



## **ANALYSIS OF PRODUCTIVITY AMONG SOYBEAN FARMERS IN BIU LOCAL GOVERNMENT AREA, BORNO STATE, NIGERIA**

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**ABSTRACT:** This study analyzed productivity among soybean farmers in Biu local Government, Borno State, Nigeria. Specifically, the study identified the socio-economic characteristics of the farmers in the study area, examined the productivity of soybean farmers, determined influence of socio-economic characteristics on productivity of farmers and identified the constraints of soybean production. A multi stage sampling technique was used to select respondents from 7 wards. Primary and secondary data were used for the study. Data were collected by the use of structured questionnaires administered to the 60 farmers sampled from the seven (7) wards at random. The data were analyzed using descriptive statistics and inferential statistics (that is, Data Envelopment Analysis and Tobit Regression model). The result revealed that majority 55.5% of the respondents were within the age gap of 21-30, 60% were males, 68.3% were formally educated, with household size of 1-5 people (48.3%). Majority were 60% married, about 70% of the farmers had farming experience of 1-10 years, 56.7% had a farm size of 1-2 hectares, 75% had access to extension services and 75% were not in any farmer's association. The DEA results for productivity revealed an average technical efficiency of 0.86. The Tobit regression analysis for socio-economic factors influencing productivity revealed age, gender, household size, educational level, farm size, access to extension services were statistically significant at 5% level of probability and positively influenced productivity while farming experience, access to agricultural credit were statistically significant at 1% while marital status and membership of farmers association were not significant. The major constraints faced by soybean farmers were inadequate capital, poor soil fertility and pest and disease.

**Key words:** Productivity, Data Envelopment Analysis, Tobit Regression Analysis, Soybean farmers, Borno State

### **INTRODUCTION**

The Soybean plant, (*Glycine max*), cultivation is said to have started in China around 1700-1100 years C. E (Common Era). Soy was introduced to other regions beyond China such as Indonesia, The Philippines and Japan during the first century C.E (O'Keeffe *et al.*, 2015). Soybean is among the major industrial and food crops grown in every continent. It has an average protein content of 40% and is more protein rich than any of the common vegetable or animal food source. Soybean seed also contain about 20% oil on a dry matter basis and is 85% unsaturated and cholesterol free (Bekabil, 2015).

The crop can successfully grow in many states in Nigeria using low level of agricultural inputs. Soybean cultivation in Nigeria has expanded as a result of its nutritive and economic importance and diverse domestic uses. The rapid growth in the poultry sector in the past five years has also increased demand for soybean meal in Nigeria (Dugje *et al.*, 2009). Soybean productivity varies according to areas and nature of practice. A study by Masuda *et al.* (2009) indicated that over the 2005-2007 period on average 217.6 million tons of Soybean were produced annually in the world, and by the continent, South America produced 101.8 million tons (46% of the world total) Northern America and Caribbean and 28.3% was produced in Asia.

Productivity is commonly defined as a ratio of a volume measure of output to a volume of input (Kristanti, 2018). Agricultural productivity refers to the output produced by a given level of input in agricultural sector of a given economy (Amire, 2016). It can be defined as the ratio of the value of total farms outputs to the value of total input used in farm production (Iwala, 2013) Also, agricultural productivity can be measured by the Total Factor Productivity (TFP). This method of calculating agricultural productivity compares an index in TFP and it is usually attributed to technological progress (Bossede *et al.*, 2017).

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In Nigeria, Benue has the highest output in tonnes per hectare (5,196 tonnes), followed by FCT (2,186.41 tonnes), Kano (1,843.59 tonnes), Oyo (282.50 tonnes) and Ondo (411.5). The findings show that soybean is produced more in the north than the south implying larger markets for the crop in the northern part of Nigeria. According to the study on soybean demand the sources of supply for soybean in Nigeria are in the central and northern states. (Benue, Kaduna, Taraba, Niger and Plateau) (Agricultural Media Resources and Extension Center, 2007).

