



Original Article

Farm household allocative efficiency and cost-Benefit Analysis of sweet potato among farming families in Igabi agro-ecological environment

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ABSTRACT

The study was conducted to ascertain the allocative efficiency of sweet potato output in Igabi agro-ecological Zone of Kaduna State, Nigeria. A total of 120 respondents were chosen for in-depth analysis using multi-stage random sampling and purposeful sampling strategies. Information for the primary data was gathered through an oral interview and a standardized questionnaire. The study's objectives were captured using the Logistic regression method, costs and return analysis, percentage replies, and allocative efficiency. The socioeconomic characteristics of the farmers revealed that the majority of respondents were older, female, and had a somewhat large household. They also belonged to an organization. The study revealed that, N1,022,000, N1,118,000, and 1:1.47 were the Net Farm Income (NFI), gross margin, and benefit cost ratio, respectively. Furthermore, by matching their factor prices to the value marginal product (VMP), none of the farmers were able to reach allocative efficiency. The findings indicated that the farmers were unable to achieve optimal resource allocation ($r=1$) because labor, fertilizer, and capital input were overutilized ($r>1$), while other resources, such as farm area (0.761) and planting material, were underutilized ($r<1$). Household size, credit, and farming expertise were the factors that determined the allocative efficiency of sweet potato output. It is necessary to improve farmers' access to credit and fertilizer educational programmes and extension services to boost their allocative efficiency.

Keywords: Household characteristics, allocative efficiency, cost-benefit analysis, sweet potato, farming families.

1.0 INTRODUCTION

It is often known that agriculture plays a significant role in economic growth. Among other things, agriculture provides food security (Food Agriculture Organization, or FAO, 2019; Kaine and Chukwuma, 2017). Sweet potatoes are one of the crops that provide the majority of farmers in sub-Saharan Africa (SSA) with both income and food security (FAO, 2019; Nomeh, 2022). The Convolvulaceae family includes the creeping, dicotyledonous sweet potato (*Ipomoea batatas*), which is native to Latin America. Nowadays, the majority of tropical and sub-tropical regions farm it.

Sweet potato is endeared to farmers because it has certain qualities, such as requiring fewer inputs and being less

labor-intensive than other crops like cereals, being more productive, and being able to adapt to marginal growing conditions (such as drought and poor soil). However, despite its extensive research and potential, the crop's yield has not been encouraging in recent years; for example, Nomeh (2023) reported that the yield of sweet potatoes in Nigeria is less than 3.0 tons/hectare, compared to the potential of 18–24 tons per hectare. Inefficient use of resources in respect to allocative efficiency may be the cause of the crop's low yield, which would leave farmers in extreme poverty (Bose et al., 2020).

Nyor et al. (2021) define allocative efficiency as the ratio of the greatest output possible at the farmer's level of resources to the output achievable at the optimal level of resources. However, allocating resources optimally as



profit maximization is a significant difficulty for sweet potato producers in the majority of underdeveloped nations. The issue of underutilization capacity, which is linked to low returns, affects farmers in the majority of developing nations. According to empirical research, the use of traditional production methods and the lack of improved inputs, as well as the high cost of loans and the onerous application procedures, prevent small-holding farms from allocating resources efficiently (FAOSTAT, 2019).

Furthermore, Ettah et al. (2021), reported that inefficient resource use may be linked to the dominance of older men and women on our farms. High labor costs, gender discrimination, and emigration are factors that work against efficient labor use, while the lack of improved inputs, high loan costs, and onerous loan application procedures impede efficient capital use. In order to attain complete allocative efficiency, Kpata et al. (2019) proposed that producers must allocate their resources efficiently, including labor, capital, fertilizer, insecticides, and among others. Several studies have been conducted in different areas of sweet potato production, it is not certain that enough study has been carried out with respect to farm household allocative efficiency and cost-Benefit Analysis of sweet potato among farming families in Igabi agro-ecological environmental Zone. It is against this background that this research was conducted. Ascertaining the socioeconomic characteristics, cost and return, allocative efficiency and determinants of allocative efficiency of sweet potato production in the study area were the specific objectives of the study.

