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Economics of Plantain Production among Farmers in Northeast Nigeria

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A B S T R A C T

This study analysed the economics of plantain production in Northeast Nigeria. The specific objectives of the study were to; describe plantain farmers' socio-economic characteristics in Northeast Nigeria; identify factors affecting plantain production in the study area, and also ascertain farmers' resource use efficiency in plantain production. The study adopted a multi-stage sampling technique to collect primary data from 250 plantain farmers selected from 13 communities. In the analysis of the data, descriptive statistics and a stochastic frontier model were used. The finding of the study indicated that most (86.8%) of the respondents were male, having an average age of the respondents was 39.15 years, who are mostly educated (92.8%) and cultivate an average of 2.39 ha of land. The stochastic frontier production function maximum likelihood estimates of the parameters indicated that the production of plantain is determined by farm size, the number of suckers planted, the amount of hired labour used, and family labour. Similarly, the plantain production cost is being influenced by the cost of plantain suckers, labour, and the depreciated cost of land. Furthermore, the study revealed that the farmers were technically and allocatively efficient, although, the maximum technical efficiency was not achieved by farmers. Therefore, it was recommended that agricultural extension agents should be encouraged to reach plantain farmers with the required production technologies to promote production efficiency.

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Introduction

Over the years, plantain has become a very significant economic plant that is cultivated under a wide range of farming systems in Nigeria (Akinyemi et al., 2010; Aina et al., 2012). As of 2017, the country's annual plantain production was about 3.1 million metric tonnes, which makes it the second-largest producer in West Africa after Ghana (World Mapper, 2021). Across various parts of the country, plantain is used to meet various needs for food, raw materials, and income generation for households (Phillip et al., 2009; Fakayode et al., 2011). According to Baruwa et al. (2011), the plant provides over 30% of the carbohydrate requirement of the country. Interestingly also, the demand for the commodity increases with an increase in income of the consumer due to its elitist status and convenience (Ojediran et al., 2018). At the industrial level, plantain serves as raw material in the production of a wide range of products (Akinyemi et al., 2008). Hence, the plant can substantially contribute to the nation's economy.

Despite plantain's diverse importance in promoting food security and poverty reduction in the country, the plant is widely cultivated by small-holder farmers who usually rely on traditional production methods (Nse-Nelson et al., 2016). Due to this widely held disposition, the production of the plant has been declining in the last few decades (FAO, 2011). Over the years, there has been a relatively slow increase in both areas under plantain production and output. For instance, between 1961 to 2019, the area under cultivation increased from 200, 000 hectares to 506, 766 hectares, while production increased from 798,000 million metric tonnes to 3, 182, 872 million metric tonnes (TILASTO, 2021). Some factors that are responsible for this slow performance of the commodity with regards to land size and output includes the farmers' perception of the profitability of the venture, the plant's short shelf life, high post-harvest losses, and inefficiency in production among others (Akinyemi et al., 2008; Nse-Nelson et al., 2016).

Traditionally, plantain is largely produced in Southern parts of the country (Ojediran et al., 2018). The low level of production of the plant in the Northern parts of the country can be attributed to inadequate knowledge on the production techniques and also the perceived unfavourable climate condition of the region (Nwaiwu et al., 2012). Currently, the nation's population has been exploding (over 200 million inhabitants) leading to an increase in demand for the commodity. Consequently, consolidating the demand and supply gap will remain a difficult task. Hence, the need to encourage more people to participate in the production of the commodity. Therefore, the essence of this study was to consider the economics of plantain production in Northeast Nigeria, to fill the existing gap in knowledge on the subject. The specific objectives of the study were to; describe plantain farmers' socio-economic characteristics in Northeast Nigeria; identify factors affecting plantain production in the study area, and also ascertain farmers' resource use efficiency in plantain production.

Methodology

The study was carried out in Northeast Nigeria which spans latitudes 6 28″ N and 13 44″ N and longitude 8 44″ E and 14 38″ E of the Greenwich meridian. The region is made up of six states with about 112 Local Government Areas. The States include Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe. The region covers a landmass of about 272,395km^2 representing about 29.45% of the nation's total landmass. In terms of climate, the area is characterized by distinct dry and rainy seasons, which is typical of a tropical climate. The average rainfall ranges from 500mm in the northwest and 1800mm (Mayomi and Yelwa, 2014; Adebayo, 2020). According to Adebayo (2020), landforms in the area are grouped into hills/mountains, valleys and troughs, and upland/lowlands. According to Mayomi and Yelwa (2014), the region's vegetation is among the poorest of the savannas in the country being a zone that is a transition to the desert. In terms of population, the region holds about 13.5% of the nation's population who are mostly farmers by occupation.