Soybean was introduced to Borno State as a commercial crop in the year 2004 to contribute to food security, improve nutritional status, reduce poverty among farmers and reduce environmental degradation (PROSAB 2003). In recent times, Soybean production has become significant due to its multiple uses as a source of livestock feed, protein and oil for the human diet, biofuel for improving soil fertility and sources of income. This is evident by the proliferation of producers (farmers) and marketers. In view of its importance, the need to improve its productivity is highly recommended.

Research emphasis in the study area has been given to other crops like Maize, Groundnut and Cowpea and also on profitability; marketing efficiency but there is little empirical research on Soybean productivity. Thus, the study analyzed the productivity of soybean among farmers in Biu Local Government Area, Borno State, Nigeria. Specifically, the study described the socio-economic characteristics of soybean farmers in the study area, estimated levels of productivity among soybean farmers, determined the influence of socio-economic variables on productivity among the soybean farmers and identified the major constraints to productivity among soybean farmers in the study area.

## MATERIALS AND METHODS

The study was conducted in Biu Local Government Area (LGA), Borno State, Nigeria. The LGA is located in the Southern part of Borno State, in North-eastern Nigeria. It is about 210 kilometers away from Maiduguri, the state capital (Nigeria Mapping Company, 1999). It is located between latitude 10.25°N to 11.60°N and longitude 11.42°E to 12.30°E with a population of 9,704,157 people from 2020 at 3.4% growth rate (National Population Commission, 2006). It lies on the Biu Plateau at an average elevation of 626 meters above sea level.

The average temperature in Biu LGA is 23.7°C and about 888mm of precipitation falls annually (Koppel - Geiger system, 2018). Agriculture is the main activity in the area. The agricultural activities can be categorized into crop production activities and animal husbandry. There are two cropping seasons, one that starts with early onset of rain, usually in May and the dry season cropping which starts soon after harvesting of the rain-fed crops between November-December. The economy is mixed agriculture based on herding cattle, goats, sheep, horses and donkeys (Encyclopedia Britannica, 2009) and farming of sorghum, millet, maize, soybean, cowpea and cotton (Raw Material Research and Development Council, 2011)

Data were collected with the aid of a structured questionnaire and oral interview schedule. Three-stage sampling procedure was used in the sample selection. In the first stage a sampling frame of soybean farmers was obtained from the Zonal headquarters of Borno State Agricultural Development Programme (BOSADP). In the second stage soybean producing communities: *Biu, Miringa, Mathlau, Mandragrau, Mainahari, Malang, Kabura* and *Tum* were selected. In the third stage, 11 farmers were randomly selected from Biu community (because it has a larger population than the others) and then seven (7) farmers were selected randomly from each of the communities from the list. A total of 60 farmers were selected. The 2021/2022 cropping season was considered.

Descriptive statistics (which included frequency, means, and percentages) and inferential statistics which included Data Envelopment Analysis (DEA) and Tobit regression analysis were used to analyse data collected.

### Data Envelopment Analysis (DEA)

As applied by Taymaz and Saatei (1997) and Makinta (2018), productivity was determined in terms of technical efficiency. Efficiency scores were constructed using Data Envelopment Analysis (DEA). Measures of technical Efficiency (productivity) were obtained by solving the following linear programming problem of each farmer.

Where:

$X_1$  = land (hectares)

$X_2$  = seed (kg)

$X_3$  = Fertilizer (kg)

$X_4$  = Herbicides (ltr)

$X_5$  = Pesticides (ltr)

$X_6$  = Labour (Man-days )

Where there are  $i$  farmers in the sample,  $\lambda_i$  is the weight given to farmer  $i$  in forming a convex combination of the input vectors. Technical efficiency indices indicate productivity levels. Technically efficient farmers are those with a technical efficiency index equal to one.

