



ESTIMATES OF STOCHASTIC FRONTIER PRODUCTION FUNCTION OF SMALL, MEDIUM AND LARGE-SCALE COWPEA FARMERS IN BAUCHI AND GOMBE STATES OF NIGERIA

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ABSTRACT

The research was conducted to determine maximum likelihood estimate of stochastic frontier production of small, medium and large-scale cowpea farmers in Bauchi and Gombe States of Nigeria. The major focus was on socio-economic attributes of the small, medium and large-scale cowpea farmers as well as the effects on their efficiency. A total of 323 small, medium and large scale cowpea farmers (i.e., 165 for small, 76 for medium and 82 for large) were selected using ballot box in 10 local government areas of the two States of the study area. Structured questionnaires and interview schedule were used as instruments for data collection. Data were analyzed using descriptive and Stochastic Frontier Analysis (SFA). The mean scores for small, medium and large-scale cowpea farmers in respect to ages, household size and farming experiences were 46, 44 and 47 years, 16, 17 and 19 persons and 12, 14 and 16 years, respectively. The Maximum Likelihood Estimates (MLE) result of the stochastic frontier production function (SFPF) for cowpea farmers indicated the presence of inefficiency. Farm size and herbicide were significant at $P > 0.001$, seed ($P > 0.05$) and family labour at $P > 0.01$. In the efficiency effects, farming experience and household size were both significant at $P > 0.001$; and extension contact and literacy level were significant at $P > 0.05$, respectively.

Keywords: Estimate, Maximum, Production, Research, Stochastic.

INTRODUCTION

Production of cowpea in Nigeria is expected to be of high value; this flows from the fact that cowpea is low cost crop to produce because it requires minimum inputs such as fertilizers. Cowpea tends to have higher output to input ratios as compared to crops such as maize (Auko, 2006). This implies that cowpea should have a high market value in terms of profitability. However other factors concerning pulses and in particular cowpea are important such as productivity, production efficiency, market dynamics, consumer preference and indeed profitability because these factors have an influence on production. Cowpea becomes an important crop in the international market. It can be transformed into so many forms, in several dishes in many houses (Nayam, 2001). It is also a significant source of vitamins.

Cowpea is gradually attaining economic importance in Nigeria, especially in the southern states of Nigeria, even though the bulk of the production is done in the semi-arid zone of Nigeria. The appreciating economic importance may be due to its food value which made it a good supplement/complimentary, source of protein for animal source (meat, egg and fish).



Cowpea contains 20%-25% of protein and 64% carbohydrate. It therefore, has a tremendous potential to contribute to the alleviation of malnutrition specifically amongst the poor.

A school advocates for effective contribution of measures aimed at increasing the level of farm resources, making efficient use of resources already committed to the food subsector and combining the enterprises in an optimal manner (Alam *et al.*, 1995). Another school of thought affirms that it is ideal to lay emphasis on allocating and distributing adequate resource inputs, investment in research and eliminating the bottle necks to efficient resource utilization at the farm level.

The paper, therefore, determined the socio-economic factors affecting cowpea productivity. It also described the socio-economic characteristics of small, medium and large-scale cowpea farmers in the study area.

MATERIALS AND METHODS

The two (2) States that the paper examined were purposely selected because of their high production of cowpea. Five (5) local government areas (LGAs) each from the two (2) selected States was randomly selected using ballot box which gives a total of 10 LGA's included in the research. A reconnaissance survey was conducted and the result of the survey revealed that in all the States identified for this research paper, there exist small, medium and large scale cowpea producers. From the finding of this survey, a list of the villages in each of the identified LGA's was prepared and five (5) villages were selected in each using simple random sampling technique. A key informant was used to prepare sample frames in each village.

Primary data were collected with the aid of structured questionnaires while secondary were sourced from journals, textbooks, newspapers, conference proceedings, Thesis, Dissertations, time series data from the ADP's and Federal Office of Statistics. The data collected were analyzed using simple statistics and stochastic frontier model.

