ANALYSIS OF PRODUCTION EFFICIENCY AMONG SMALL-SCALE SOYBEAN FARMERS IN SABON GARI LOCAL GOVERNMENT AREA OF KADUNA STATE, NIGERIA

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Abstract
The study was carried out to analyze the production efficiency of small scale soybean farmers in Sabon-Gari L.G.A of Kaduna State, Nigeria. Random sampling method was used to select 120 respondents. Data were collected through the use of structured questionnaires, both descriptive statistics and Stochastic Frontier analytical technique were employed in the analysis. Result of the study showed there was significant relationship between input and output in soybean production. Coefficients of seed (-27.15) and farm size (3048.95) were statistically significant (p< 0.01) while fertilizer was statistically significant at p< 0.05. Result on technical efficiency indicate coefficient of land (0.6253), labour (0.4315) and fertilizer (0.2205) were positive and significant each at 1% level of probability. Seed and agrochemicals remained insignificant as revealed by the result of this study. The mean technical efficiency of the farmers was approximately 80%, which is an indication that the farmers were technically efficient. Estimates of the technical inefficiency result showed age (-0.0294) was significant. Household size (-0.0089) and extension contacts (-0.0064) have negative relationship with the output but are insignificant. Lack of threshing machine (60.83%), high cost of labour (54.17%), inadequate capital (48.33%) and lack of access to credit (39.17%) were identified as constraints hindering soybean production. Thus, it was concluded that labour, availability of land and fertilizer were technically efficient and additional increase in these variables will enhance productivity of small scale soybean farmers in the State. The study recommended government should come up with an intervention programme to assist farmers with mechanized implements and credit facilities to alleviate the farmers' challenges of inadequate capital and credit in their production.

Keywords: Production Efficiency; Small-Scale Farmers; Soybean; Kaduna State; Nigeria

Introduction
Agricultural productivity is crucial to the economies of most developing countries for food security, poverty alleviation and sustainable development. Its role in the provision of

foreign exchange and development of economies cannot be overstated, as it remained for a long time the main source of earnings (Nkamelu, Nyemeck and Gockowski, 2010; Adeniyi and Ogunsola, 2014; Ameachi, 2018). Although the Nigerian economy relies heavily on petroleum and gas sector, in particular, agriculture continues to play an important role in the economy (Ugwu, 2009; Agbaeze, Udeh and Onwuka, 2015).
Soybean (*Glycine max L.*) is an annual herbaceous legume plant of the pea family leguminosae that grows in tropical, subtropical and temperate climates. Soybean was introduced to Africa in the 19th century by Chinese traders along the east coast of Africa (International Institute for tropical Agriculture [IITA], 2007). Soybean accounts for about 35% of total harvested area devoted to annual and perennial oil-crops globally. The crop's share in global oil-seed output is estimated at over 50%. The leading producers are U.S.A. (45%), Brazil (20%) and China (12%) (Food and Agriculture Organisation [FAO], 2015). Combined, soybean and its derivatives are the most traded agricultural commodity, accounting for over 10 percent of the total value of global agricultural trade (Tani, Anh, James, and Mark, 2016). Soybean (*Glycine max* [L.] Merril) is an important source of vegetable oil for human consumption and is quoted to serve as an alternative source of protein (Couto, Wang, Green, Kiely, Siddaway, Borer, Pears, and Lakin, 2011; Abbasi, Ghulam and Muzammil, 2012). As one of the most important legumes species, soybean contains about 40% highly nutritious protein with all essential amino acids compared to other leguminous crop (Raghuvanshi and Bisht, 2010).