### Tobit regression analysis

Tobit regression analysis was used to determine relationship between socio-economic characteristics that influence productivity. The model is specified as follows:

$$\ln\Theta = B_0 + \ln B_1 X_1 + \ln B_2 X_2 + \ln B_3 X_3 + \ln B_4 X_4 + \ln B_5 X_5 + \ln B_6 X_6 + \ln B_7 X_7 + \ln B_8 X_8 + U$$

Where,

$\ln\Theta$  = Productivity

$X_1$  = Age (yrs)

$X_2$  = Gender (Male/Female)

$X_3$  = Educational Level (Years)

$X_4$  = Farm experience (Years)

$X_5$  = Household size (number)

$X_6$  = Marital Status (Married=1; Single=0)

$X_7$  = Access to Extension Services (Yes=1; No=0)

$X_8$  = Access to loan credit (Yes=1; No=0)

$X_9$  = Farmers association (Yes=1; No=0)

$X_{10}$  = Farm size (hectare size)

$U$  = Error term

$B_1$ - $B_{10}$  = estimated coefficients

## RESULTS AND DISCUSSION

### Socio-Economic Characteristics of Soybean Farmers

The socio-economic characteristics of soybean farmers analysed include: age, gender, farming experience, educational level, farm size, household size, marital status, farmer's association, access extension services and access to credit. The result on the socio-economic characteristics of the farmers studied is presented on Table 1.

**Table 1: Socio-Economic Characteristics of the Soybean Farmers (n = 60)**

| Variable              | Frequency | Percentage | Mean |
|-----------------------|-----------|------------|------|
| <b>Age</b>            |           |            |      |
| <20                   | 1         | 1.7        |      |
| 21-30                 | 33        | 55.0       |      |
| 31-40                 | 9         | 15.0       |      |
| 41-50                 | 14        | 23.3       |      |
| >50                   | 3         | 5.0        | 33   |
| <b>Gender</b>         |           |            |      |
| Female                | 24        | 40.0       |      |
| Male                  | 36        | 60.0       |      |
| <b>Marital status</b> |           |            |      |
| Married               | 36        | 60.0       |      |
| Single                | 24        | 40.0       |      |
| <b>Household size</b> |           |            |      |
| 1-5                   | 29        | 48.3       |      |
| 6-10                  | 27        | 45.0       |      |
| 11-15                 | 4         | 6.7        | 7    |

Source: Field survey, 2022.

**Table 1 Continued: Socio-Economic Characteristics of the Soybean Farmers (n = 60)**

| Variable                       | Frequency | Percentage | Mean       |
|--------------------------------|-----------|------------|------------|
| <b>Years of education</b>      |           |            |            |
| 0                              | 19.0      | 31.7       |            |
| 6                              | 4         | 6.7        |            |
| 12                             | 17        | 28.3       |            |
| 15                             | 20        | 33.3       |            |
| <b>Farming Experience</b>      |           |            |            |
| 1-5                            | 42        | 70.0       |            |
| 6-10                           | 17        | 28.3       |            |
| 11-15                          | 1         | 1.7        | <b>8</b>   |
| <b>Farm size</b>               |           |            |            |
| < 1                            | 20        | 33.3       |            |
| 1-2                            | 34        | 56.7       |            |
| 3-4                            | 6         | 10.0       | <b>1.4</b> |
| <b>Access toExt. Service</b>   |           |            |            |
| Yes                            | 57        | 75         |            |
| No                             | 3         | 25         |            |
| <b>Access to Agric Credits</b> |           |            |            |
| Yes                            | 12        | 20         |            |
| No                             | 48        | 80         |            |
| <b>Farmers' Association</b>    |           |            |            |
| Yes                            | 15        | 75         |            |
| No                             | 45        | 25         |            |

Source: Field survey, 2022.

### Age of farmers

The socio-economic results showed that majority 55.0% of farmers were relatively young and fell within the age range of 21-30 and the mean age was 33 years. This meant that they were in their economically active age. This was similar to the findings of Audu *et al.* (2017) who indicated that majority of the respondent 57.54% were at the age range of 25-45. This implied that while the majority were in their economically active age and were actively productive.

### Gender of farmers

The results on gender of respondents showed that majority 60% of the farmers were male, while the remaining 40% were female. This implied that male farmers dominated the study area. This was probably because they were the heads of their families and were responsible for providing for their families. This was in line with a study by Okonkwo *et al.* (2013) which indicated majority 69.44% of respondent were male.