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents

Socio-economic result revealed that gender segregation gives room to the division and assignment of responsibilities among people. Males tend to undertake more tedious and outdoor jobs, while females are left with simpler indoor activities. However, majority of the respondents were male in both the small, medium and large-scale cowpea farmers as can be seen in Table 1. This implies that cowpea productions in north-eastern States of Nigeria were mainly dominated by male. The result disagrees with the work of Odii (1992), who observed that female farmers contributed significantly to agricultural production. Thus, the results may not be unconnected with the fact that, the picking and drying of cowpea require much time and labour which of course will be endured by male farmers.

Different educational background of farmers usually account for different ability to evaluate farm risk, which to a large extent determine the overall success of farm business. Faye *et al.* (2000) reported high positive correlation between the level of farmer's education and his ability to meaningfully utilize his credit facilities and adopt new innovations. The result in Table 1 shows that majority of the of the cowpea farmers in the study area could at least read and write.

Majority of the respondents for small, medium and large-scale interviewed reported that they were not members to any cooperative organization and had contact with extension



services in the study area. The respondents reported that they had contact with extension agents in the cropping season.

Access to credit has been empirically proven to be an important factor that influenced productivity. Akinseinde (2006) using Tobit model showed that access to credit facilities contributed positively to a households' production efficiency in the humid forest agro-ecological zone of Nigeria. The result indicates that majority of the farmers in the study area have no access to credit facilities in the financial institutions. The inaccessibility of the farmers may largely be due to the ignorance of the existence of the facilities or to the stringent measures that are usually required for obtaining the loan from the banks. Thus, the result agrees with the findings of Awoke (2003) that identified lack of collateral and high interest rate as some of the major problems of groundnut producers. The result also showed that small, medium and large-scale cowpea farmers were within their productive ages.

Furthermore, from Table 1 results, it is realized that the respondents' large family size was above the recommended average size of four (4) per family in Nigeria. Family labour is recognized as a source of labour supply in small holder food crop production in most part of Nigeria. The result agrees with the finding of Otitoju & Arene (2010) that majority of the respondents (medium-scale soybean farmers in Benue State, Nigeria) had average family size of about 7 people.

The farming experience of the respondents was considered in terms of how long they had been in cowpea production. Hamidu *et al.* (2006) observed that although farming experience may not count in terms of risk taking, it has considerable influence on production efficiency and adoption of new technology. The result showed that majority of small, medium and large-scale cowpea farmers had a significant years of farming experience. This implies that farmers in the study area have acquired enough experience in cowpea production therefore adoption of new innovations will pose no problem. Kwaghe (2006) corroborates these findings that farmers with many years of experience in farming are more willing to changes towards recommended techniques.

Effect of Socio-economic Characteristics of Cowpea Farmers Using Stochastic Frontier Production Function

The maximum likelihood estimates (MLEs) of the stochastic frontier production function for cowpea farmers are presented in Table 2. Four (4) out of the six inputs used in the model were statistically significant at varying degrees of probability. They included farm size, herbicides/pesticides, seed and labour. However, fertilizer is not statistically significant but positively related to the output of cowpea in the study area. The variance parameters of the stochastic frontier production function were represented by sigma squared (δ^2) and gamma (γ). The sigma square (0.311) is statistically different from zero at $P < 0.01$ probability level. This indicates a good fit and correctness of the specified distributional assumption of the composite error terms. The variance ratio defined by Gamma (γ) was estimated at (0.701) and was statistically significant at $P < 0.01$ probability level. The Gamma (γ) estimated shows the amount of variation arising from technical inefficiencies of the cowpea farmers. Therefore, the existence of technical inefficiency among cowpea farmers accounted to about 70% of the variation in the output level. In other words 70% of the variation in cowpea farms output was attributed to differences in technical efficiency.