The study adopted a multistage sampling technique to draw respondents for the study. Taraba and Adamawa states were purposively selected in the first stage due to the high concentration of plantain farmers in the area. Conventionally, plantain is notably produced in southern parts of Nigeria due to favourable climatic conditions of the areas and cultures of the people. Taraba and Adamawa states in Northeastern parts of the country have climatic conditions that favour the cultivation of plantain, and farmers in recent years have been cultivating the plant. In the second stage, two Local Government Areas from Adamawa (namely Ganye and Toungo) and three Local Governments Areas from Taraba (namely Takum, Ussa, and Kurmi) were selected. Also, a purposive sampling technique was used to select thirteen (13) villages. In the last stage, the snowball sampling method was used to select 250 plantain farmers. Data for the study was collected using a semi-structured questionnaire.

In analysing the data, descriptive statistics and stochastic frontier production functions were used. Plantain farmers' socio-economic characteristics were described using descriptive statistics. Similarly, the Stochastic Frontier model was used in identifying factors influencing the output of plantain production and also ascertaining resource use efficiency by the farmers. The model is specified as:

$$\bar{Y}_i = f(X_i; \beta) + (V_i + U_i) \quad (1)$$

Where:
$\bar{Y}_i$ = Production of the ith farm
X_i = Vector for input quantities of ith farm
β = Vector of unknown parameters

The Cobb- Douglas function form was used to specify the production technology of the farms. The Stochastic Frontier models are better estimated using either the Cobb-Douglas or Translog functional form. The empirical Stochastic frontier model is specified as:

$$LnY_i = \beta + \beta_1 LnX_1 + \ldots\ldots + \beta_6 LnX_6 + V_i U_i \quad (2)$$

Where:
Y = Output (number of bunches within one year)
X_1 = Size of the farm (ha)
X_2 = Quantity of suckers planted (number)
X_3 = Cost of hired labour (in man-days)
X_4 = Family labour (in man-days)
X_5 = Herbicide used (litres)
X_6 = Quantity of fertilizer used in Kg
U_i and U_i as previously defined

The technical efficiency of plantain producer for the ith farmer, defined by the ratio of observed production to the corresponding frontier production associated with no technical inefficiency, is expressed by

$$TE = \bar{Y}i^* \backslash \bar{Y}i \quad (3)$$
$$= f_1 (X_i; \beta) \text{ esp } (V_i - U_i) \backslash f(X; \beta) \text{ esp } (V_i)$$
$$TE = \text{esp } (U_i) \quad (4)$$

Where TE<1 and U_i>0. Yi achieves its maximum feasible value of $f(X_i; \beta)$ esp (V_i) if and only if TE = 1, otherwise TE<1 provides a measure of the shortfall of the observed output from the maximum feasible output.

The corresponding cost function as applied by Ogundari (2006) can be derived analytically and written in general form as:

$$C = f(p, Y_i \gamma) + (Vi + Ui) \quad (5)$$

Where
C =the minimum cost used in the production of $Y_{i,}$
Y_i = the quantity of output in kg
p = vector of input price and
γ = vector of parameters to be estimated

The stochastic cost function is specific thus :

$$\text{In } Ci == \beta_0 + \beta_1 \text{inP}_I + \ldots\ldots_+ \beta_5 \text{inP}_5 \, _+ (V_{i+} U_i) \quad (6)$$

Where:
In = logarithm to base e
C_i = Total cost of production (₦/Ha)
P_1 = Cost of suckers (₦/Ha)
P_2 = Cost of fertilizer (₦/Ha)
P_3 = Cost of Labour (family and hired labour)
P_4 = Depreciation on land (₦)
P_5 = Cost of agrochemicals (₦/Ha)
Y_i = Output (Bunches)