### Household size of farmers

The results revealed a mean household size of 7 persons. This implies that having up to 5 persons in a family is an advantage to family labour and could help reduce hired labour thereby reducing costs of inputs and increasing productivity. The results is in line with the findings of Odenomenem and Inakwa (2011) in a study on the economic analysis of rice production in Cross River State, Nigeria, which revealed that most 58.4% of respondents had household size of 6-15 people.

### Educational level of farmers

The results showed that 68.3% of the farmers had formal education, with years of education ranging from 6-15 years. The results implied that since most of the farmers are educated, they will be willing to improve their awareness on

new agricultural innovations in order to enhance their productivity. This is in line with the findings of Maurice *et al.* (2015) who reported that education affects productivity through a choice of better inputs and output, and through a better utilization of existing inputs.

### **Marital status of farmers**

The results of the analysis on marital status showed majority 60% were married, while 40% were single. This implied that the farmers being married were more responsibilities and thus, were expected to make wise decisions that will enhance their productivity. Similar to this is the findings of Adamu and Bakari (2015) which revealed that majority of the respondents were (61.4%) were married.

### **Farming experience of farmers**

The distribution of soybean farmers by their farming experience revealed that majority 70% of the farmers had 1-10 years of experience. This implied that the farmers were more experienced and were able to make sound decisions that were technically feasible as regards to resource allocation and their productivity. This is similar to the findings of Ogunmefun and Achike (2015) that the average number of years spent by majority of the farmers was 13 years.

### **Farm size of farmers**

Farm size determines the level of output produced, the result of the farm size distribution of the respondents showed that 56.7% cultivated 1-2 hectares of land, while 33.3% cultivated less than a hectare. This implied that most respondents in the study area were small scale farmers cultivating less than five hectares of land and there is likelihood of low output and income to the farmers. This is in conformity with the findings of Ibitola *et al.* (2019) which revealed that 48.2% of the maize farmers in Oyo State, Nigeria, cultivated less than one hectare while the remaining 51.8% cultivated above one hectare.

### **Access to extension services**

Extension contact is very essential to the improvement of farm productivity among farmers. The ultimate aim of extension services is to enhance farmer's ability to efficiently utilize resources through the adoption of new and improved method of soybean production. The distribution of farmers on access to extension services revealed that majority 75% had access to extension services, while 25% had no access to extension service. This implies that farmers are aware of modern ways of soybean production. This is in contrast with the findings of Adeseji *et al.* (2010) that majority of the farmers 76.44% in Ogun State, Nigeria, had no contact with extension services for the past three years, while only 27.40% were visited.

### **Access to agricultural credit**

In agricultural production, adequate funding is required by farmers to finance their production activities. However, a large number of farmers face serious shortage of funds to finance their production activities, which in turn limits their level of productivity. The result revealed that majority 80% had no access to credit and only few 20% had access to credit. This may likely affect their financial stand as well as their level of productivity. This is in line with the findings of (Onojah *et al.*, 2013) which showed that majority (89.2%) of the maize farmers in Nigeria depended solely on their personal income as source of farm credit, while only 1.70% accessed bank loans.

### **Membership of Farmers Association**

Farmers association bring farmers together since they have one interest in common i.e to improve their productivity. Farmers association helps farmers in disseminating knowledge to each other, finding solutions to their problems and creating a platform for creating more awareness. The distribution of farmers in the study area showed that majority 75% were not in any farmers association. This is in contrast with the findings of Ibitola *et al.* (2019) which revealed that 62% of the maize farmers in Oyo State, Nigeria belonged to a farmers association while 38% of respondents did not belong to any farmers association.

### Levels of Productivity among Soybean Farmers

The productivity (Technical efficiency) estimates for soybean farmers in the study area was obtained from the Data Envelopment Analysis (DEA) model using output-oriented DEA technical efficiency from the Variable Return to Scale Data Envelopment Analysis (VRSTE-DEA).

