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COMPARATIVE TECHNICAL EFFICIENCY ANALYSIS OF SMALL AND MEDIUM-SCALE SOYBEAN FARMERS IN BENUE STATE, NIGERIA: A STOCHASTIC FRONTIER APPROACH

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Abstract

This study examined technical efficiency in small and medium-scale soybean production in Benue State, Nigeria, using cross-sectional data. The study used multistage sampling technique for the selection of 160 respondents, comprising 96 small-scale and 64 medium-scale soybean farmers. The analytical techniques involved descriptive statistics and the estimation of technical efficiency following one-step approach of Maximum likelihood Estimation (MLE) procedure available in frontier 4.1. The results of the analysis show that there are differences in the socio-economic characteristics and production inputs of the small and medium-scale soybean farmers. However, the technical efficiency of small-scale soybean farmers ranged from 0.102 to 0.958 on the scale of 1.00 with a mean of 0.842 while that of medium-scale soybean farmers ranged from 0.487 to 0.999 on the scale of 1.00 with a mean of 0.725. For small-scale soybean farmers, family size, age, farming experience, credit accessibility, and land fragmentation were statistically significant. For medium-scale soybean farmers, age, and off-farm income were consistent with a priori expectation and significant at 5% level of probability. The test of null hypotheses on the differentials in technical efficiency between the two groups of soybean farmers showed that there was significant difference at 5% level. Small-scale soybean production was found to be more technically efficient which implies that Nigeria agricultural development is still at the stage where young and experienced small-scale farmers are to be included in agricultural planning and programmes to achieve poverty reduction and economic emancipation of many Nigerians rather than encouraging programmes that exclude them.

Key Words: Technical efficiency, stochastic frontier models, small and medium-scale, soybean farmers

Introduction

In soybean production, Nigeria was ranked as the largest producer of soybean in Africa in the year 2003 by the International Development Research Centre (IDRC), Canada (http://www.idrc.ca). For food, the country is also the largest producer of soybean in the West and Central Africa (Root, Morr & Thomas, 1987). The high protein level of soybean makes it a substitute to animal protein (Ayoola, 2001). The high quality protein level (40%) and inexpensive nature of soybean made the demand for the crop to increase. This spurred governments to bring up policies and programmes in order to address the demand - supply gap. For example, Institute of Agricultural Research (IAR), Ahmadu Bello University, Zaria which has a research mandate for soya bean in Nigeria, National Coordinated Research Project (NCRP) on soybeans transformed into the present Nigerian Soybean Association (NSA) in February 1987; University of Agriculture, Makurdi established in 1988 which has the mandate to carry out research on crops found in the catchment area. More recently the presidential initiative on Vegetable Oil Development Programme, (VODEP) launched in 2002, which is to address five oil-producing crops- cocoa, oil palm, cotton, groundnut and soybean, in order to meet the 300,000- 400,000 tonnes per annum supply deficit of vegetable oil (PRCU,2003). Interested institutions like the International Institute of Tropical Agriculture (IITA) and Institute of Agricultural Research (IAR), ABU, tried in the generation of improved, adaptable (TGX and TGM) and Samsoy varieties, respectively, to replace the Malayan variety first introduced to the country (Ayoola, 2001).

