African Journal of Agricultural Research Vol. 5(17), pp. 2276-2280, 4 September, 2010
Available online at http://www.academicjournals.org/AJAR
ISSN 1991-637X ©2010 Academic Journals

Full Length Research Paper

Constraints and determinants of technical efficiency in medium-scale soybean production in Benue State, Nigeria

Moradeyo Adebanjo Otitoju* and C. J. Arene

Department of Agricultural Economics, University of Nigeria, Nsukka, Enugu State, Nigeria.

Accepted 13 August, 2010

This study presents the empirical analysis of the constraints and determinants of technical efficiency in medium-scale soybean production in Benue State, Nigeria. Primary data were collected on 64 medium scale soybean farmers selected from the 2 major soybean-producing agricultural zones in the state in Nigeria. The selection of respondents was multi-staged and involved random sampling as well as purposive sampling methods. Mean and standard deviation were used to analyse the constraints on soybean production while translog stochastic frontier model was used to estimate the determinants of technical efficiency of the farmers. The major constraints on soybean production as perceived by medium-scale farmers among others was inadequate processing facilities ($\overline{X}$ = 3.42) and lack of mechanical services ($\overline{X}$ = 3.41). The average technical efficiency was about 73%. The determinants of technical efficiency which were statistically significant were sex, age and experience. Sex and age had an inverse relationship with technical inefficiencies of the farmers while experience had a direct relationship. Hence, Nigeria public and private policies that would improve the farmers' experiences in soybean production especially in handing the available technologies would lead to significant increase in the level of technical efficiency in medium-scale soybean production.

Key words: Constraints, determinants, stochastic frontier, technical efficiency, medium-scale, soybean production, Nigeria.

INTRODUCTION

Nigerian farmers (medium-scale soybean farmers inclusive) are often being constrained by several factors which have direct or indirect effects (or impacts) on agricultural productivity and invariably on production but some of these problems or factors had been addressed by successive Nigerian Governments through different intervention programmes or policies in the past but many of these policies are inconsistent with unintended consequences as identified by Idachaba (1991, 2000) and Olaitan (2007) which then bring about the poor performance of Nigerian agriculture. About 80% of all farm holdings in the country are classified as small-scale farms; this class of farms range from 0.10 to 5.99 ha. Medium-scale farms range from 6.00 to 9.99 ha and they account for about 14% of all farm holdings in Nigeria in 1973/1974 (Olayide, 1980). It is appropriate that intervention programmes and policies should focus on all farmers irrespective of their class. Medium-scale farmers are also important when considering appropriate intervention programmes, if Nigeria is to experience increased agricultural production.

Nigeria is the largest producer of soybean (*Glycine max* L.) for food in the West and Central Africa (Root et al., 1987). More recently, Nigeria was ranked as the largest producer of soybean in African (2003) by the International Development Research Centre (IDRC), Canada

*Corresponding author. E-mail: maobanjo@yahoo.co.uk.

Table 1. Summary of statistics of key variables of medium-scale soybean farmers.

Variable	Sample mean	Sample standard deviation	Minimum	Maximum
Output (Kg)	7102.344	1567.73	4500	11100
Labour (man-days)	1155.10	321.39	752	2102
Land (hectares)	6.93	0.97	6.0	9.6
Fertilizer (Kg)	366.31	266.42	0	1100
Family size (Numbers)	7.33	3.48	2	20
Years of schooling	10.83	4.62	0	18
Age of the household head (Years)	38.81	11.65	20	70
Farming experience soybean production	12.67	7.33	1	30

Source: Field Survey, 2007.

(http://www.idrc.ca). The estimated output of soybean from 1998 to 2003 were 327,000, 333,000, 339,000, 383,000 times (revised) and 402,000 ton (provisional), respectively (CBN, 2000, 2001, 2002).

Benue State is the largest producer of soybean in Nigeria. It was declared a special soybean producing area in 1985 by the Federal Government of Nigeria (Ayoola, 2001). The efficacy of soybean protein has been reported in comparison to other traditional sources of protein; 1 kg of soybean contained as much protein as 2 kg of boneless meat or 5 dozen of eggs or 45 cups of cow's milk and that it is relatively cheap compared to these other traditional protein sources (Dashiell, 1993). These qualities have led to the successful incorporation of soybean into an ever-increasing list of traditional foods of different regions and ethnic groups in Nigeria. At least 140 food products with improved nutritive value and high acceptability were developed. Some of these products were scaled up to industrial level (Okoruwa, 1999).