**Table 2: Productivity Scores of Soybeans Farmers (n =60)**

| Efficiency Score (Levels) | Frequency | Percentage (%) |
|---------------------------|-----------|----------------|
| >0.40                     | 1         | 1.70           |
| 0.41 - 0.50               | 4         | 6.70           |
| 0.51 - 0.60               | 7         | 11.60          |
| 0.61 – 0.70               | 3         | 5.0            |
| 0.71 – 0.80               | 5         | 8.3            |
| 0.81 – 0.90               | 1         | 1.7            |
| <1.00                     | 39        | 65.0           |
| Total                     | 60        | 100            |
| Mean                      | 0.86      |                |
| Maximum                   | 1.00      |                |
| Minimum                   | 0.01      |                |
| Most efficient farmers    | 34        | 56.7           |

Source: Field Survey, 2022.

The results on Table 2 shows the mean, minimum and maximum technical efficiency scores (productivity) of the soybean farmers. The estimated technical efficiency scores of soybean farmers ranged from 0.01 to 1.00, with a mean value of 0.86. This implied that the soybean farmers could lower their inputs level by 14.0% without decrease in their levels of output. This implied that on the average, inefficient soybean farmers could decrease their levels of inputs usage by 14.0% to produce same level of output. Majority 86% of the soybean farmers possessed technical efficiency scores (productivity) 0.60, which implied that soybean farmers in the study area exhibited high level of productivity. This is similar to the findings of Makinta (2018) who reported 0.63 mean technical efficiency of rice producers in some selected local governments in Borno State, Nigeria.

The most efficient productive (frontier) farmers were 34 out of 60 farmers and constituted 56.7%. These farmers as shown on Table 1 had an average farming experience of 8years, 1.4 hectares, average level of education in N.C. E, with a mean age of 33years and adequate extension services with the PROSAB programme which lasted 5years. These characteristics most likely enhanced their productivity.

### Socio-Economic Factors influencing Soybean Productivity

Table 3 showed the results of Tobit regression analysis showing the influence of socio-economic factors on productivity among soybean farmers in Biu Local Government Area, Borno State. Based on the magnitude of the coefficient of variables as well as their statistical significance.

**Table 3: Regression Result of Socio-Economic Variables on Productivity**

| Variables               | Coefficient | Std error | t-value            |
|-------------------------|-------------|-----------|--------------------|
| Age of farmers          | .1599       | .0781     | 2.05**             |
| Gender                  | .8268       | .3473     | 2.38**             |
| Household size          | .4826       | .1695     | 2.85**             |
| Years of education      | .3688       | .1526     | 2.42**             |
| Marital status          | .2688       | .0025     | 0.36 <sup>NS</sup> |
| Farming experience      | .5907       | .1097     | 5.38***            |
| Farm size               | .2079       | .0969     | 2.15**             |
| Access to Ext Services  | .8101       | .3262     | 2.48**             |
| Access to Agric credits | .0946       | .0211     | 4.48***            |
| Farmers associations    | .0055       | .0038     | 0.46 <sup>NS</sup> |

Source: Field Survey, 2022. \*\*\*=Significant at 1%, \*\*=Significant at 5%.

Table 3 showed that out of the ten variables, six variables: age, gender, household size, educational level, farm size, access to extension services were significant at five percent level of probability and influenced productivity positively. While farming experience and access to agricultural credit were significant at one percent and positively influenced productivity. This is similar with the findings of Wakil *et al.* (2018) who reported that out of the eight variables analyzed, seven were found to influence efficiency positively and were statistically significant at various levels of probability. These variables included age, educational level, number of years of experience, household size, farm size and access to credit of the farmers.

The coefficient of age was 0.159 significantly and positively related to productivity in the area at five percent level of probability. This implied that age influences productivity as young farmers were not strong enough to handle farm activities and good decisions, while farmers within the average age were more productive as they were in their vibrant stage. Older farmers were weak and have begun to lose their capacity to handle farm operations efficiently thereby making them to have less productivity.

The coefficient of gender 0.827 was positive and significant at five percent level of probability. This implied that gender has an influence on productivity as male farmers were more productive than female farmers because they are stronger and also as the head of the family and were expected to provide for the family at large, while women have shortcomings such as childbirth, pregnancy and home-keeping which affected their productivity. The coefficient of household size 0.483 was positive and significant at five percent level of probability. This implied that as household size increased the energy-use efficiency of soybean productivity also increased. Thus the higher the household size the higher the source of family labour and the higher the productivity.