Most efforts made by governments have been on technology improvement and the issues on model technique side of productivity have received less attention from the socio-economic research and policy makers circle. Productivity increases do not depend on technology adoption rate only. What is also needed is the effective use of the available technology. Policy makers seldom realize the importance of the efficient use of technology, otherwise called technical efficiency (Kebede, 2001; Obwona, 2006). The term technical efficiency, according to Obwona (2000), generally, refers to the performance of processes of transforming a set of inputs into a set of output. This has received less attention in the developing agricultural economies (Ali & Chaudhry, 1990; Obwona 2000; 2006). It will then be appropriate to see how productivity as a result of technique technology improvement *vis-à-vis* farm holdings (small and medium-scale) can help in achieving increased production in soybean. Oyebanji (2005) reported that soybean production in 2004 increased by 9.9% over that of 2003. Despite this increased production in soybean the demand/ supply gap is yet to be bridged. In a bid to address the demand/ supply gap in soybean, governments have at various times come up with policies and programmes. It has been observed that these policies have not been consistent. As identified by Idachaba (2000), inconsistent policies is a major source of poor performance of Nigerian agriculture. Thus, the changes in policies and the limited capacity of the Nigerian soybean sector to match domestic demand raised a number of pertinent questions both in the policy circles and among researchers. For example, what are the factors explaining why domestic soybean lags behind the demand for the commodity in Nigeria? Although several studies have been carried out on estimation of efficiency in African agriculture (Ajibefun, 2006; Ajibefun, 2007; Ajibefun, Battese & Daramola, 2002; Asogwa, 2005; Asogwa, Umeh & Ater, 2006; Ogundele & Okoruwa, 2006; Okoruwa & Ogundele, 2006), none of these studies looked into the issue of determining the factors influencing technical efficiency of soybean-growers. The only study that attempted to determine the cause of technical inefficiency among soybean-farmers is that of Kondoun (2000). The major drawbacks in that study are: he restricted technical efficiency differentials to educational attainment and he used small-scale farmers as his sample units. Obwona (2006) also studied the determinants of technical efficiency differentials amongst small-and-medium-scale tobacco-farmers in Uganda. One major drawback of Obwona's study is his inability to show in clear terms the differential in efficiency between the two groups (small and medium-scale farmers). Hence, this study, seeks to estimate and compare the technical efficiency of these two groups of farmers in soybean production and explain those factors that determine their levels of technical efficiency in Benue State, Nigeria as this will guide policy in the direction of technology allocation in the context of present level of agricultural development in Nigeria. This study is therefore set to achieve the following specific objectives:

(i) to determine and compare the technical efficiency of small and medium-scale soybean farmers; and

(ii) to identify the factors that influence technical efficiency of small and medium-scale soybean farmers.

MethodologyThe Study Area:

The study area is Benue State. The State is located in the middle belt of Nigeria, approximately between latitudes 6.3°N to 8.1°N and longitudes 8°E to 10°E. The state has a total land area of about 32, 866.25 square kilometers. (Benue State Agricultural and Rural Development Authority [BNARDA], 1998; 2000). There are 23 local government areas(LGAs) broadly divided into three agricultural zones namely; (i). Eastern Zone (zone A): comprises Katisina-Ala, Kwande Ukum, Vandeikya, Ushongo, Konshisha, (ii) Northern zone (zone B): consisting of Gboko, Gwer, Gwer West, Makurdi, Buruku, Guma and Tarka. (iii). Central zone (zone C): consisting of Ado, Oju, Agatu, Apa, Obi, Ogbadibo, Ohimini, Otukpo and Okpokwu. Soybean is mainly produced in the Northern and Eastern agricultural zones of the state. (BNARDA, 2000). For the purpose of this study, purposive sampling, multi-stage random sampling and stratified random sampling methods were used for selecting the respondents. The major soybean-producing areas were purposively selected for the study, that is, the Northern and Eastern agricultural zones consisting of 14 local government areas. Secondly, random sampling technique was adopted for selecting two local government areas from each zone, making four LGAs in all. Thirdly, two districts were selected from each LGA amounting to eight districts in all. Fourthly, two villages were selected from each district to make up sixteen villages in all. The list of the soybean farmers was collected from Benue State Agricultural and Rural Development Authority (BNARDA) their zonal offices. This served as the sampling frame for the study. From each frame, 10 soybean farmers were selected from each village; adopting proportional stratified random sampling method to select the small-scale and medium-scale soybean farmers in the proportion of 60% and 40%, respectively in each village, that is, six small-scale and four medium-scale farmers. This proportion was used because of the preponderance of small-scale farmers over medium-scale farmers in Nigeria agricultural situation (Olayide, 1980). According to Olayide (1980) classification small-scale farms range from under 0.10 hectare to 5.99-hectares, medium-scale farms range from 6.00 to 9.99-hectares holdings.