Nigeria produces soybean worth $85 million in the international market and it is consumed locally where it is used in the production of soymilk and specially formulated foods to help malnourished infants and children. In Nigeria, soybean is mostly produced in the middle belt with Benue State accounting for over 70% of the production in Nigeria. Some of the states producing soybean in Nigeria include Kwara, Kogi, Oyo, Ondo, Osun, Nassarawa, Kaduna, Niger, Bauchi, Ogun, and Taraba states (Foramfera, 2011; Ugbabe, Abdoulaye, Kamara, Mbaval and Oyinbo, 2017). Increasing food production is vital for enhancing future food security in the country as this is no longer debatable but a necessity. To achieve this, good knowledge of the current efficiency or inefficiency inherent in crop production as well as factors responsible for the level of efficiency and inefficiency must be critically examined.

Efficiency is often used synonymously with that of productivity which relates output to input. In agriculture, the analysis of efficiency is generally associated with the possibility of farm production to attain optimal level of output (Upev, Haruna and Giroh, 2016). As stated by Kumbhakar and Lovell (2000), efficiency represents the degree of success which producers achieve in allocating the available inputs and the outputs they produce in order to achieve a high degree of efficiency in cost, revenue, or profit. More importantly, enhanced technical efficiency will not only enable farmers to increase the use of productive resources, it will also give direction for the adjustments required in the long run to achieve food sustainability. Therefore, to increase the yield and productivity of soybean, efficient utilization of improved production practices must also be promoted. Technical efficiency improvement in soybean production means farmers can produce more without necessarily increasing the usage of resources (Patrick, Lawrence and Job, 2015; Ugbabe *et al.,* 2017; Moses, 2017). Thus, this study set to (i) determine the technical efficiencies and inefficiencies in soybean production and (ii) identify the constraints faced by soybean farmers in the study area.

Methodology

The Study Area

The study was conducted in Sabon-gari Local Government Area of Kaduna State, Nigeria. Kaduna State is one of the North-Western states in Nigeria located between latitudes 90^0N and 12^0N of the equator and between longitudes 6^0E and 9^0E of the prime meridian. It shares common borders with six other states (Katsina, Kano, Zamfara, Nasarawa, Plateau and Niger). The hottest months are March-April while the coldest are December/January. Rainfall is heaviest in the south and decreases northwards with an annual mean rainfall varying between 942mm and 1000mm which lasts from May till October (Kaduna State Government, 2014).

Sampling Procedure

Multi-stage sampling technique was used in this study. The target populations for this study were soybean farmers. The first stage involved the purposive selection of three villages (Shika, Bomo and Bassawa) in the local government area. Purposive selection was used to select these villages based on high intensity of soybean production in the area. In the second stage, there was no comprehensive list of soybean farmers in these villages but a list was generated with the help of the cooperative groups and two hundred and thirty nine (239) soybean farmers were identified. A total of one hundred and twenty (120) respondents were randomly selected and interviewed using a structured questionnaire.

Empirical Model

Stochastic Frontier Production Function

The stochastic frontier production function independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and Van Den Broeck (1977) assumes that maximum output may not be obtained from a given input or a set of inputs because of the inefficiency effects. It can be written as:

$Y_i = f(X_i;â) + å$ ....(1)

Where: Y_i is the quantity of agricultural output produced by the ith farming household; X_i is the vector of input quantities for ith farming household; â is a vector of parameters to be estimated; and $å_i$ is an error term defined as:

$å_i = V_i – U_i$, i = 1,2, … n farms .... (2)

V_i is a symmetric component that accounts for pure random factors on production, which are outside the farmers' control such as weather, disease, topography, distribution of supplies, combined effects of unobserved inputs on production and so on. U_i is a one-sided component, which captures the effect of inefficiency and hence measures the shortfall in output Y_i from its maximum value given by the stochastic frontier $f(X_i;â) + V_i$.

The model is expressed as:

$Y_i = \exp(X_i â + V_i - U_i)$ .... (3)

The stochastic frontier production model has the advantage of allowing simultaneous estimation of individual technical efficiency of the respondent farmers as well as determinants of technical efficiency (Battese and Coelli 1995).