Results and Discussion

Socio-Economic Characteristics of the Respondents

The description of the respondents' socio-economic characteristics is presented in Table 1. The finding of the study indicated that the average age of the respondents was 39.15 years (±9.54) which implies that the majority of respondents were within their energetic age bracket and could afford to engage in production. The study is in line with the submission of Kainga and Seiyebo (2012) in Bayelsa State of Nigeria. Similarly, the distribution of the respondents by sex shows that the majority (86.8%) of the respondents were males while 13.2% were females. This distribution could be attributed to the tedious nature of plantain production requiring physical strength and agility (Adebayo, 2012). Based on their marital status, the finding of the study revealed that the majority (90.8%) of respondents were married and only 9.2% were unmarried. Family size is an important source of family labour especially in traditional agriculture where farming is highly labour intensive (Gwande, et al, 2010 and Jude et al., 2011). This study revealed that the average household size of the respondents in the area was about 9 persons (±5.68) implies that households in the study area are relatively large in size and family labour can easily be provided for production activities, thus reducing the cost of production. Concerning the respondents' educational attainment, the result indicated that about 92.8% had attended formal schools to some extent. This outcome suggests that the respondents may have the requisite knowledge that can ease the adoption of plantain production technologies (Gbegeh and Akubulo, 2013; Tsue et al., 2014). Membership of a group is a strategy for acquiring social capital, which is important for attaining sustainable livelihood (Pretty, 2002). In this study, the majority (74%) of the farmers do not belong to cooperatives. This implies that most of the respondents could miss out on the various benefits that could be obtained by belonging to cooperative societies (Olaniran, 2015; Shahab, 2015). The distribution of the respondents by mode of land acquisition showed that most (82.8%) of the respondents acquired their land through inheritance. The implication is that farmers who would want to embark on large-scale production may find it difficult thereby resulting in low agricultural production and output (Omonona et al., 2010). The distribution of the respondents by access to credit shows that the majority (72.8%) lacked access to credit in the period under review. This implies that the production potential of the respondents could easily be hampered by farmer access to financial assistance for the acquisition of needed production resources (Nwankwo, 2010). The distribution of the respondents according to extension contact reveals that the majority (63.6%) had not contacted any agricultural extension agent in the period under review. This can greatly affect the quality of plantain production information the farmers access and utilise.

Table 1. Socio-Economic Characteristics of the Respondents

Specifications	Variable	Frequency	Percentage
Age (Years)	< 30	61	24.4
	30-40	50	20.0
	41-50	45	18.0
	51-60	41	16.4
	>61	53	21.2
	Mean	39.15	
Sex	Male	217	86.8
	Female	33	13.2
Marital Status	Married	227	90.8
	Unmarried	23	9.2
Household Size (People)	1-5	68	27.2
	6-10	45	18.0
	11-15	43	17.2
	16-20	52	20.8
	21 and above	42	16.8
	Mean	9	
Educational Attainment	No formal education	18	7.2
	Primary	69	27.6
	Secondary	95	38
	Tertiary	68	27.2
Method of Land Acquisition	Inheritance	207	82.8
	Purchase	19	7.6
	Rent	19	7.6
	Gift	5	2.0
Farm Size (Ha)	<1	159	63.6
	1.1-2.00	81	32.4
	Mean	2.39	
Access to Credit	Yes	68	27.2
	No	182	72.8
Extension Contact	Yes	159	63.6
	No	91	36.4
Membership of Self-help Group	Non-Member	65	26.0
	Member	185	74.0

Source: Field Survey, 2019

Table 2. Stochastic Frontier Production Function

Variables	Parameter	Coefficient	Standard error	T- value
Constant	β_0	2.9105	0.4478	6.4992***
Farm Size (X_1)	β_1	0.2779	0.0142	19.549***
Suckers (X_2)	β_2	0.0939	0.0129	7.2894***
Hired Labour (X_3)	β_3	0.1519	0.0310	4.9004***
Family Labour (X_4)	β_4	0.0831	0.0352	2.3596*
Herbicide (X_5)	β_5	0.0294	0.0726	0.4043^{NS}
Fertilizer (X_6)	β_6	0.0357	0.0711	0.5018^{NS}
Sigma squared	σ^2	0.0664	0.0211	3.1446**
Gamma	Γ	0.5440	0.03680	14.7842***