Method of Data Collection:

Data for this study was obtained from primary source using structured questionnaire and or interview schedule by three trained research assistants who are indigenes of the study locations. The questionnaire focused on obtaining input-output data, such as: output of soybean production in kg, total labour used in man-days and family labour used in man-days, hired labour used in man-days, and socio-economic characteristics, etc. The data was analyzed using the Maximum Likelihood Estimation of Stochastic Frontier Production Function available FRONTIER Version 4.1 (Coelli, 1996).

Model Specification: Stochastic Frontier Production Function

This is stated as:

$$Yi = Xi\beta + (Vi - Ui)$$

$$i = 1...., N$$

Where: Y_i is (the logarithm of) the production of soybean of the ith farmer; X_i is a k x 1 vector of input quantities of the ith farm; β_i is a vector of unknown parameters; The V_is are random variables which are assumed to be iid~ N (0, σv^2), and independent of the U_i which are non-negative random variables which are assumed to account for technical inefficiency in soybean production and are often assumed to be iid N (0, σu^2). The data was fitted into Cobb-Douglass and transcendental logarithimic functional forms for the two small-scale and medium-scale soybean farmers.

(i) Cobb-Douglass production form:

(ii) Transcendental logarithmic (translog) production form;

$$\ln Yi = \beta o + \sum \beta i \ln(Xi) + (Vi - Ui) \quad \text{………………. (1)}$$

$$\ln Yi = \beta o + \sum_{i=1}^{3} \beta i \ln xi + \frac{1}{2} \sum_{i \le j=1}^{3} \sum^{3} \beta ij \ln Xi \ln Xj + Vi - Ui; \quad \text{…………(2)}$$

ln represents the natural logarithm; Where $\sum$ stands for summation; j=represents the input variables in the second-order term of the translog model;

output of soybean harvested for the ith farmer (in kilogramme), Xi=ith input variables in the model, X_1=total labour used in man-days, X_2=total area of land planted to soybean in hectares, X_3=total fertilizer used in soybean production in kilogrammes, β_0 is the constant parameter. β_i is the parameter estimate of the ith variable. The V_is are random errors that are assumed to be independent and identically distributed as N ($0\sigma_v^2$)random variables; and the U_is are non-negative technical inefficiency effects that are assumed to be independently distributed among themselves and between Vis such that U_i is defined by the truncation or a half-normal of the N distribution. $(\mu_i \sigma^2)$

Inefficiency Model

$$\mu_i = \delta_0 + \sum \delta j Zji \quad \text{………………………………… (3)}$$

μ_i is the technical inefficiency of the ith farmer; Where: δ unknown scalar parameters estimated, δo is the parameter estimate of the constant in the inefficiency model. δj is the parameter estimate of the determinant jth in the inefficiency model. Z_1 = Family size (number of persons in the family); Z_2 = Sex of household head (1 for male and 0 otherwise); Z_3 = Age of household head (in years); Z_4 = Education of household head (in years); Z_5 = Farming experience (in years); Z_6 = Health status (1 for presence of sick member (s) of the household i.e. protracted sickness and 0 otherwise.); Z_7 = Off-farm income (1 for off-farm income and 0 otherwise); Z_8 = Non-family labour in man-days; Z_9 = Credit accessibility (1 for access to credit and 0 otherwise); Z_{10} = Degree of fragmentation (Number of fragmented land used in soybean production in the cropping season); and Z_{11} = Contact with extension service (Number of visits in the cropping season).

To choose the functional form that best describes the inefficiency effect, the following hypotheses were tested using generalized log-likelihood ratio test; (i). $H_0 = \beta ij = 0$, for all i and j, which states that the Cobb-Douglas production function is an adequate representation of the data for soybean farmers. If this hypothesis is rejected, then H_1 will be accepted, meaning that the translog production function best describes the data; and (ii). H_0: $\gamma = \delta_0 = \delta_1 = ... \delta_{11} = 0$, this hypothesis specifies that the technical inefficiency effects are not present in the model. If this hypothesis is accepted, then the soybean farmers are fully technically efficient.