To achieve objective (i) the model used is given as:

$\ln Y â = â_0 + â_1 \ln X_1 + â_2 \ln X_2 + â_3 \ln X_3 + â_4 \ln X_4 + â_5 \ln X_5 + â_i – I_i$ .... (4)

Where:

$\ln Y_i$ = log of output (Y) in kilogram (kg)
$\ln X_1$ = log of seed (X_1) in Kilogram (kg)
$\ln X_2$ = log of land (X_2) in hectare (ha)
$\ln X_3$ = log of labour (X_3) in man per day
$\ln X_4$ = log of fertilizer (X_4) in kilogram (kg)
$\ln X_5$ = log of agrochemicals (X_5) in liter (lt)
â= vector of parameters to be estimated
$V_i – U_i$ = error terms for ith farm

V_i is a symmetric component that accounts for pure random factors on production, which are outside the farmers control.

U_i is a one-sided component, which captures the effect of inefficiency and hence measures the shortfall in output Y_i from its maximum value.

The model to be used for achieving objective (ii) is given as follows:

$Ui = á_0 + á_1 Z_1 + á_2 Z_2 + á_3 Z_3 + á_4 Z_4 + á5Z5$… .... (5)

Where:

U_i = technical inefficiency effects
Z_1 = age of farmer (years)
Z_2 = farming experience (years)
Z_3 = level of education (years in schooling)

Z_4 = household size (number of persons)
Z_5 = Access to extension (number of contacts)
$á_1$ - $á_5$ = vectors of parameters to be estimated.

Results and Discussion
Technical Efficiency of Soybean Production

Technical efficiency analysis shows the resources use efficiency in a production process. Result in Table 1 revealed coefficient of land (0.6253) to significant and positive, this positive effect of land size on soy bean output implies that increase in the size of farm will lead to an increase in output of soy bean by 6kg. The coefficient of land size was statistically significant at 1 percent level of probability, indicating the relevance of land on soybean. This result is in line with the work of Moses (2017) that farm size contributes to output. The coefficient of labour input is also positive (0.4315) and statistically significant suggesting its importance in agricultural production. The positive effect implies that increase in family labour will lead to increase in output of soybean with 4.3kg. Fertilizer (0.2205) was also positive and significant at $p < 0.01$. This is in line with the *apriori* expectation and thus implies that 1% increase in fertilizer will increase in output respectively.

The result of this study is in agreement with Kasim, Mad, Rusli, Y. and Alias (2014) who revealed that coefficients of labour and fertilizer were positive and significant at 1% level of probability. Seed and agrochemicals remained insignificant as revealed by the result of this study. Though not significant, the negative coefficients of seed and agrochemicals indicate that any attempt to increase any of them would lead to decrease in output. This could be due to the fact that plants have reached the maximum density on the farmland, and soybean plant requires use of agrochemical application. Contrary to the finding of this study, Kebede and Adenew (2011) revealed that seed positively and significantly affects the technical efficiency of commercial wheat farms in Ethiopia.

The mean technical efficiency of the farmers was approximately 80%, which is an indication that the farmers are technically efficient. The remaining 20% loss in production may be due to farmers' socio-economic inefficiencies. This result corresponds with Kasim, Mad, Rusli, and Alias (2014) which revealed that the mean score for the technical efficiency from the agro ecological zones of Nigeria are 86.7% for Southern guinea savanna, 83.8% for Sudan savanna and 83.4% for Northern guinea savanna. The result of this research also corresponds with findings of Dlamini, Masuku and Rugambisa (2012) which estimated the mean technical efficiency of maize farmers in Swaziland to be 80%, while Shalma (2014) estimated the mean technical efficiency of soy bean farmers in Nigeria to be 95%.