The rising demand for soybean in Nigeria, both for domestic consumption and industrial use spurred government to bring up policies and programmes in order to address the demand/supply gap. Some of these policies are inconsistent and do not directly include medium-scale farmers except small and medium enterprises (SMEs) under the Agricultural Credit Guarantee Scheme Fund (ACGSF) of the Central Bank of Nigeria. Thus, badly formulated and poorly executed policies always affect Nigerian agricultural production. The limited capacity of the Nigerian soybean sector to match the domestic and industrial demand raised a number of pertinent questions both in the policy circles and among researchers. For example, what are the factors (or constraints) explaining why domestic soybean lags behind the demand for the commodity in Nigeria?

Central to this explanation is the issue of efficiency of the soybean farmers, especially the medium-scale farmers, which this paper addresses, in the use of available resources or technology. Ajibefun (2006) opined that efficiency of production is central to raising production and productivity in the African agriculture. Several studies have been carried out on estimation of efficiency especially among small-scale farmers (Ajibefun et al., 2002; Ajibefun et al., 2006; Kondoun, 2000) but little or no empirical studies have been conducted on the efficiency of medium-scale farmers. Thus, this paper addresses the constraints and determinants of technical efficiency of medium-scale soybean farmers in Nigeria.

MATERIALS AND METHODS

Empirical analysis

The data used for this study were obtained from surveys in the major soybean-producing areas of Benue State, Nigeria. The survey was conducted in March – April, 2007 by research assistants who were final year students of Agricultural Economics, University of Agriculture, Makurdi, Benue state, Nigeria.

The survey collected information on input-output data; data on output of soybean production in kg, total labour used in man-days, total land area planted to soybean in hectare, fertilizer used in kg and some socio-economic variables like family size, sex of household head, age of household head, years of schooling and farming experience in soybean production.

The survey targeted medium-scale soybean farmers in Benue State, Nigeria. The major soybean-producing agricultural zones were purposively selected for the study; Northern and Eastern agricultural zones consisting of 14 local government areas. Then, 2 local government areas (LGAs) were randomly selected from each zone. 2 Districts were selected from each LGA and 2 soybean-farming villages were randomly selected from each district. Lastly, 4 medium-scale soybean farmers were randomly selected from each farming-village. The total number of farmers was 64 for the study.

A summary of the values of the key variables in the stochastic frontier model is presented in Table 1. The output of soybean produced by sample farmers varied between 4500 and 11,100 kg with the average of 7102.34 kg. The main sources of labour were family, hired and exchange labour, which varied from 752 to 2102 man-days. The average land areas that were cultivated by sample farmers were 6.93 ha. The average use of fertilizer in medium-scale soybean production was 366.31 kg; some of the farmers did not use fertilizer. The average family size of the sample farmers was about 7.

The average years of schooling, age of sample farmers and experience in soybean production were about 11, 39 and 13 years, respectively indicating that the medium-scale soybean farmers were quite not too old with considerable experience in soybean production but with formal education at least secondary education (completed or uncompleted).

Table 2. Maximum likelihood estimates for parameters of the Translog Stochastic frontier production function for medium-scale soybean farmers in Benue State, Nigeria.

Variable	Parameter	Coefficient	Standard error	t-ratio
Production function				
Constant	β_0	31.230	4.906	6.366**
Labour	β_1	- 6.697	1.249	-5.363**
Land	β_2	9.610	7.827	1.228***
Fertilizer	β_3	-3.258	1.173	-2.777**
[Labour]^2	β_{11}	0.283	0.421	0.670
[Land]^2	β_{22}	- 2.482	1.143	-2.172**
[Fertilizer]^2	β_{33}	0.00435	0.00981	0.443
[Labour x Land]	β_{12}	0.107	1.481	0.0720
[Labour x Fertilizer]	β_{13}	0.462	0.200	2.310**
[Land x Fertilizer]	β_{23}	0.0231	0.166	0.139
Inefficiency model				
Constant	δ_0	0.577	0.0925	6.245**
Family size: (Z_1)	δ_1	-0.000145	0.00691	-0.0210
Sex: (Z_2)	δ_2	-0.0862	0.519	-1.661***
Age: (Z_3)	δ_3	-0.00861	0.00302	-2.849**
Years of schooling: (Z_4)	δ_4	-0.00162	0.00460	-0.352
Experience: (Z_5)	δ_5	0.0140	0.00392	3.558**
Variance parameter				
Total parameter	σ_s^2	0.0246	0.00399	6.158**
Gamma	γ	0.999	0.130	7.695**
Log likelihood function		31.711		

Significant at 5% Level, *** Significant at 10% Level.

Stochastic frontier analysis

The empirical results from our analysis indicated that the transcend-dental logarithmic (translog) production function is an adequate representation of the data, given the specification as defined below. Because of this funding, results for only the translog stochastic frontier production function are presented in this paper. The translog model that was estimated in this paper is defined as:

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

Where, Yi represents the quantity of soybean harvested for the sample farmer (in kilogrammes); X_1, the total labour used in medium-scale soybean production (in man days); X_2, is the total area of land planted to soybean (in hectares); X3, is the total quality of fertilizer used in soybean production (in kilogrammes).