Test of the above hypotheses was obtained by using the generalized likelihood-ratio statistic, which is defined by:

λ = -2 ln [L(H_0)/L(H_1)] = -2 ln[L(Ho)-L(Hi)]

Where L(H_0) is the value of the likelihood function for the frontier model, in which the parameter restrictions specified by the null hypothesis, H_0 are imposed; and L(H_1) is the value of the likelihood function for the general frontier model. If the null hypothesis is true, then λ has approximately a Chi-square (or a mixed square) distributed with degrees of freedom equal to the difference between the parameters under H_1 and H_0, respectively; that is the number of parameters excluded in the model.

Results and Discussion

Descriptive statistics

The average age of the farmers was about 33 and 39 years for small and medium-scale, respectively, which means soybean farmers will still be productive and efficient in the use of resources in the next decade and soybean production in the country is expected to increase.

Education plays a significant role in skill acquisition and enhances one's ability to understand and apply technological innovations as well as his ability to plan and take risks. Table 1 shows that the average year of schooling was about 11 years for the two groups of soybean farmers. This implies that majority of the farmers attended secondary school or its equivalent. Obwona (2000; 2006) found that it is not necessarily the number of years of formal education, but that the education has to be relevant and of vocational agriculture-biased for efficiency and productivity to be enhanced. The average experience of small and medium-scale soybean farmers in soybean production was 8.70 and 12.67 years, respectively, with 40 and 30 years maximum of farming experience. The medium-scale farmers are more experienced than the small-scale farmers. Then, the longer a person stays on a job, the greater the tendency the person is to become an expert. The average household size was about 6 and 7 for small and medium-scale farmers, respectively. However, this higher size does not translate to higher use of family labour.

Table 1: Summary statistics of variables in soybean production

Variable	Sample mean	Standard Deviation	Minimum value	Maximum value
Output (Kilogrammes)				
Small-scale	1741.11	1081.90	300	5550
Medium-scale	7102.34	1567.73	4500	11100
Labour (Man -day)				
Small-scale	416.96	222.42	121	1021
Medium-scale	1155.10	321.39	752	210.2
Land (Hectare)				
Small-scale	2.19	1.20	0.5	5.5
Medium-scale	6.93	0.97	6.0	9.6
Fertilizer (Kg)				
Small-scale	134.22	168.75	0	750
Medium-scale	366.31	266.42	0	1100
Household size (Number)				
Small-scale	6.44	4.41	1	32
Medium-scale	7.33	3.48	2	20
Age (years)				
Small-scale	33.31	9.38	20	65
Medium-scale	38.81	11.65	20	70
Education level (years)				
Small-scale	11.31	3.51	0	16
Medium-scale	10.83	4.62	0	18
Farming experience (years)				
Small-scale	8.70	6.73	0	40
Medium-scale	12.67	7.33	1	30
Extension contact (number)				
Small-scale	0.28	0.45	0	1
Medium-scale	1.10	1.52	0	6
Land fragmentation				
Small-scale	3.69	2.12	1	10
Medium-scale	3.78	1.92	1	12

Source: Data analysis. 2007.

Maximum Likelihood Estimates (MLE) for Parameters of Cobb-Douglas and Translog Models

Maximum Likelihood Estimation (MLE) was used to achieve the objective of this paper, which involved the estimation of the two specified models (the Cobb-Douglas and the translog stochastic frontier models). The selection of the preferred model for each group of the soybean farmers was carried out with the generalized log likelihood-ratio statistic. The results of these tests are presented in table 3. The estimated stochastic frontier model (general model) is given in Table 2 and the inefficiency model in Table 5. The first null hypothesis H_0: ij=0, ij= 1, 2, 3, which specifies that the Cobb-Douglas frontier model is an adequate representation of the data, is strongly rejected for small scale soybean production, hence, the data from small-scale soybean farms are better analyzed with the translog frontier model. However, this hypothesis is strongly accepted for the medium-scale soybean production, hence, Cobb-Douglas frontier is therefore used for the analysis. The second null hypothesis, $H_0: \gamma = \gamma_0 = \gamma_1 \ldots = \gamma_{11} = 0$, which states that inefficiency effects are absent from the frontier model, is rejected for both groups of soybean farmers. Given the results of the test of hypotheses, the general (translog) frontier model was selected as the preferred model that better fits the data of small-scale soybean farms, however, the Cobb-Douglass (Restricted) frontier model was selected as the preferred model that better fits the data of medium-scale soybean farms. Hence, the discussions are based on the general (translog) frontier model for small-scale soybean production and on the restricted (Cobb-Douglas) frontier model for medium scale soybean farms.