***Significant at 1% ** Significant at 5% *Significant at 10% NS Not Significant, Source: Field Survey, 2019

Table 3. Stochastic Cost Function

Variables	Parameter	Coefficient	Standard error	T- value
Constant	β_0	1.7201	0.2628	6.5455***
Cost of Sucker (P_1)	β_1	0.7958	0.1057	7.5277***
Cost of Fertilizer (P_2)	β_2	0.1058	0.0675	1.5674^{NS}
Cost of Labour (P_3)	β_3	0.1964	0.0622	3.1592**
Cost of Land (P_4)	β_4	0.0710	0.0279	2.5401**
Cost of Agro-chemicals (P_5)	β_5	0.0400	0.0303	1.3205^{NS}
Sigma squared	σ^2	0.0988	0.0123	8.0052***
Gamma	γ	0.7058	0.0332	21.283***

***Significant at 1% ** Significant at 5% NS Not Significant, Source: Field Survey, 2019

Table 4. Technical, Allocative and Economic Efficiencies Estimates

Efficiency score	Technical efficiency	Allocative efficiency	Economic efficiency
0.30-0.39	-	1(0.4)	2(0.8)
0.40-0.49	-	2(0.8)	3(1.2)
0.50-0.59	-	18(7.2)	37(14.8)
0.60-0.69	-	26(10.4)	52(20.8)
0.70-0.79	4(1.6)	66(26.4)	107(42.8)
0.80-0.89	148(59.2)	82(32.8)	49(19.6)
0.90-0.99	98(39.2)	55(22.0)	-
Total	250(100)	250(100)	250(100)
Mean	0.89	0.80	0.71
Minimum	0.73	0.37	0.35
Maximum	0.95	0.97	0.86

*Figures in parenthesis represents percentage, Source: Field Survey, 2019

Input-Output Relationship in Plantain Production

Stochastic Frontier Production Function

Table 2 presents the stochastic frontier production function parameter estimates for the factors influencing plantain production in the study area. The maximum likelihood estimates of the parameters of the stochastic frontier production function revealed that farm size, the number of suckers planted, amount of hired labour used and family labour were all statistically significant and hence are the major determinants of plantain production in the study area. Specifically, farm size (X_1) had a coefficient of 0.2779, which was statistically significant at 1%. This implies that a unit increase in farm size would raise plantain output by 0.2779%. This finding lends credence to the submission of Ojokojo (2016) who reported that farm size was positive and significant in plantain production in Bayelsa state and that increase in the farm size would increase the output level of farmers. Similarly, the coefficient for the number of suckers planted (X_2) was positive (0.0939) and statistically significant at 1%. The positive sign of this variable indicates that as the number of suckers planted increases, plantain output will also increase by 0.0939%. This contradicted the submission of Idumah et al. (2016) who revealed that the coefficient of plantain suckers was positive but not significant, implying that an increase in the planting densities of plantain suckers is not a requirement to increase yield under the agroforestry system in Edo State, Nigeria. The study further revealed that the coefficient for the amount of hired labour utilized in plantain production (X_3) was found to be 0.1519 (statistically significant at 1%). The positive sign for this coefficient implies that a unit increase in the usage of hired labour would enhance plantain output by 0.1519% the study is in line with the submission of Idumah et al. (2016) who revealed that labour is one of the major factors that influence the production of plantain. Similarly, the coefficient for family labour (X_4) was also positive (0.0831) and statistically significant at 10%. The positive coefficient for family labour implies that a unit increase in the amount of family labour would increase plantain output by 0.0831%, implying that an increase in the magnitude of these inputs increased plantain output. The further revealed that the estimate of sigma squared was 0.0664 and statistically significant at a 1% level of probability suggesting correctness of the specified distributional assumption of the composite error term and goodness of fit of the model. Furthermore, the gamma value was estimated at 0.5440 in the study area. This implies that a 54.4% variation in plantain output in the study area is a result of differences in the technical efficiencies of the respondents.

