals.org/JAFS.

Baba MD, Dabai JS, Senchiand DB & Umar A 2013. Cost and returns of groundnut production in Zuru Local Government Area of Kebbi State, Nigeria. *AdvanAgric Sci. & Engr. Res.*, 3(11): 63-75.

Battese GE & Coelli TJ 1995. A model for technical inefficiency effects in stochastic frontier production function for panel data. *Empirical Economics*, 20: 325 - 332.

Beghin J, Diop N, Matthey H & Sewadah M 2003. The Impact of Groundnut Trade Liberalization: Implication for the Doha Round. Mimeo, Selected Paper Presented at the 2003 A`AEA Annual Meetings, Montreel, Canada.

Biye SU 2016. Analysis of Production Efficiency and Profitability among Groundnut (*Arachis hypogeal.*) Farmers in Bauchi state, Nigeria. Unpublished PhD Thesis, Department of Agricultural Economics & Extension, School of Agriculture and Agricultural Technology, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria, p.135.

Chirwa EW 2002. Sources of Technical Efficiency among Smallholder Maize Farmers in Southern Malawi. Work in Progress Report presented at the Biannual Research Workshop Organised by the African Economic Research Consortium, Durban, South Africa.

Coelli TJ, Rao DSP & Battese GE 1998. An introduction to efficiency and productivity analysis. Kluwer Academic Publishers. *Economics* 21: 169-179.

Desai M 1976. *Applied Econometrics*, Philip Allan Publishers Ltd, Deggington, Oxford, pp. 52-60.

Ebong VO, Okoro US & Effiong EO 2009. Determinants of technical efficiency of urban farming in Uyo Metropolis of Akwa–Ibom State, Nigeria. *J. Agric& Social Sci.*, 5: 89–92.

Farrell MJ 1957. The Measurement of Productivity Efficiency. *J. Royal Statistical Society, Series A*, 120(3): 253 - 290.

Federal Ministry of Agriculture 1993. Food Security and Nigeria's Agriculture; A National Agenda; Federal Ministry of Agriculture, Water Resources and Rural Development, Abuja.

Greene WH 1993. The Econometric Approach to Efficiency Analysis. In: Fried HO, Lovell CAK & Schmidt SS (Ed.) *The Measurement of Productive Efficiency: Techniques & Applications*. Oxford University Press, pp. 68-119.

Hamidu BM, Kuli SG & Mohammed I 2006. Profitability Analysis of Groundnut (*Arachishypogae*L.) Processing among Women Entrepreneurs in Bauchi Metropolis. A Paper Presented at 20th Annual National Conference of Farm Management Association of Nigeria held at Forestry Research Institute of Nigeria, Federal College of Forestry Jos, Plateau State 18th –21st September

Henderson D 2003. *The Measurement of Technical Efficiency Using Panel Data.* Mimeo, State University of New York at Binghamton, New York.

Jondrow J, Lovell CAK, Materov IS & Schmidt P 1982. On estimation of technical inefficiency in the stochastic frontier production function model. *J. Econometrics* 19: 233-238.

Kumbhaker SC & Lovell CAK 2000. *Stochastic Frontier Analysis*, Cambridge: Cambridge University Press, United Kingdom.

Otitoju M & Arene CJ 2010. Constraints and determinants of technical efficiency in medium-scale soybean production in Benue State, Nigeria. *Afri. J. Agric Res.*, 5(17): 2276–2280.

Shamsudeen A, Donkoh SA & Sienso G 2011 Technical efficiency of groundnut production in West Mamprusi District of Northern Ghana. *J. Agric& Bio. Sci.*, 2(4): 071-077.

Shehu JF, Iyortyer JT, Mshelia SI & Jongur AAU 2010. Determinants of Yam Productivity and Technical Efficiency among Yam Farmers in Benue State, Nigeria.*J. Social Sci.*, 2: 24.

United Nations Population Division/Desa 2009. World Population to Exceed 9 Billion by 2050. *Press Release*, 18: 7 – 15.