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Profitability of Investment and Farm Level Efficiency Among Groups of Vitamin A Cassava Farmers in Oyo State Nigeria

Ogunleye Ayodeji Sunday[*], Bamire Adebayo Simeon, Awolola Olatundun

Department of Agricultural Economics, Obafemi Awolowo University, Ile-Ife, Nigeria

Email address:
ogunleyedeji@yahoo.co.uk (A. S. Ogunleye), asbamire@yahoo.co.uk (A. S. Bamire), awolola.o@yahoo.com (O. Awolola)
[*]Corresponding author

Abstract: Biofortified (vitamin A) cassava was developed through convectional breeding similar to most other improved varieties cultivated by Nigeria farmers. Despite its potential in addressing the increasing food demand and malnutrition in the country, lack of empirical knowledge about its yield and return on investment has been a major barrier to the uptake of this technology among farmers in Nigeria. This study examined the socio-economic characteristics of vitamin A cassava farmers; analyzed farm level efficiency and return on investment from vitamin A cassava in the study area; determined the factors affecting farm level efficiency and productivity, and examined the constraint to productivity and profitability among vitamin A cassava farmers. A multistage random sampling was used to select a total of 100 vitamin A cassava farmers in the study area. The data collected were analyzed using descriptive statistics, stochastic frontier production function (SFPF), profitability ratio and regression analysis. The results indicated that investing in vitamin A cassava as a business was very profitable. The result showed that 82% of the respondents were male, the mean age of the farmers was 53.25, 49% had only primary school certificate education, 66% farmed on the land between 1-2 hectares. The result further showed that on the average, total revenue was N261511.90, the total variable cost was N87754, gross margin was N173757.9, total cost was N179828.8, and net income was N81683.05. Mean technical efficiency was 78.73%. The study concluded that vitamin A cassava production in the study area was efficient and profitable. These results have implications for the design of effective advocacy strategies to attract more farmers into vitamin A cassava production in Nigeria.

Keywords: Profitability, Vitamin A Cassava, Technical Efficiency

1. Introduction

Biofortified cassava variety popularly known as Vitamin A cassava was developed through convectional breeding similar to most other improved varieties cultivated by Nigeria farmers [1]. The varieties that were released by the National Variety Release Committee of Nigeria are; UMUCASS 36, UMUCASS 37, and UMUCASS 38; and are recognized as IITA genotypes TMS 01/1368, TMS 01/1412, and TMS 01/1371. These were developed by the International Institute of Tropical Agriculture (IITA) in partnership with the National Root Crops Research Institute, Nigeria using traditional breeding methods in a HarvestPlus- funded project. The development and delivery of vitamin A cassava in Nigeria has been ongoing for more a decade and it is intended to complement existing national strategies in combating nutrient deficiency. Cassava is the most important staple food in Nigeria given the number of people who eat it daily and the huge amount of calories derivable. It has evolved from being a peasant's crop to cash and industrial crop. With low cost of production, vitamin A cassava varieties have a high potential to reduce poverty and malnutrition among the smallholder farm households in Nigeria. Despite the potential of vitamin A cassava in addressing the increasing food demand and malnutrition among the growing population in Nigeria, studies [2] have

shown that one of the barriers to the uptake of new technology among the rural households is usually lack of empirical knowledge about the yield and return on investment. In this paper, we address this area by examining the socioeconomic characteristics of vitamin A cassava farmers, determining the profitability and productivity of vitamin A cassava, analyzing factors affecting its profitability, and examining the constraints to vitamin A cassava productivity and profitability with a view to enhancing its performance in the study area.

2. Efficiency- Stochastic Frontier Analysis

The production frontier has undergone a substantial development in recent years. The earliest works on production frontiers assumed these to be deterministic [3], [4] & [5]. Deterministic frontiers attribute all deviations from the frontiers to inefficiency. Studies have argued that the parameters of deterministic frontiers were estimated with a mathematical programming technique (which is non-statistical) [6] & [7]. He also indicated that the one-sided disturbance term of the deterministic frontier explicitly assumes some particular form that violates the regularity of conditions for the application of maximum likelihood. Therefore, the estimation of deterministic frontiers is not completely straightforward. This issue has motivated other researchers to develop a probabilistic frontier [8]. However, since a probabilistic frontier is a deterministic frontier computed from a subset of the original sample using a mathematical programming technique, it remains non-statistical, which makes hypothesis-testing impossible. Other studies [9] & [10] attempted to address the problems associated with deterministic and probabilistic production frontiers by introducing a stochastic production frontier. The stochastic production frontier decomposes the disturbance term into measurement error and inefficiency effect. The parameters in the stochastic frontiers are estimated with the maximum likelihood approach. The present study adopts the stochastic frontier approach already developed by earlier studies [11]. The production frontier of the cassava farms can be modeled with a general stochastic frontier model:

$$R_i = f(x_{ij}; \beta)e^{(\emptyset_i - \eta_i)}, u_i = \emptyset_i - \eta_i \text{ and } i = 1,2,3, \dots . N; j = 1,2, \dots . J \qquad (1)$$

Where R_i denotes the output of the ith farm, (x_{ij}) represents a (1xK) vector of inputs, and β is (kx1) vector of the unknown parameters to be estimated. Equation (1) is a nonlinear function that is linearized (2) by taking the natural logarithm of both sides and manipulating the relevant terms to give (2), which is a Cobb-Douglas production frontier.

