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(RESEARCH ARTICLE)

Economics of sweet potato production in Yenagoa Local Government Area of Bayelsa State, Nigeria: A Stochastic Approach

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Abstract

The study examines the technical efficiency and profitability of sweet potato production in Yenagoa Local Government Area of Bayelsa State, Nigeria. A total of one hundred sweet potato farmers were selected through a multi-stage sampling technique. Data collected were analysed using descriptive statistics, budgetary analysis and stochastic approach. The average age of the farmers was 35 years, majority (54%) of the sweet potato farmers were males, majority (87%) of the farmers had one form of education, average fish farming experience of the farmers was 9 years, and majority (55%) of the sweet potato farmers were married. The result of production function depicts the coefficient of multiple determinations (R^2) to be 41%. It further shows that the relationship between output and farming experience which had a coefficient of 0.11 was positive indicating that as years of farming experience increased, the amount of output increased. Moreover, the mean technical efficiency was 0.73 with minimum and maximum efficiencies of 0.19 and 1.76 respectively. Total Cost (TC) was ₦20,755.53while total returns were ₦31,715.20 with Net Farm Income (NFI) of ₦10,959.67. Return on investment was ₦0.53, which implies profitability of sweet potato production in the study area. The study also identified inadequate finance, lack of land, and high cost of labor as the major problems faced by the farmers. Government is therefore recommended to support in terms of revitalization and prioritizing funding of extension delivery system of the state owned Agricultural Development Programmes (ADPs).

Keywords: Sweet potato; Efficiency; Stochastic frontier; Budgetary model; Profitability

1. Introduction

Sweet potato is an important source of carbohydrate, vitamin C, and β-carotene, a precursor of vitamin A. Sweet potato requires few inputs to become established and can be planted in erosion prone areas to protect farmland as it spreads to cover the soil. Early maturing varieties usually mature in about 90 days from planting date and tubers are mostly marketed fresh. In developing countries, sweet potato ranks as the fifth most important food crop on a fresh weight basis after rice, wheat, maize, and cassava. Production represents 95% of world output and it is considered as a food crop that can be used to alleviate the food shortage and overcome hunger. Research efforts are ongoing to disseminate early maturing, high yielding, and vitamin A–rich sweet potato varieties to ensure sustainability of production and meet the ever-growing world food demand [1]. Therefore, given the relatively easy production methods, high nutritional value and pro-poor nature of the sweet potato crop, enhancing its production and utilization can be seen as a major opportunity for poverty reduction, income generation, food and nutrition security and sustainable ecosystems. Also, promotion of its nutritional benefits, especially of orange-fleshed sweet potato (OFSP) varieties is needed to increase awareness and stimulate demand. To improve sweet potato varieties there is a need to ascertain the efficiency and profitability of sweet potato production which constitutes the basis for this study.

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2. Analytical Framework

The level of technical efficiency of a particular firm is characterized by the relationship between observed production and some ideal or potential production [2]. The measurement of firm specific technical efficiency is based upon deviation of observed output from the best production or efficient production frontier.

The explicit Cobb Douglas function used to capture efficiency is stated as follows;

$$\text{In } Yi = \beta 0 + \beta 1 \text{In} X_1 + \beta 2 \text{In} X_2 + \beta 3 \text{In} X_3 + \beta 4 \text{In} X_4 + \beta 5 \text{In} X_5 \ (Vi + Ui) \ldots\ldots\ldots\ldots (1)$$

Where,
Yi: Output of sweet potato (kg/ha)

X_1 = Cost of transportation (₦)

X_2 = Cost of harvesting (kg)

X_3 = Cost of chemical (₦)

X_4 = Cost of planting material (₦)

X_5 = Hired Labor (Man-days)

The inefficiency model U_i is defined by

$$U_{ij} = \delta_0 + \delta_1 Z1_{ij} + \delta_2 Z_{2ij} + \delta_3 Z_{3ij} + \delta_4 Z_{4ij} \ldots\ldots\ldots\ldots (2)$$

Where;

Z_1 = Age (years)

Z_2 = Farming experience (years)

Z_3 = Farm size (hectare)

Z_4 = Educational level (years of formal educational qualification)