Stochastic Frontier Cost Function

The stochastic frontier cost function's estimate of parameters for plantain production in the study area is shown in Table 3. Allocative efficiency entails optimal use of inputs considering the prevailing prices and production technologies. The results indicated that the cost of plantain suckers, cost of labour, and depreciated cost of land were the major factors influencing the total cost of plantain production in the study area. The result revealed that the coefficient for the cost of plantain suckers (P_1) was 0.7958. The value of the coefficient was statistically significant at 1%. This implies that a unit increase in the cost of plantain suckers would increase the total cost of production by approximately 0.7958%. The study further revealed that the estimated coefficient for the cost of labour (P_3) was 0.1964 and statistically significant at 5%. This means that the cost of labour is a determinant of the total cost of production in the study area. The study supported the finding of Tijani et al. (2009) who carried out a similar study in a state in Southwest Nigeria. They revealed that labour cost is significant at $P<0.05$ and following a prior expectation, implying that increase in the cost of labour inputs will lead to a drastic reduction in the use of such input with consequent effect on farmers' and farmland productivity. The coefficient for the depreciated cost of land (P4) was found to be positive (0.071) and statistically significant at 5%. This implies that a unit increase in the depreciated cost of land would also raise the total cost of production in the study area by 0.071%. This is in line with the findings of Omonona et al. (2010) who used stochastic frontier to determine the technical efficiency of production in Osun state. They revealed that the cost of land was significant at the 1% level. The result further indicates that the estimate of sigma squared was 0.0988 and statistically significant at a 1% level of probability. This implies that the model has a good fit of the model. Likewise, the gamma value was 0.7058 in the study area. This implies that about 70.58% variation in the total cost of plantain production is a result of differences in cost efficiencies of the respondents

Efficiency Estimates of the Plantain Producers in the Study Area

The efficiency estimates of the respondents were derived from the stochastic frontier production and cost functions. Technical efficiency is the ability of the firm or farm to maximize output for a given state of resources or inputs. Allocative efficiency is the farmer's ability to produce a given level of output ratios, and Economic efficiency is the farmer's ability to produce the predetermined quantity of output at the maximum cost given the available technology. Table 4 presents the estimates of plantain production efficiencies. The mean, minimum and maximum technical efficiency scores were 0.89, 0.73, and 0.95 respectively. This shows that plantain farmers in the study area were technically efficient although their technical efficiency can be improved by 11% through better resource allocation. The study agrees with Idumah et al. (2016) who reported that Individual technical efficiency indices ranged between 34.95% and 98.75% with a mean of 86.91%, and it also showed that 8.3%, 11.7%, and 75% of the plantain farmers had technical efficiency indices ranging between 61-70 percent, 71-80 percent and 81-100 percent respectively. The wide variation in the farmers' technical efficiency from the frontier level as revealed by the analysis, implies that the plantain farmers are not fully technically efficient in resource use. The allocative efficiency estimate of the sampled farmers shows that the mean efficiency score of the respondents was less than 1, hence there is still scope for improvement. The minimum allocative efficiency in the study area was 0.37, while maximum efficiency was 0.97 with a mean efficiency score of 0.80. This result indicates a huge variation in allocative efficiencies of the sampled farmers. The distribution of the allocative efficiency among plantain producers in the study area further shows that the majority (81.2%) of them operated above the efficiency score of 0.70. This implies that the sampled farmers were relatively efficient in producing plantain at a given level of output using the cost-minimizing input ratio to derive maximum output from inputs used in the production process. Similarly, the estimate of economic efficiencies differs substantially among the farmers ranging between the values of 0.30 - 0.89 in the study area. The study also reveals that the mean economic efficiency was 0.71. This implies that the overall efficiency of the farmers can be raised by 29% through better resource allocation. Thus, the total efficiency of the farmers is still below the frontier output boundary. Bifarin et al. (2010) reported that there is also a wide gap between the lowest and highest economic efficiency indices, with a mean of 35%. This demonstrates that a great potential exists to increase the gross output, and profit, of smallholder farmers at the existing level of technology, by improving utilization of the production factors.

Conclusion and Recommendations

Plantain production can be a profitable venture in the study area. The study revealed that the farmers were technically and allocatively efficient, although, the maximum technical efficiency was not achieved by farmers (with the best farmer producing at 0.97, just 0.03 below the frontier). The mean technical efficiency was 0.89. This means that there is an opportunity for increasing the output of the plantain farmers in the study area by increasing the efficiency with which resources are utilised at the farm. Based on the findings of the study, the following recommendations were made;

- Agricultural extension agents should be encouraged to reach plantain farmers with the required production technologies to promote production efficiency.
- The government, non-governmental organization, banks, and other financial agencies, should assist farmers through the provision of loans, subsidies, and other incentives with minimum collaterals to enhance plantain productivity in the area.
- Research institutes should make available improved varieties of plantain suckers to boost plantain production in the area.

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