2.0 RESEARCH METHODOLOGY

Igabi is one of the agro-ecological farming zones in Kaduna State, Nigeria. Thus, politically representing Igabi Local Government Area (LGA). About 430,753 people live in the 3,727km² Local Government Area, which is the largest in Kaduna State (NPC, 2006). The projected population figure as at the year 2018 was estimated to be a total of 475,542 people using a 3% annual rate of increase. Most of the people who live there are farmers who raise livestock and food crops for both commercial and subsistence use, including vegetables, sweet potato, rice, guinea corn, maize, beans, and sugar cane. To actualize the objectives and the data needed for the investigation, a multi-stage sampling strategy was employed. The selection of communities was the first step. A total of six (6) communities were chosen at random. The selection of the sweet potato farmers was the second step. With a total sample size of 120 sweet potato farmers employed for the study, 20 farmers were chosen at random from each of the communities that were first chosen. Primary sources of data were used to get information from the respondents for the study. Utilizing skilled enumerators, structured questionnaires were distributed to the 120 farmers. The information gathered addressed the study's particular goals. The data requested by the questionnaires was contested by personal observations and oral interviews. Both qualitative and quantitative

techniques were used to code and analyze the acquired data.

2.1 Model Specification

2.1.1 Net Farm Income Analysis

The net farm income can be calculated by gross margin less fixed input. Gross margin, which is the difference between the total revenue (TR) and the total variable cost (TVC)

$$GM. = TR - TVC..... (1)$$

$$i.e. G.M = \sum_{i=1}^n P_i Q_i - \sum_{j=1}^m r_j x_j (2)$$

The net farm income can be calculated by gross margin less fixed input. The net farm income can be expressed as thus:

$$NFI = \sum_{i=1}^n P_i Q_i - \left[\left(\sum_{j=1}^m r_j x_j \right) + k \right] (3)$$

Where:

- GM = Gross margin (₦)
- NFI = Net farm income (₦)
- P1 = Market (unit) price of output (₦)
- Q = Quantity of output (Kg)
- ri = Unit price of the variable input (Kg)
- xi = quantity of the variable input (Kg)
- K = Annual fixed cost (depreciation) (₦)
- i = 1 2 3 n
- j = 1 2 3 m

2.1.2 Allocative Efficiency: Logistic Regression Model

The model is expressed as:

$$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + e (4)$$

Where:

- Y = value of sweet patoto output (₦),
- X₁ = farm size (ha), X₂ = labour (manday),
- X₃ = planting material (kg),
- X₄ = fertilizer (kg),
- X₅= Pesticides (Litres); X₅ = capital (₦)
- x₁ - x₅ = coefficient of the parameters to be estimated, while e₁ was the error term and b₀ was the coefficient.

2.1.3 Determinants of Allocative Efficiency

The determinants of allocative efficiency in the study area can be represented as:

$$y = f (x_1, x_2, x_3, x_4, x_5, x_6, \dots x_n + e)$$

- Where: y = technology adoption (1 for yes, 0, otherwise)
- X₁ = Age (Years)
- X₂ = Educational level (Number of years spent in school)
- X₃ = Access to credit (access =1, no access = 0)
- X₄ = Farming experience (Years),
- X₅ = Membership of Organization (Dummy)
- X₆ = Household size (Number of persons in the household)

3.0 RESULTS AND DISCUSSIONS

3.1 Socio-economic characteristics

The study showed that, 41.7% of respondents were between the ages of 25 and 40, while 58.3% of respondents were over 40 years and controlled farming in



the research region. One factor that may influence a farmer's capacity to manage agricultural activities effectively is age. According to Kpaka et al. (2019), there is conflicting evidence regarding the impact of age on a farmer's efficiency. On the one hand, older farmers are thought to be more productive than younger ones due to their extensive production experience. However, compared to older farmers, younger farmers might be more open to embracing and adjusting to more effective technologies and possessing greater physical strength to perform farm tasks, they said.