The ratio used to measure the profitability is stated as follows;

NFI = GR – TC

NROI = NFI / TC

Where:

NFI = Net Farm Income

NROI = Net returns on investment

TC = (TVC + TFC) = P_x. X

GR = P_y. Y

GR = Gross Return

P_y= Unit Price of Output

Y = Quantity of Output

P_x= Unit Price of Input

X = Quality of Input

TC = Total Cost (N)

TFC = Total Fixed Cost (N)

TVC = Total Variable Cost (N)

3. Methodology

The study was conducted in Yenagoa Local Government Area in Bayelsa State, Nigeria. Yenagoa agricultural zone shares boundaries with Delta State on the North, Rivers State on the East and the Atlantic Ocean on the West and South, National Bureau of Statistics, [3]. The study Area enjoys a humid equatorial climate and mean annual rainfall ranging from 2000mm-4000mm and alternating rainy (March-November), and dry (December-February) seasons, featuring a short dry period between July and September (August break). It lies within the rainforest zone and has a maximum temperature average of 30°C with a relative humidity ranging between 55 and 99 percent, depending on season and location. The major occupations of the people are fishing, farming and trading, while lumbering, raffia palm tapping and gathering of fruits constitute economic activities by the people.

Multi stage sampling technique was used for the study. First stage involves a simple random selection of 24 communities from the existing communities in YELGA. The second stage involves the selection of five (5) sweet potato farmers each from the selected communities making a total of one hundred and twenty. One hundred (100) were retrieved and used for the analysis. All participants were provided information about the study, including voluntary participation –i.e., the freedom to refuse to answer any question or opt out at anytime. Confidentiality and anonymity were guaranteed. Data collected were analyzed with descriptive statistics and Stochastic Frontier Production Function.

4. Results and discussion

4.1. Socioeconomic Characteristics of the Sweet Potato Farmers

Table 1 show that 54% of the farmers were male while 46% were female indicating that men who naturally are the stronger gender carry out most of the activities on the farms as stated by Nwaru [4]. Majority (75%) of the farmers were 21-30 years of age. The average age of the farmers was 35 years. This implies that most of the farmers are young and energetic since they are in their active age. The table also showed that 87% of the farmers had some form of formal education of which 14% had primary, 32% had secondary, and 41% had tertiary education only 13% had no education. This indicates that most of the farmers were literate, with reading and writing skills. Majority (69%) of the farmers had farming experience of 6-10 years while the average farming experience of the farmers was 9 years (Table 1). This implies that farmers in the study area have been in farming business right from when they were adult; therefore, adoption of new innovation will pose no problem. Only 18% applied fertilizers while 82% applied no fertilizers as they claimed of having fertile land that does not require fertilizer. Also, 92% of the farmers had farm sizes of less than 1 hectare which implies that the farm holdings of the farmers are mostly small scale. Labor was intensively used as both hired and family labours were combined since most household hold size comprises of children of school age.

4.2. Technical Efficiency of Sweet Potato Production

Table 2 showed the distribution of the farmers' technical efficiency indices derived from the analysis of the stochastic frontier production function. The result indicated that technical efficiency of farmers sampled in the study area was on average below the maximum frontier output. The range of technical efficiency showed that the most efficient farmer was above the maximum frontier output of 1.0 as the maximum was 1.76, while the least efficient farmer was producing at only 19% (0.19) efficiency level leaving much room for improvement. The mean technical efficiency was 73% thus the output of sweet potato farmers can still be increase by 27% to reach level of optimum technical efficiency [5]. The frequency distribution of level efficiency of the farmers showed that 17% of them were operating at between 0-0.2 level of efficiency, 13% operated at 0.21-0.40 level of efficiency, 24% operated at between 0.41-0.60 level of efficiency, while 21% operated at over 1.0 efficiency level.