Table 1: Qualitative Socio-economic Characteristics of the Cowpea Farmers (n = 323)

Variables	Farmers		
	Small-scale Frequency	Medium-scale Frequency	Large-scale Frequency
Sex			
Male	122(73.94)	61(80.26)	68(82.93)
Female	43(26.06)	15(19.74)	14(17.07)
Marital Status			
Single	37(22.42)	12(15.79)	10(12.20)
Married	120(72.73)	51(67.16)	52(63.41)
Divorced	4(2.43)	6(7.89)	10(12.20)
Widowed	4(2.43)	7(9.21)	10(12.20)
Educational Level			
Primary	52(31.52)	11(14.47)	19(23.17)
Secondary	50(30.30)	12(15.79)	17(20.73)
Tertiary	32(19.39)	32(42.11)	23(28.05)
No formal education	10(6.06)	10(13.16)	12(14.63)
Qur'anic	21(12.73)	11(14.47)	11(13.41)
Membership to Cooperatives			
Member	33(20.00)	33(43.42)	20(24.40)
Non member	132(80.00)	43(56.58)	62(75.60)
Extension Agents Contacts			
Had Contact	135(81.82)	61(80.26)	68(82.93)
No Contact	30(18.18)	15(19.74)	14(17.07)
Sources of Finance			
Personal Savings	126(76.36)	47(61.84)	65(79.27)
Borrowed	239(13.94)	22(28.95)	12(14.63)
Both	16(9.70)	7(9.21)	5(6.10)

Note: Figures in parentheses shows percentage of the total frequency

Source: Field Survey, 2016



Table 1: Quantitative Socio-economic Characteristics of the Cowpea farmers (n = 323) **Cont'd**

Variables	Farmers		
	Small-scale Frequency	Medium-scale Frequency	Large-scale Frequency
No of Extension Contact			
1-5	107(64.84)	21(27.63)	13(15.85)
6-10	32(19.39)	10(13.16)	10(12.20)
11-15	14(8.48)	33(43.42)	47(57.32)
16-20	12(7.27)	12(15.79)	12(14.63)
Age Structure			
24 – 33	16(9.70)	13(17.11)	10(12.20)
34 – 43	22(13.33)	15(19.74)	9(10.98)
44 – 53	83(50.30)	23(30.26)	45(54.88)
54 – 63	22(13.33)	10(13.16)	7(8.54)
64 – 73	11(6.67)	10(13.16)	5(6.10)
74 – 83	11(6.67)	5(6.58)	6(7.32)
Mean	46 years	44 years	47 years
Household Size			
01 -07	43(26.06)	14(18.42)	10(12.20)
08 – 14	74(44.85)	18(23.68)	10(12.20)
15 – 21	22(13.33)	26(34.21)	40(48.78)
22 – 28	16(9.70)	9(11.84)	12(14.63)
29 – 35	10(6.06)	9(11.84)	10(12.20)
Mean	16 persons	17 persons	19 persons
Farming Experience			
02 – 06	36(21.82)	15(19.74)	9(10.98)
07 – 11	84(50.91)	17(22.37)	47(57.32)
12 – 16	21(12.73)	22(28.95)	10(12.20)
17 – 21	12(7.27)	12(15.79)	10(12.20)
22 – 26	12(7.27)	10(13.16)	6(7.32)
Mean	12 years	14 years	16 years

Note: Figures in parentheses shows percentage of the total frequency

Source: Field Survey, 2016

Thus, the result in Table 2 showed that farm size was a significant factor in small, medium and large-scale cowpea production with a positive elasticity coefficient of 0.122, 0.32 and 0.223, respectively, which was statistically significant at $P < 0.01$ level of probability. The implication is that, a 10% increase in hectare of land cultivated would increase output of cowpea by 1.22%, 3.2% and 2.23% for small, medium and large-scale cowpea farmers. This is an indication that land as a factor of production is very vital in cowpea production in the study area. This result is in conformity with the findings of Awotide & Adejobi (2006) which found out that farm size is one of the important factors in agricultural production.