The V_{is} are random errors that are assummed to be independent and identically distributed as N (0, σv^2) random variables; and the U_{is} are non-negative technical inefficiency effects that are assumed to be independently distributed among themselves and between the V_{is} such that U_i is defined by the truncation of the N (μ_i, σ^2) distribution, where μ_i, is defined by:

$$\mu_{i,} = \delta_0 + \sum_{i=1}^{5} \delta j \, Zji \quad (2)$$

Where, Z_1 represents the family size of sample farmer (in number); Z_2 represents the sex of household head (dummied as 1 for male and 0 otherwise); Z_3 represents the age of household head (in years); Z_4 represents the years of schooling of household head and Z_5 represents the farmer's experience in soybean production (in years).

The Z_s are included in the model to indicate their possible influence on the technical efficiencies of the medium–scale soybean farmers. The estimates for all the parameters of the stochastic frontier production function and inefficiency model were contemporaneously obtained using the computer programme, FRONTIER Version 4.1 (Coelli, 1996), which estimates the variance parameters in terms of $\sigma_s^2 = \sigma^2 + \sigma_r^2$ and $\Upsilon = \sigma^2/\sigma_s^2$. Generalised likelihood - ratio statistic, λ = - 2ln [$L(H_0)/L(H_1)$ is the value of the likelihood function for the frontier model, in which the parameter restrictions that are stated by the appropriate null hypothesis, H_0, are imposed and L (H_1) is the value of the likelihood function for the general frontier model. The generalised likelihood ratio statistic has approximately a chi-square (or mixed chi-square) distribution if the null hypothesis is true.

RESULTS AND DISCUSSION

Estimation of the frontier model

The maximum likelihood estimates of the parameters in

Table 3. Technical efficiencies of sample medium-scale soybean farmers.

Technical efficiency	Frequency	Percentage
0.401 – 0.600 (Medium)	10	15.6
0.601 – 0.800 (High)	35	54.7
0.801 – 1.000 (Very high)	19	29.7
Total	64	100.0

the stochastic frontier model, defined by Equations (1) and (2), are given in Table 2. The estimate for the γ - parameter in the stochastic frontier model was quite large (0.999), which means that the inefficiency effects werehighly significant in the analysis of soybean output of the farmers. Land variable was positive and significant at 10% level. This value implies that increase in land variable was positive and significant at 10% level and that increase in land by 1% is likely to increase medium-scale soybean production by 9.610%. Labour and fertilizer inputs were also significant at 5% but with negative coefficients. These negative values may be as a result of over-use of labour and fertilizer by medium-scale soybean farmers. The coefficient of the squares of the logarithm of land was negative and statistically significant at the 5% level. This indicates that the translog model exhibited decreased marginal productivity with respect to land. The coefficient of interaction between labour and fertilizer was significant at 5% level. The coefficients of some of the explanatory variables (or determinants) like sex, age and experience were statistically significant.

The positive sign for experience shows that farmers with higher experience in soybean production tended to have higher technical inefficiencies. This could be that the experience the farmers had, was not geared towards the competency or skills needed for excellence in handling the available technologies required in medium-scale soybean production. This may be in consonance with the dictum, 'it is not how far but how well'. The estimated negative coefficient for sex of household head shows that male-headed medium-scale soybean household tended to be more technically efficient than female headed household.

So, an additional male-headed household will reduce technical inefficiency in medium-scale soybean production by 0.0862%. The estimated negative coefficient of age of household head means that older farmers tended to have smaller technical inefficiencies than younger farmers, *Ceteris paribus.* This means 1% increase in age of the farmers will reduce technical inefficiencies by 0.0081%.

The null hypothesis, Ho: $\gamma = 0$, means that there were no technical inefficiencies in medium-scale soybean production, which shows that traditional response function OLS was an inadequate representation of the data for medium-scale soybean farmers and not translog model.

The generalised likelihood ratio test was conducted. The Chi-square (X^2) distribution showed that the computed Chi-square was 34.49 while the critical value of the Chi-square at 5% level of significance with 7 degree of freedom X^2 (5%, 7) was equalled to 14.07. Thus, the null hypothesis was strongly rejected, leading to the preference of translog model for adequate representation of the data.