*A negative sign on coefficient of a parameter means that the variable reduces technical inefficiency and hence, increases technical efficiency, while a positive sign increases technical inefficiency (*Coelli, 2005). *Table 1 showed age (-0.0294) is significant at 1% level of probability with a negative sign. This implied that an increase in the age of the farmer will lead to decrease in the farmer's technical inefficiency by 0.02%, hence increasing the farmer's technical efficiency. This result corresponds with* Adeyemo, Oke and Akinola (2010) who discovered age of farmers in Ogun State to be significant. *Household size (-0.0089) and extension contacts (-0.0064) have negative relationship with the output but are insignificant. This implies that they have the tendency of reducing technical inefficiency of the farmers and hence, increase technical efficiency. Farming experience (0.0077) and level of education (0.0369) have positive relationship with output, however coefficients were not statistically significant.*

Table 1: Estimates of the technical efficiency and inefficiency model

Variable	Co-efficient	Standard Error	t-ratio
Constant	-0.2438	0.4856	-0.5022
Land	0.6253	0.1234	5.0679***
Labour	0.4315	0.0982	4.3934***
Seed	-0.0106	0.0212	-0.4982
Fertilizer	0.2205	0.0373	5.9066***
Agrochemical	-0.0023	0.0229	-0.0998
Inefficiency model			
Constant	1.1061	0.2236	4.9474
Age	-0.0294	0.0072	-4.1066***
Farming Experience	0.0077	0.0074	1.0411
Education	0.0369	0.0258	1.4319
Household Size	-0.0089	0.0083	-1.0750
Extension Contact	-0.0064	0.0224	-0.2845
Sigma squared	0.0402	0.0096	4.1679***
Gamma	0.7797	0.1013	7.6943***
Log likelihood function	54.7587		
Mean Technical Efficiency	79.65		

Source: Field survey, 2018

Note: (***) implies statistical significance at 1%, Mean T.E = 79.65%

Constraints Associated with Soybean Production

The various constraints associated with soybean production according to their magnitude as felt by the respondents is shown in Table 2. The Table shows the constraints militating against farmers' production of soybean; lack of threshing machine was identified by majority (60.83%) of the respondents, high cost of labour and inadequate capital hinders their capability in procuring inputs such as fertilizer, seed, and herbicide. This result is in consonance with Opaluwa, Ali and Ukwuteno (2015) who revealed that poor access to credit facility is a major constraint affecting maize production in the agricultural zones of Kogi State. High cost of seed was identified as constraint by 25% of the respondents, while 20% claimed low selling price as a constraint. These results are in conformity with Berchie, Adu-Dapaah, Dankyi, Plahar, Nelson-Quartey, Haleegoah and Addo (2010), who reported that the main constraints to Bambara groundnut production in the Upper East Region of Ghana are unpredictable weather, inadequate access to labour and farm inputs.

Lack of threshing machine was identified by 60.83% of the respondents, furthermore, 10.83% of the respondents stated land tenure system was a constraint. This result agrees with Wilson, Prince, Edward, John, Inusah and Aliyu (2013) which stated that lack of right over land was found to be the most important constraint to soybean production in both Saboba and Chereponi districts of Northern Region of Ghana. Lack of right over land or land insecurity may therefore have negative consequences on both productivity and production improvements.

Table 2: Constraints associated with soybean production

Constraint	Frequency	Percentage	Rank
High cost of seed	30	25.00	5th
Inadequate capital	58	48.33	3rd
High cost of fertilizer	19	15.83	7th
Land tenure system	13	10.83	8th
Lack of access to credit	47	39.17	4th
Lack of extension services	11	9.17	9th
Lack of threshing machine	73	60.83	1st
High cost of labour	65	54.17	2nd
Low selling price	24	20.00	6th

Source: Field survey, 2018

Conclusion and recommendations

This study established labour, availability of land and fertilizer were technically efficient and additional increase in these variables will enhance productivity of small scale soybean farmers in the State. Furthermore, coefficient of age, household size and extension visitations have the tendency of reducing technical inefficiency of the farmers. Since the study revealed some inefficiencies that exists in the production of soybean in the study area, it is suggested efficiencies be increased by increasing the usage of inputs to farmers. Government should come up with an intervention programme to assist farmers with mechanized implements and credit facilities to alleviate the farmers' challenges of inadequate capital and credit in their production.

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