The result established that, majority (81.7%) of the respondents were formally educated, while 16.7% were not. According to FAO (2019), education improves farmers' capacity to extract, decode, and assess critical information for agricultural output. Increased production and efficiency would result from farmers' capacity to understand agrochemical instructions, implement contemporary agricultural technologies, and make well-informed judgments about their farming operations. It has been reported that farmers with formal education have better skills (efficiency) and are more adaptable to change and risk (Ume and Kaine, 2021). The result revealed that the majority of the sampled farmers (62.5%) had large households. The labour supply for agricultural tasks increases with household size. This outcome is consistent with the research conducted by Tewe et al. (2012). They stated that the high cost of hired labor may be one of the reasons why family labour is used in farming.

The study further revealed that, majority of the respondents (68.3%) had 11–20 years of farming experience, while only 31.7% had 1–10 years. A farmer's decision-making processes and willingness to take chances related to implementing innovation to boost

agricultural productivity are more effective the more experience the farmer has (NRCRI 2019).

The result also indicated that, 33.3% of respondents did not have access to credit, whereas 66.7% did. It is implied that farmers with finance availability were often more technically and allocatively efficient than those without. FAOSTAT (2020), established that, the availability of credit causes the cash constraint to move outside, allowing farmers to promptly buy agricultural supplies that they were unable to supply with their own resources.

Extension contact result studied indicated that, 25% of the farmers sampled had access to extension services, but the majority (75%) did not. This suggested that the respondents lacked enough access to agricultural technology and information that would have increased their level of farm productivity and efficiency. The disparity between extension services and farmers in developing nations, according to Ume and Kaine (2021), restricts the human interactions that were essential to the ultimate acceptance of technology. It is essentially impossible to adopt technologies that were deemed to be both economically and technically viable, socially acceptable, and compatible with the resources available to farmers. The future of agriculture is not looking good under these circumstances.

The study as indicated in Table 1 showed that, majority of respondents (66.50%) did not belong to cooperative societies, whereas 37.5% belonged. According to Kpaka et al. (2019), farmers who are members of farm groups or cooperative societies have the possibility to obtain agricultural loans more easily, receive agricultural inputs at reduced prices, and effectively disseminate information on better agricultural practices.

Table 1. Distribution of respondents according to socio-economics Characteristics

Variables	Frequency	Percentage
Age		
25-40	50	41.67
Above 40	70	58.33
Educational Level		
No formal education	22	16.70
Formal education	98	81.67
Household size		
1-6	45	37.50
7 and above	75	62.50
Farming experience		
1-10	38	31.70
11-20	82	68.30
Access to credit		
No access	40	33.30
Access	80	66.70
Membership of cooperative		
No	75	66.50
Yes	45	37.50
Access to extension services		
Yes	30	25.00
No	90	75.00

Source; Field Survey; 2025



3.2 Cost and Return Analysis of Sweet Potato production

Farm tools and implements, fertilizer, pesticides, and sweet potato vine (creeping stem) were the cost components of sweet potato production considered. No effort was made to assign a value to land that receives little or no rent. Cutlasses, spades, baskets, and hoes were among the agriculture implements that were discounted. In terms of input costs, 80 bundles of sweet potato vine were utilized on average per hectare (bundles costing ₦300 each), for a total of ₦24,000. A hectare of sweet potatoes was also treated with three (3) bags of fertilizer (NPK), which cost ₦45,000 at a rate of ₦15,000 per bag. Physical inputs came to a total cost of N76,000.

Transportation costs accounted for the smallest (0.77%), whereas mounding and exported ridging accounted for the largest portion (46%). Jote et al., 2018 observed that mounding and ridging are labor-intensive tasks, workers charge more for them than for any other crop farming operation.