The coefficient of education 0.368 was positive and significant at five percent level of probability. Indicating that educated farmers had higher productivity than the non-educated farmers. The higher the level of farmer's education, the easier to understand and adopt improved practices and modern farming systems to become more efficient. The coefficient of farming experience 0.590 was positive and significant at one percent. This implied that farmers with higher experience in soybean production had higher technical efficiencies than farmers with less experience. Thus, farmers that are well experienced are likely to be wiser, more familiar with soybean cultivation and also willing to acquire more skills to enhance their productivity.

The coefficient of farm size 0.207 was positive and significant at five percent, which showed that farm size has a positive influence on productivity. Hence productivity of soybean increased with increased farm size. Farmers with larger farm size had higher output and thus higher productivity. The coefficient of access to extension services 0.810 was positive and significant at five percent level of probability, which implied access to extension services improved farmers' productivity.

The coefficient of access to agricultural credits 0.094 was positive and significant at one percent. This showed that farmers that had access to agricultural credit, were more technically efficient. Agricultural credit acts as an instrumental motivation to produce more efficiently and being able to purchase the required inputs for efficient production.

### Constraints to Soybean Production

**Table 4: Constraints to Soybean Production (n = 60)**

| Constraint              | Frequency | Percentage | Ranking |
|-------------------------|-----------|------------|---------|
| Inadequate capital      | 56        | 93.3       | 1       |
| Pest and diseases       | 54        | 90.0       | 3       |
| Poor storage facilities | 34        | 56.7       | 6       |
| High cost of labor      | 47        | 78.3       | 4       |
| Lack of Improved seed   | 32        | 53.3       | 7       |
| Poor soil fertility     | 55        | 91.7       | 2       |
| Insufficient fertilizer | 48        | 66.7       | 5       |

Source: Field Survey, 2022.

The result on Table 4 indicated that inadequate capital was ranked first and constituted 93.3%. Without adequate funding farmers are unable to buy sufficient inputs thereby making it a constraint to soybean production. This agreed with the findings of Nasiru (2010) who studied microcredit delivery in Ogun State, Nigeria and noted that access to credit could have a prospect in improving the productivity of farmers. Poor soil fertility was ranked as the second problem faced by farmers in the study area and constituted 91.7%. Soil depletion reduces the amount of output gain, hindering the expected output. Pest and diseases were ranked third at 90.0%, which led to reduction in output quantity and quality.

High cost of labour was ranked fourth as a constraint to soybean farming, 78.3% of farmers identified high cost of labor as a constraint. This was in line with the findings of Onojah *et al.* (2013) which revealed that 66.9% of the maize farmers in Nigeria identified high cost of labour as a very severe constraint. Other constraints identified were insufficient fertilizer, poor storage facilities and lack of improved seeds. Insufficient fertilizer 66.7% with poor soil fertility were major setbacks to soybean production as the soil nutrients are depleted and there is no sufficient fertilizer to restore the soil nutrients leading to a low level of output. Poor storage facilities 56.7% was also a problem identified by farmers in the study area. The need to store their output is important to avoid huge loss in the output quality and quantity. Lastly 53.3% farmers identified lack of improved seeds as a constraint. Improved varieties are more disease and drought tolerant thus increase output. Lack of improved seed promoted the use of local seed which are genetically poor and could yield to low output.

## CONCLUSION

It was included that the soybean farmers in Biu Local Government Area of Borno State, Nigeria were small scale male famers that were married, literate, young, well experienced and exhibited high level of productivity. Age, gender, household size, educational level, farm size, access to extension services, farming experience, access to agricultural credit positively influenced the productivity of soybean farmers. Inadequate capital, poor soil fertility, pest and disease were the major constraints to productivity among soybean farmers in the study area.

Extension services was found to have been effective to make farmers to be efficient. Government agencies Non-Governmental Organization and farmers' associations should collaborate to establish extension programmes to help farmers to improve productivity. Also, policy makers should provide guidance and directions that will make credit more accessible to farmers, increase productivity, income and hence improve their standard of living.

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