Technical efficiencies

The mean technical efficiency of all sample farmers selected from Benue State, Nigeria, given the specifications of the stochastic frontier model, was 0.727, while the maximum and the minimum values of the technical efficiency of the sampled farmers were 0.993 and 0.524, respectively. About 54.7% of the total sampled farmers had high technical efficiencies that were between 0.60 and 0.801 (Table 3). Any constraint with mean value of 2.50 and above was a major constraint. Inadequate processing facilities ranked first among the major constraints as perceived by the sample farmer with mean value of 3.42 followed by lack/inadequate access to mechanical services such as tractor hiring with mean values of 3.41 (Table 4).

Conclusion

The study observed that technical efficiency of medium-scale soybean farmers varied due to the presence of technical inefficiency effects in soybean production in Nigeria. The variable of sex and age decreased the farmers' technical inefficiency and invariably increased their technical efficiencies, while experience increased their technical inefficiencies. Moreover, inadequate processing facilities ranked first among major constraints on medium – scale soybean production as perceived by the sample farmers.

Farmers should therefore be encouraged by creating skill acquisition training centre on medium–scale soybean production so that they can acquire the competencies required in soybean production. Male-headed soybean production household should be given more incentives for their farming programmes so that increased soybean production can be witnessed in order to bridge the

Table 4. Constraints on soybean production as perceived by sample medium – scale farmers.

Constraint	Means	Standard deviation
High cost of production	3.23*	0.58
Inadequate storage facilities	2.75*	0.99
Problem of land ownership	2.17	1.11
Credit inaccessibility	2.75*	0.82
Inadequate processing facilities	3.42*	0.81
Low and / or fluctuating price of produce	3.36*	0.78
Weed problem	2.64*	1.17
Rest problem	3.36*	0.87
Lack of improved varieties	1.63	0.88
Lack of finance	2.59*	0.83
Inadequate/lack of access to mechanical services such as tractor hiring	3.41*	0.79
Souring for farm labour	2.38	0.90
Low/poor extension services/contact	3.22*	0.86
Lack of skills and technical know how	2.22*	0.86
Lack/inadequate access to farm resources such as fertilizers, herbicides	2.58*	0.89
Inaccessible market	1.69	0.96

existing demand/supply gap of soybean in Nigeria.

REFERENCES

Ajibefun IA (2006). Linking Socio-economic and Policy Variables to Technical Efficiency Evidence from Nigeria. A paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August, pp. 12-18.

Ajibefun IA, Daramola AG, Falusi AO (2006). Technical Efficiency of small scale farmers: An Application of the stochastic Frontier Production Function to Rural and Urban Farmers in Ondo State, Nigeria. In: Int. Econ. J., 20(1): 87-107, March.

Ajibefun IA, Battese GE, Daramola AG (2002). Determinants of Technical Efficiency in Smallholder Food Crop Farming: Application of Stochastic Frontier Production Function. In: Q. J. Int. Agric. 41(3): 225-240.

Ayoola GB (2001). Essays on the Agricultural Economy: A Book of Readings on Agricultural Policy and Administration in Nigeria, Ibadan: TMA. Publishers, 1: 1-5.

CBN (Central Bank of Nigeria) (2000; 2001; 2002). Annual Reports, Nigeria.

Dashiell KE (1993). Soybean Production and Utilization in Nigeria. Paper Presented at the National Workshop on held at IITA, Ibadan, Nigeria.

Idachaba FS (1991). The Nature of the Nigerian Food Problems. In: J. Agric. Sci. Technol., 1(1): 1-11.

Idachaba FS (2000). Desirable and Workable Agricultural Policies for Nigeria in the First Decade of the 21st Century. In: Topical Issues in Nigerian Agricultural Series, University of Ibadan, Nigeria.

IDRC (International Development Research Centre), Canada. Retrieved December 16, 2006. In: http://www.idrc.ca.

Kondoun TM (2000). Education and Technical Efficiency of Small Scale Production: A case study of soy bean Farmers in Gboko LGA of Benue State. Unpublished M. Sc. Thesis submitted to the Dept. of Agricultural Economics, University of Agric., Makurdi, Nigeria.

Okoruwa AE (1999). Soybean Pressing and Utilization for Healthy Nutrition in West Africa. In: IDRC/IIIA Soybean Utilisation Project Phase III Final Report. May 1994 – Sept. 1999.

Olaitan SO (2007). Sustaining Reforms in Agriculture for the Achievement of the Millennium Goal in Food Production, Employment Creation and Poverty Reduction. A paper presented at the National Conference of Faculty of Education, University of Nigeria Nsukka 6-9 August.

Root MA, Morr CV, Thomas RL (1987). West and Central Africa: Nigeria Sets Examples for Expression of Soybean. In: S. R. Singh, K. O. Rachie and K. E. Dashiell (eds.): Soybean for the Tropics: Research, Production and Utilization. Chiohester: John Wiley and Sons Ltd., 81-85.