The gross margin, net farm income (NFI), and benefit cost ratio were N1,022,000, N1,118,000, and 1:1.47, respectively. The Benefit Cost Ratio (BCR) of 1:1.47 obtained in this study implied that for every ₦1.00 invested in sweet potato in the study area, there was a return of ₦1.47 kobo. This also implied that sweet potato was profitable.

Table 2. Costs and Return of Sweet Potato production

Items	unit	Quantity	Price/unit	Cost/value
Root	Kg	3000	500	1,500,000
Sales of vine (stem)	Bundle	30	300	9,000
Total Revenue				1,509,000
Total Physical Product				
Labour cost				
Vine cutting	Bundle	80	300	24,000
Fertilizer	Kg	3	15,000	45,000
Miscellaneous				7,000
Total				76,000
Land clearing	man-day	12	5,000	60,000
Mound/ridge making	man-day	30	6,000	180,000
Planting	man-day	5	3,000	15,000
Fertilizer application	man-day	7	3,000	21,000
Weeding	man-day	20	3,000	6,000
Harvesting/bagging	man-day	15	3,500	53,000
Transport cost				3,000
Total				391,000
Total Variable Cost (TVC)				467,000
Gross Margin (TR – TVC)				1,118,000
Depreciation of assets excluding land				2,000
Total Fixed Cost (TVC+TFC)				487,000
Farm Income (TR – TC)				1,022,000
Benefit Cost Ratio				1:1.47

Source: Field Survey, 2025

3.4 Allocative efficiency result

The study showed that none of the factors considered had an efficiency ratio equal to 1 (one), as was indicated in Table 3. This demonstrated or indicated wasteful use of resources. The ratio of marginal value product (Mvp) to marginal factor cost (MFC) for planting material and farm size were 2.07 and 3.02, respectively. The results obtained were greater than 1, indicating that the farmers in the study area were underutilizing the resource. This showed that less resources were used than was necessary to maximize profits. Hence, for profit to be optimal in sweet potato production in the research region, farm size and planting materials need be increased from their current level by - 1,860 and 85.4% respectively. On the other hand, maximizing profits required reducing fertilizer, labour and capital inputs from their current levels of production by 54.8%, 46.9% and 36.4% respectively.

The elasticity of sweet potato production and return to scale was determined and presented in Table 4. The result showed that the low resource endowment of most farmers may be due to a poor financial base, which lead to under-utilization of resources. The allocative efficiency indices of fertilizer, labour and capital were 0.913, 0.998, and 3.327 respectively, which were less than unitary. This suggested that the resources were over-utilized, which implied less profit maximization of the resources. Nomeh (2022) and Ume et al. (2016) reported that the employment of a large number of workers, especially family workers, who are not included in the total cost of production in a small holding farm, could lead to over-utilization. Ume and Kaine's (2021) findings supported the above claim, positing that the above scenario is more prevalent when wages are low.

Table 3: Allocative efficiency indices of sweet potato

Variable	Y	X	Bi	MPP	MVP	MFC	R	(D)%
Farm size	840	64.8	0.761	639.24	41422.8	20000	2.07	-1,860
Improved cutting	840	6.57	0.579	486.36	3195.4	1000	3.20	85.43
Fertilizer	840	12.6	0.776	651.84	8213.2	9000	0.913	1000
Labour	840	8.90	0.601	504.84	4,493.1	4500	0.998	-7.60
Capital	840	-17.80	0.433	363.72	-6,474.2	2000	-3.237	-28.83