Maximum likelihood estimates for parameters of the two estimated models are presented in table 3. Land and labour are highly significant at 5% level of probability for small-scale farmers while land and fertilizer are significant at 5% and 10% levels, respectively for medium-scale farmers. The estimated value for the - parameter in the preferred models (translog stochastic frontier production function for small-scale soybean production and Cobb-Douglasstochastic frontier production function for medium- scale soybean production), are quite large and significant, 0.889 for small scale soybean production and 0.999 for medium scale soybean production. These values indicate that technical inefficiency is highly significant in the production activities of soybean production. The -parameter shows the relative magnitude of the variance in output associated with technical efficiency. The coefficients of the variables derived from the Maximum Likelihood Estimation (MLE) are very important for discussing results of the analysis of the data. These coefficients represent percentage change in the dependent variables as a result of percentage change in the independent (or explanatory) variables.

Table 3: Generalised Log-likelihood ratio tests of Null Hypotheses

Null hypothesis	Log-likelihood	Test Statistics	Critical value*	Decision
H_0: γ ij =0, iγj = 1, 2, 3.				
Small-scale	-19.66	48.69	12.59	Reject H_0
Medium-scale	30.56	8.42	12.59	Accept H_0
H_0: $\gamma = 0$				
Small-scale	-31.63	72.64	21.00	Reject H_0
Medium-scale	19.15	22.82	21.00	Reject H_0

* The critical values were obtained from the chi-square table. Degree of freedom = Number of restrictions

Source: Data Analysis, 2007

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Table 2: Maximum Likelihood Estimates of Stochastic Frontier Production Functions for Small and Medium -Scale Soybean Farms

Variable	Parameter	Small-scale Soybean Farms				Medium-scale Soybean Farms			
		Cobb-Douglas function		Transcendental logarithmic function[a]		Cobb-Douglas function[a]		Transcendental logarithmic function	
		Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	β_0	5.197 (1.054)	4.929***	24.923 (1.530)	16.288***	6.413 (0.757)	8.467***	22.155 (1.129)	19.629***
Ln(Labour)	β_1	0.296 (0.195)	1.519*	-6.155 (0.622)	-9.899***	0.165 (0.162)	1.020	-6.396 (1.017)	-6.292***
Ln(Land)	β_2	0.755 (0.181)	4.170***	0.874 (0.149)	5.878***	0.757 (0.313)	2.416**	16.236 (1.065)	15.240***
Ln(Fertilizer)	β_3	0.016 (0.012)	1.271	0.420 (0.429)	0.979	0.027 (0.021)	1.269	-2.697 (1.321)	-2.041**
[Ln(Labour)^2]	β_{11}	0	-	0.510 (0.069)	7.385***	0	-	0.577 (0.285)	2.025**
[Ln(Land)^2]	β_{22}	0	-	-0.741 (0.119)	-6.221***	0	-	-1.097 (2.015)	-0.545
[Ln(Fertilizer)^2]	β_{33}	0	-	0.006 (0.012)	0.510	0	-	-0.002 (0.009)	-0.234
[Ln(Labour) x Ln (Land)]	β_{12}	0	-	0.202 (0.034)	5.912***	0	-	-1.768 (1.117)	1.505*
[Ln(Labour) x Ln(Fertilizer)]	β_{13}	0	-	-0.079 (0.082)	-0.961	0	-	0.323 (0.206)	1.569*
[Ln(Land) x Ln (Fertilizer)]	β_{23}	0	-	-0.053 (-0.072)	0.730	0	-	0.250 (0.158)	1.587*
Variance Parameters									
Total Variance	$\delta^2{}_S$	0.861 (0.400)	2.152**	0.262 (0.076)	3.475***	0.029 (0.009)	3.219***	0.022 (0.005)	4.282***
Gamma	γ	0.961 (0.019)	51.323***	0.889 (0.059)	15.024***	0.999 (0.097)	10.335***	0.999 (0.224)	4.471***