Table 1 Socioeconomic Characteristic of Sweet Potato Farmers

Variable	Frequency	Percentage
Gender		
Male	54	54
Female	46	46
Total	100	100
Age		
≤20	13	13
21-30	75	75
31-40	10	10
≥50	2	2
Total	100	100
Educational Level		
No formal education	13	13
Primary education	14	14
Secondary education	32	32
Tertiary education	41	41
Total	100	100
Use of Fertilizer		
Compost	9	9
Cow manure	9	9
No fertilizer	82	82
Others	0	0
Total	100	100
Farming experience (Years)		
≤5	31	31
6-10	35	35
11-15	16	16
≥16	18	18
Total	100	100
Farm size (Hectares)		
≤0.5	51	51
0.6-1.0	41	41
1.1-1.5	5	5
1.6-2.0	3	3
>2.0	0	0
Total	100	100
Labour type		
Family labour	28	28
Hired labour	14	14
Both	58	58
Total	100	100

Average farm experience 9 years, Average farm size is 0.5 hectare.
Source: Field Survey Data, 2021.

Table 2 Technical efficiency distribution of sweet potato farmers

Efficiency level	Frequency	Percentage
0-0.2	17	17.00
0.21-0.40	13	13.00
0.41-0.60	24	24.00
0.61-0.80	14	14.00
0.81-1.0	11	11.00
>1.0	21	21.00
Total	100	100.00
Min	0.19	
Max	1.76	
Mean	0.73	

Source: Field Survey Data, 2021.

4.3. Estimate sweet potato production function

According to the results in table 3, four of the ten independent variables (educational level, household size, farming experience and labor) influenced positively and significantly the farmers' technical efficiency. The relationship between output and farming experience which had a coefficient of 0.11 was positive indicating that as years of farming experience increased, the amount of output increased. Transport (0.50), labor (0.10) and education (0.06) had positive coefficients but were not significant. This implies that, these variables though contributed to the influence of farmers' resource efficiency but their contributions were not significant.

Table 3 Maximum likelihood estimation (MLE) function for sweet potato farmers

Variables	Parameter	Coefficients	Standard Error	t Stat	P-value
Constant	β_0	4.48646	0.33695	13.3149	5.5E-23
ln(Transportation cost)	β_1	0.50549	0.14254	3.54619	0.00062
ln(Harvesting Cost)	β_2	-0.0534	0.41463	-0.1288	0.89784**
ln(Cost of Chemical)	β_3	-0.8386	0.48504	-1.729	0.08724**
ln(Cost of Planting material)	β_4	-0.1756	0.28832	-0.6092	0.54392
ln(Cost of Labor)	β_5	0.10838	0.11842	0.91524	0.36251
Inefficiency effects					
Constant	Z_1	0.2223	0.78868	0.2223	0.78868**
Age (Years)	Z_2	-0.0192	0.11149	-0.1719	0.86393**
Farming experience (Years)	Z_3	0.10925	0.07057	1.54803	0.12512***
Farm size (ha)	Z_4	0.92759	0.21109	4.39429	3E-05***
Education level	Z_5	0.05595	0.06857	0.8159	0.41671
Multiple R	0.63699				
R Square	0.40576				
Adjusted R Square	0.34634				
Standard Error	0.6613				
F	6.82822				
Significance F	2E-07				

Source: Field Survey Data, 2021.

Generally, the results imply that all the variables together explained about 40.57% of R^2value and F-ration of 6.82822in the total variability of rural farmers' sweet potato production in the study area. The model also revealed that the inputs that were being used efficiently in the production of sweet potato were land preparation costs ($p<.05$), and planting costs ($p<.05$). These findings are similar to [Okoye, Onyenweaku, and Asumugha] [6].

4.4. Estimate of Costs and Returns analysis

This section shows the quantity of inputs used, cost and the total revenue realized from the sale of Sweet potato. From table 4, the total variable cost to cultivate a hectare of sweet potato in the study area is ₦11,050. An average of N31, 715.20/ha is accrues to a farmer as a revenue, and ₦20, 665.20 is left as gross farm income. The average net farm income was ₦10, 959.67. The positive and large farm income indicated return is higher than the cost as such; Sweet Potato production in the study area is profitable. This coincides with the findings of Tewe, Ojeniyi and Abu, that Sweet potato production in Oyo state was found to be very profitable [7]. It also agrees with Ogbonna et al, that despite it is high production cost, farmers are encourage to go into Sweet Potato production as it appear to be profitable [8]. Also in the table, the average rate of return on investment was ₦0.53k. This implies that for every ₦1.00k invested in producing one kilogram of Sweet Potato, 53 kobo was realized. Similarly, Adebayo, found that Sweet Potato is more profitable compared to Cocoyam because of its relative ease and lower cost as compared to cereals and other root crops makes it increasingly popular among farmers [9]. This is also attributable to the rising cost of inputs such as fertilizer, which is not usually used in sweet potato production.