Source: Field Survey, 2025

3.5 Determinants of allocative efficiency of Sweet Potato production

The study revealed that there was an inverse relationship between age of the farmers and allocative efficiency. FAOSTAT, (2017) reported that farmers become less innovative as they age. However, Nomeh (2022) reported that older farmers were effective in using resources, which leads to high farm output. Additionally, the coefficient of educational level (-0.892) was also negatively related to allocative efficiency and statistically significant at the 5% probability level. The variable's sign may be due to a negative attitude toward farming, though these trends are rapidly changing (Onuwa et al., 2021). To improve their agricultural output and productivity, educated people, however, employ resources wisely and embrace technology (FAO, 2020). Additionally, at the 5% probability level, the years of farming experience coefficient (0.768) was positive and significant. Experience in farming helps farmers overcome the challenges of farming, resulting in a high level of output through adequate resource allocation efficiency (Kaine and Chukwuma, 2017). Coefficient of access to credit (0.194) had a direct correlation with the allocative

efficiency, which was significant at the 5% alpha level. Tewe et al. (2011) also found a direct correlation between the coefficient of credit access and the allocative efficiency. They claimed that farmers work harder to use credit efficiently, especially when they borrow it to increase their income because it is easier to repay. However, high interest rates and other factors may cause farmers to abandon the loans they have obtained, which could be the cause of the resource coefficient's sign identity (NRCRI, 2019). The result of the coefficient of labour (1.2885) was observed to be significant and positive at 5% alpha level. The result was in consonance with that detected by Kaine et al (2024). A similar result was also obtained by Abojei et al (2025) among NERICA rice farmers in Anambra State, Nigeria. The authors stated that increase in labour utilization will result to greater output. The use of family labour in the farm by household head may be responsible for the sign of the coefficient of the variable (Kaine et al 2025 and Ettah, et al; 2021). In contrary, Ume, et al; (2016) posited that the use of large number of family labour on small farms would result in over-utilization and hence the resultant inefficiency.

Table 4. Determinants to allocative efficiency of Sweet Potato production

Variable	Coefficient	Standard Error	t- value
Gender	0.157	0.437	-0.358
Age	-0.329	0.124	-2.65**
Educational Level	-0.892	0.434	-2.371**
Farming Experience	0.768	0.290	2.650**
Access to credit	0.194	0.0692	2.7988**
Household size	1.3885	0.5523	2.5132**
Farm Size	0.0096	0.0223	0.7024
Labour	1.2885	0.4523	2.5132**
Organization	0.081	0.088	0.920
Constant	0.921	0.1671	5.658***
Sigma	0.1196 (0.3367)		
R-squared	0.889		
F ratio	14.002***		
Pseudo R square	- 2.3221		
Log likelihood	216.1180		

***, **, *, 1, 5, and 10% significance level respectively

Source; Field Survey, 2025

4.0 CONCLUSION AND RECOMMENDATION

The following conclusions were drawn from the outcome of the study: The socioeconomic factors revealed that the majority of respondents were young, female, educated, had a moderate family size, were cooperative members, experienced, educated, and had access to credit. The gross margin, benefit cost ratio, and net farm income (NFI) were

N1,022,000, N1,118,000, and 1:147, respectively. Additionally, the allocative efficiency result indicates that none of the farmers were unable to achieve optimal resource allocation ($r=1$) since labor, fertilizer and capital inputs were overutilized, while farm size and planting material resources were underutilized. Credit, household size, and farming experience were the factors that



determined the allocative efficiency of sweet potato output.

In light of the results, the following suggestions were made:

- i. the government should assist farmers by offering interest-free loans to increase their output and productivity; and
- ii. since sweet potato farmers in the research region were inefficient in their use of resources, to achieve complete efficiency, farmers should enhance the increase utilization of scarce resources (planting material and farm size) and optimize the use of labor fertilizer and capital inputs.
- iii. In order to achieve resource use efficiency, farmers should be encouraged to use more labour and fertilizer through incentives and strategies.
- iv. The government should encourage financial institutions to offer farmers credit facilities at the appropriate time, location, and with reasonable collateral;
- v. Research should be done to develop labor-saving devices like hand-driven ploughs to reduce production costs, particularly in peasant agriculture where farming activities are almost entirely mechanized; and
- vi. It is important to encourage seasoned farmers to continue farming by offering them subsidized prices for productive inputs.

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