Table 4: Technical Efficiency Estimates of Small and Medium-scale Soybean Farms

Efficiency level	Frequency	
	Small-scale	**Medium-scale**
≤0.50	3 (3.13)	1 (1.56)
0.51 – 0.60	4 (4.17)	11 (17.19)
0.61 – 0.70	0 (0.00)	19 (29.68)
0.71 – 0.80	13 (13.54)	14 (21.88)
0.81 – 0.90	37 (38.54)	12 (18.75)
0.91 – 1.00	39 (40.62)	7 (10.94)
Total	**96 (100.00)**	**64 (100.00)**
Mean	0.84	0.73
Standard Deviation	0.136	0.131
Minimum	0.10	0.49
	0.96	0.99

Figures in parentheses represent percentages.
Source: Data analysis, 2007.

Factors influencing Technical Efficiency of Small-scale and Medium-scale Soybean Farmers

This section presents the results of the analysis of the factors that influence technical efficiency in small and medium-scale soybean production in Benue State. These explanatory variables (or factors) are of interest in this study because they have important policy implications. Table 5 presents the result of the inefficiency model for the two groups of soybean farmers.

For the small-scale soybean farmers, family size, age, farming experience, credit accessibility, land fragmentation and extension services had significant effects on the level of technical inefficiency. This means that farming experience, credit accessibility, land fragmentation and extension service/contact had positive relationship with technical inefficiency, while for their medium-scale soybean counterparts, age and off-farm income had significant effects on the level of technical inefficiency. The positive coefficients imply that the variables have the effect of increasing the level of technical inefficiency. Any increase in the value of such variables would lead to a decrease in the level of technical efficiency. Also in small-scale farms, family size and age of household head had negative relationship with technical inefficiency. The negative coefficients imply that any increase in the value of the variable would lead to an increase technical efficiency level of the farmers. However, in medium-scale soybean farms, age and off-farm income have negative relationship with technical inefficiency. The negative coefficients imply that these variables have the tendency of increasing the technical efficiency level of the farmers.

Family size is very essential in smallholder farming in most parts of Africa including Nigeria because family labour, which is predominantly used in farming, is derived from the size of the family he estimated coefficient has a negative sign and was significant at 5% for small-scale soybean farmers. This implies that as family size increases, technical inefficiency. This is in agreement with the findings of Obwona (2000; 2006).

Age: The estimated coefficients *of* age for small and medium-scale soybean farmers have negative signs, as shown in table 5. This suggests that as the age of farmers in soybean production increases their level of technical efficiency increases. The finding is a deviation from the findings of Ajibefun *et al.* (2002) and Ojo (2003) in which they found out that technical inefficiency tends to increase with age. However, the finding agrees with the findings of Chavanapoonphol, Battese & Chang (2005) and Ogundari (2006) in which they found out that technical efficiency and profit efficiency, respectively, increase with age. The results from table 5 show that age was significantly related to technical efficiency at 5% level for the two groups of soybean farmers.

Farming Experience: The estimated coefficient has positive sign for small-scale soybean farmers and is significantly related to technical efficiency at 10% level of probability. The finding disagrees with the findings of Ajibefun *et al.* (2002), Ajibefun (2006), Ajibefun, *et al.* (2006) and Ogundele and Okoruwa (2006), which indicated that efficiency increases with experience. However, the finding agrees with the finding of Ojo (2003) which found that technical efficiency decreases with experience. This finding has the implication that farming experience had the effect of increasing technical inefficiency of small-scale soybean farmers.

Off-farm income: The estimated coefficient of off-farm income has negative significant relationship with technical inefficiency for medium-scale soybean farmers at 5% level of probability. This suggests that off-farm income had the effect of increasing technical efficiency of medium scale soybean farmers. This indicates that off-farm income has a strong link with medium-scale soybean production. It could be that off-farm income was used in procuring some of the production resources used in the cropping year. This finding agrees with the findings of Obwona (2000; 2006).