Herbicide/pesticide was also a significant input in cowpea with an elasticity coefficient of 0.102, 0.123 and 0.113 for small, medium and large scale cowpea farmers and was statistically significant at $P < 0.1$ probability level. This implies that a 10% increase in the use of other agrochemical (herbicides/pesticide) in cowpea production would increase output by 10.2% for small scale, 12.3% for medium scale and 11.3% for large-scale cowpea



production. Apart from minimizing expenditure on weeding, the use herbicides reduces stress and fatigue associated with cowpea production especially land clearing. By implication, the use of herbicides will enable farmers to cultivate large hectares of land which results in increased output.

Seed was the most important factor in cowpea production with an elasticity coefficient of 0.323 for small scale and 0.414 for large-scale cowpea production implying that a 10% increase in the quantity of seed would increase output of small and large-scale cowpea farmers by 3.2% and 4.4%, respectively. The result therefore agrees with the findings of Tashikalma (2011) which found that agricultural productivity can be increased through increase in seed as input.

The estimated coefficient of labour of small, medium and large scale cowpea production are 0.102, 0.123 and 0.113 respectively and were statistically significant at $P < 0.1$ probability level and positively related to the total output. A 10%, 12% and 11% increase in labour would increase output of cowpea by 10%, 12% and 11%, respectively, for small, medium and large scale cowpea production. This result is in consonance with the findings of Adegeye and Dittoh (1985) which found out that, family labour in small holder farmers' in Nigeria is one of the important factor of production.

The analysis of the inefficiency parameters is very important as a basis for informing agricultural policies on what need to be done to improve agricultural production. The inefficiency parameters as specified are those that relate to farmers specific socio-economic characteristics which appear to have significant roles in determining the level of technical efficiency of the farmers. These were examined using sigma (δ) coefficient. Note that a negative sigma (δ) coefficient implies that the parameters have a positive effect on efficiency and vice versa.

The estimated coefficient of farming experience was found to be negative and statistically significant at $P < 0.01$ probability level in both the small, medium and large-scale cowpea production. This indicates that as the cowpea farmers get more experienced, they are likely to be technically efficient compared to inexperienced farmers. This result agrees with the findings of Ajibefun and Abdulkadir (2004), Ajibefun *et al.* (2002), and Idjasa (2007) Ajani (2000) that found out that efficiency level of farmers was significantly affected by farming experience.

The coefficient of sex was found to be negative but not statistically significant at any probability level. The possible explanation is that as more of small, medium and large-scale cowpea farmers were male and are likely to own land may likely become hindrance that may bring about technical efficiency. This result disagrees with the findings of Adekanye (1988) which found out that women have far less access to land and other productive inputs.

Household size has a negative coefficient and statistically significant at $P < 0.01$ significance level in both the small, medium and large-scale cowpea farmers. This implies that farmers with relatively large family size have the potential to increase farm output. This result is in consonance with the findings of Ya'ashe *et al.* (2010) which found that the mean household falls between the range of 5 and 9 persons. They also said that, the people within these study areas appreciate large families ostensibly because of the labour they stand to benefit.

The estimated coefficient of literacy level of the small, medium and large-scale cowpea farmers was found to be negative and statistically significant at $P < 0.05$ probability level. The possible explanation is that farmers with formal education are more likely to be technically efficient compared with the uneducated ones. The result can be further explained



in terms of the enhanced abilities of farmers with formal education to acquire technical knowledge and adopt new innovations easily which makes them to be efficient in the use of productive inputs and other simple machines used in agricultural production. The coefficient of extension contact was estimated to be negative and statistically significant at $P < 0.05$ probability level in both the small, medium and large-scale cowpea farmers (Adewuyi, 2002).