Table 4 Cost and Returns structure of farmers

Cost Items and Revenue	Cost (₦/Ha)	Percentage
Rent for land	2,705.53	13.04
Wheel barrow	4,500.00	21.68
Hoe/Cutlass	1,900.00	9.15
Bags and rope	600.00	2.89
TFC	9,705.53	46.76
Planting material	0.00	0.00
Transport to market	2,500.00	12.04
Harvesting	0.00	
Manure/chemical	4,550.00	21.92
Labor	4,000.00	19.27
TVC	11,050.00	53.24
Total Cost	20,755.53	100.00
Returns from Potato sold	31,715.20	
Net Farm Income	10,959.67	
Gross Farm Income	20,665.20	
Rate of Return on Investment (ROI)	0.53	

Source: Field Survey Data, 2021.

4.5. Estimate level of Sweet potato output

This section shows the distribution of farmers according to the quantity of Sweet potato output. Table 5 showed that 18 farmers produced less than or equal to 200 kg/ha, while those that produced 201 – 400 kg/ha were 36%, 401 – 600 kg/ha were 23%, those who produced between 601 – 800 kg/ha is 10% and those with production rate of 801kg/ha and above is 13%. The mean output of the sweet potato harvested by farmers was 530kg/ha. This implies that the farmers operated at different levels of farm sizes as the analysis of the inputs revealed an average farm size of 1ha per farmer, an indication that the study covered small scale.

Table 5 Estimate of Sweet Potato Output

Potato output (kg/ha)	Frequency	Percentages (%)	Mean
≤200	18	18.00	530
201-400	36	36.00	
401-600	23	23.00	
601-800	10	10.00	
801-1000	4	4.00	
>1000	9	9.00	
Total	**100**	**100.00**	

Source: Field Survey Data, 2021.

4.6. Constraints to Sweet Potato Farming

The major constraints faced by sweet potato farmers in the area in table 6 includes scarcity of land, inadequate storage facilities, access to credit, inadequate production capital, and high cost of labour. The table shows that majority of the farmers reported inadequate land as a major problem challenging sweet potato farming in the area. Commercial sweet potato farming requires vast land for its farming operations but the farmers had small and fragmented farm sizes as most of the lands were either by inheritance or by lease. Inadequate finance was the second major problem reported by 26% of the sweet potato farmers. This could be due to the lack of involvement in secondary occupations that could finance the farm enterprise. The third serious problem was the problem of flooding (22%), as they complained that the best way they could preserve the longevity of the sweet potato was to leave it in the grounds but flooding forces them to harvest early. The forth serious problem to sweet potato farming reported by 20% of the farmers was high cost of labour. This is due to the lack of technology, use of crude tools and dryness of the soils in the area. Other problems identified include transportation and pest and diseases spread.

Table 6 Constraints associated with sweet potato farming

S/N	Constraints	Frequency	Percentage (%)	Rank
1	Insufficient Land	38	27.1	1st
2	Inadequate Finance	26	18.6	2nd
3	High rate of flooding	22	15.7	3rd
4	High cost of Hired labour	20	14.3	4th
5	High Cost of Transportation to Markets	19	13.6	5th
6	High Spread of Pest and Diseases	15	10.7	6th
	Total	**140***	**100**	

*Multiple Entries Entered
Source: Field Survey Data, 2021.

5. Conclusion

These results call for policies aimed at encouraging new entrants to cultivate sweet potato and the experienced ones to remain in farming. There is a need of government support in terms of revitalization and prioritizing the land use act and funding of extension delivery system of the state owned Agricultural Development Programmes (ADPs). This will help to mobilize and motivate the extension agents to reach the target farmers with relevant information on improved farm management practices, hence, reduce the problem of inefficiency in the use of productive resources.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

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