Access to credit: The estimated coefficient of access to credit was positive but of significant effect for small-scale soybean farmers at 5% level of probability. The finding shows that the technical inefficiencies tend to increase for farmers that had access to credit. The finding disagrees with the findings of Abdulahi and Huffman (1998), Solios, *et al.* (2006) and Taylor and Shonkwiler (1986), which indicated that inefficiency decreases with credit accessibility. However, this finding agrees with the findings of Obwona (2000; 2006) and Donkor and Owusu (2014). It implies that a well-structured and supervised credit programme or facilities have to be put in place with easy access and less administrative bottlenecks in public financial institutions for small-scale soybean farmers to benefit from.

Farm plot/land fragmentation: The coefficient of land fragmentation variable is positive and significant at 5% level for small-scale soybean farmers. For small-scale soybean farmers, an increase in the number of fragmented land tends to decrease technical efficiency level. This agrees with the finding of Obwona (2006), which found out that increase in the number of fragmented land decreased technical efficiency. **Extension services/contacts:** The estimated coefficient of extension services/contacts has positive sign and significant at 5% level of probability for small-scale soybean farmers. This implies that an increase in the number of extension contact/ services would increase the level of technical inefficiency. This finding agrees with the findings of Ajibefun (2006) of mixed Croppers, Kebede (2001), Obwona (2000; 2006), which found that an increase in extension contact would decrease the level of technical efficiency. But the finding here disagrees with the findings of Ajibefun (2006) of cassava croppers, rice croppers and maize croppers and Ogundele and Okoruwa (2006), which found that increase in extension contacts led to increase technical efficiency.

Table 5: Factors that influence Technical Efficiency in Small and Medium -scale Soybean Production

Inefficiency model Variable	Parameter	Small-scale			Medium-scale		
		Coefficient	Standard error	t-ratio	Coefficient	Standard error	t-ratio
Constant	δ_0	-0.678	0.950	-0.714	0.677	0.232	2.922***
Family Size (Z_1)	δ_1	0.214	0.0426	-5.030***	0.013	0.018	0.763
Sex (Z_2)	δ_2	-0.0498	0.377	-0.132	-0.091	-0.089	-0.010
Age (Z_3)	δ_3	-0.488	0.0261	-1.833*	-0.0959	0.005	-1.953*
Education level (Z_4)	δ_4	0.0278	0.0554	0.502	0.0009	0.0077	0.129
Farming Experience (Z_5)	δ_5	0.0418	0.0268	1.556*	0.0082	0.0064	1.287
Health Status (Z_6)	δ_6	-0.124	0.303	-0.409	0.0692	0.0709	0.976
Off-farm income (Z_7)	δ_7	0.643	0.470	1.369	-0.174	0.0921	-1.883*
Non-family labour (Z_8)	δ_8	-0.00225	0.00154	-1.461	0.0000815	0.00021	0.387
Access to credit (Z_9)	δ_9	0.787	0.245	3.214***	0.00710	0.0727	0.0976
Land fragmentation (Z_{10})	δ_{10}	0.267	0.00956	2.780***	-0.00819	0.0167	-0.491
Extension Contact (Z_{11})	δ_{11}	0.962	0.342	2.814***	0.00821	0.00901	1.287

Values in parentheses are standard errors. ***,**, *, significant at 1%, 5%, and 10% respectively.
Source: Data analysis, 2007.

Conclusion and Recommendations

The study examined and compared the technical efficiency in small and medium-scale soybean production in Benue State, Nigeria. The findings revealed that, family size, age, farming experience, off-farm income, non-family labour, credit accessibility, land fragmentation and extension contact influenced the technical efficiency of small-scale soybean production. Age, farming experience, off-farm income and extension contact influenced the technical efficiency of the medium-scale soybean production. Small-scale farmers in the area were markedly more technically efficient than the medium-scale soybean farmers. It is then evidenced that the Nigeria agricultural development is still at the level where small-scale soybean farmers are to be included in agricultural planning and programmes and must also be focused with necessary productive resources so that the production of the crop can be increased in order to bridge the noticeable demand/ supply gap.

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