Table 2: Maximum Likelihood Estimate (MLE) of Stochastic Frontier Production Function of the Cowpea Farmers (n = 323)

Variable	Parameters	Farmers					
		Small-scale		Medium-scale		Large-scale	
		Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std.
Constant	β_0	1.01*** (3.12)	0.032	3.01*** (5.32)	0.056	2.10*** (4.41)	0.048
Farm size	β_1	0.122*** (2.12)	0.0434	0.32*** (3.53)	0.0923	0.223*** (3.02)	0.0084
Fertilizer	β_2	0.0023 (0.052)	0.0016	0.0032 (0.095)	0.0036	0.0021 (0.074)	0.0028
Herbicide	β_3	0.102*** (2.17)	0.0021	0.123*** (4.32)	0.0044	0.113*** (3.29)	0.0040
Seed	β_4	0.323** (1.61)	0.0210	0.414** (2.23)	0.0413	0.524** (1.80)	0.0302
Family labour	β_5	0.102* (1.02)	0.0032	0.113* (2.87)	0.0062	0.103* (2.03)	0.0053
Hired labour	β_6	0.0011 (0.062)	0.0013	0.0024 (0.971)	0.0017	0.0013 (0.080)	0.0016
Expenses on ploughing	β_7	0.0066 (0.043)	0.0012	0.0907 (0.089)	0.0023	0.0097 (0.067)	0.0015
Inefficiency effects							
Farming	δ_1	-0.13*** (2.39)	0.0044	-0.29*** (4.56)	0.0093	-0.18*** (3.29)	0.0086
Sex	δ_2	-0.16 (0.022)	0.0365	-0.19 (0.569)	0.0513	-0.17 (0.033)	0.0497
Household size	δ_3	-0.11*** (1.25)	0.0062	-0.22*** (3.65)	0.0072	-0.22*** (2.76)	0.0094
Extension contact	δ_4	-0.14** (1.42)	0.0063	-0.26** (3.64)	0.0067	-0.18** (2.13)	0.0086
Literacy level	δ_5	-0.12** (1.95)	0.0044	-0.22** (3.76)	0.0086	-0.13** (2.05)	0.0077
Age	δ_6	-0.0022 (0.061)	0.0033	-0.0033 (0.875)	0.0047	-0.0044 (0.081)	0.0055
Access to credit	δ_7	-0.213 (1.53)	0.012	-0.219 (2.43)	0.036	-0.317 (1.68)	0.024
Variance parameters							
Sigma- Squared	σ^2	0.283*** (6.64)	0.0016	0.422*** (7.89)	0.0025	0.311*** (7.32)	0.0018
Gamma	Γ	0.6811*** (6.76)	0.0071	0.753*** (8.45)	0.0633	0.701*** (7.75)	0.0093

*** Significant at 1%, ** Significant at 5%, * Significant at 10%; Values in parentheses denotes T-value.

Source: Computed from Field Data Computer Frontier 4.1C Version Print-Out

The possible expectation is that, since extension contacts/services have influence on adoption of agricultural and farm technologies among farmers, there is the tendency that farmers who were opportune to be visited or contacted with the extension agent will readily adopt new innovations. This result agrees with the findings of Ransom *et al.* (2003) which found out that contact with extension significantly and positively affected adoption of improved varieties in hills of Nepal. In addition, the studies of Ajani (2000) and Awotide (2004), all reported that efficiency level of farmers was significantly affected by extension service.



CONCLUSION AND RECOMMENDATIONS

The result revealed that cowpea production is dominated by male who are married and within the age bracket of 44-53 years. Most of them have attended one form of education or the other, with a farming experienced for small, medium and large-scale cowpea farmers as 2-11 years and a mean of 12, 14 and 14 years, respectively. Based on the findings of the result, the following recommendations were made:

1. Based on the results of socio economic characteristics of cowpea farmers in the study area which found extension contact to be relevant, thus, there is a need of government support in term of reviving and funding of extension delivery system of the state owned agricultural development programme.
2. The literacy level of the farmers was found to be an important factor that increases output in the area, there is need for the farmer to be given proper orientation and/or basic trainings in major farm management techniques as this will help increase their productivity, hence be more efficient.

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