$$lnR_i = \alpha + \sum_{j=1}^{J} \beta_j lnx_{ij} + \emptyset_i - \eta_i, u_i = \emptyset_i - \eta_i \dots \qquad (2)$$

Where $\emptyset_i$ is the systematic random error that accounts for measurement error and other factors that are not under the

control of the farm household, and η_i denotes the asymmetric non-negative random error component that measures technical inefficiency effects. The systematic random error variable is assumed to be independently and identically distributed with zero mean and variance σ^2 [12]. The non-negative variable, η_i, is assumed to be independently and identically distributed truncations (at zero from below) of the $N(0, \sigma^2)$ distributed. Moreover $\emptyset_i$ and η_i are assumed to be independent of each other and also independent of the input x_{ij}. The variance parameters of the model are parameterized as in (3):

$$\sigma^2 = \sigma_\emptyset^2 + \sigma_\eta^2, \gamma = \frac{\sigma_\eta^2}{\sigma_\emptyset^2} \text{ and } o \leq \gamma \leq 1 \qquad (3)$$

The technical efficiency of a farm, denoted by TE_i, can be estimated as:

$$TE_i = \frac{R_i}{R_i^*} = \frac{f(x_i;\beta)e^{(\emptyset_i - \eta_i)}}{f(x_i;\beta)e^{(\emptyset_i)}} = e^{-i} \qquad (4)$$

2.1. Profitability - Farm Budgeting Techniques

The budgeting technique is used to analyse costs and returns to biofortified cassava production. The gross margin analysis was used to estimate the returns to pro-vitamin A. This involved gross income minus total variable costs. Net farm income = total gross margin minus explicit fixed costs. Profitability is the ability of a firm to generate income that will cover all costs incurred at various levels during the production. Profitability ratios are designed to evaluate the firm's ability to generate earnings.

$$GM = \sum_{i=1}^{n} Y_i P_{yi} - \sum_{i=1}^{n} \sum_{i=1}^{k} PX_i \qquad (5)$$

Where GM = Gross Margin, P_{yi} = Unit price of the product, P_{xi} = Unit price of the input, Y_i = Quantity of the product, X_i = Quantity of the input, K = number of inputs and n = number of enterprises.

2.1.1. Net Profit Margin (NPM)

NPM highlights the efficiency of operation and also indicates the average spread between the operating cost and revenue. It is an indication of the total margin available to cover operating expenses and yield a profit.

$$NPM_i = TR_i - TC_i \qquad (6)$$

Where NPM_i = Net profit margin of firm i, TR_i = Total Revenue of firm i (₦) and TC_i = Total Cost of firm i (₦).

2.1.2 Return on Investment (ROI)

An indication of the firm's profitability from current operations without regard to the interest charges accruing from the capital structure. It is calculated as:

$$ROI_i = \frac{Net\ Profit\ Margin_i}{Total\ Variable\ Cost_i} \qquad (7)$$

2.2. Multiple Regression Model

Regression analysis includes any techniques for modeling and analyzing several variables, when the focus is

on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps us understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. However, when we are interested in the dependence of a random variable Y, on another variable X which is not necessarily a random variable, an equation which relates Y to X is usually called a regression equation as expressed below

$$Y_i = \beta_0 + \beta_i X_i + e \qquad (8)$$

Where; Y_i = Yield, X_i = Farm households' factors, β_0 = Intercept, B_i = Parameter to be estimated, and e = Error term.

3. Methodology

3.1. Research Site and Sampling Procedure

The study was carried out in Oyo State, Oyo State is an inland State in south-western Nigeria, it is bounded in the north by Kwara State, in the east by Osun State, in the south by Ogun State and in the west by Ogun State and the Republic of Benin. Oyo State was purposively selected because it was one of the four pilot states used during the introduction of biofortified cassava varieties in Nigeria in the year 2011.

3.2. Sampling Procedure

Multistage sampling procedure was employed; the first stage involves purposive selection involved selection of three (3) Local Government Areas (LGA) from the thirty- three LGAs where biofortified cassava production was predominance. The second stage involved proportionate random selection of farmers from each of the LGAs based on the list of cassava growers' association obtained from the relevant agencies in each LGA. Hence, the number of biofortified cassava farmers that was chosen was a function of the number of farmers available in each LGA (to size). The proportionality factor used in the selection of farmers is stated as:

$$Xi = n/N*10 \qquad (9)$$

Where Xi= number of biofortified cassava farmers to be sampled from a LGA, n = number of biofortified cassava farmers in the particular LGA, N = sum total number of biofortified cassava farmers in the three LGAs. In all, 100 farmers were selected and interviewed for this study. The survey questionnaire captured information on the socioeconomic characteristics of the respondents, such as age, gender, household size, education, extension contact, credit access, land tenure, distance to nearest market and farming experience. It also solicited information on technical factors such as labour, seed, fertilizer, pesticides and farm size. Information on of biofortified cassava output was captured by the survey questionnaire.

3.3. Analytical Techniques

Data collected were analyzed using the following analytical tools: descriptive statistics, budgetary analysis, stochastic frontier analysis (SFA) and regression analysis.

3.3.1. Budgetary Analysis

The gross margin analysis (GMA) was carried out to determine the profitability of provitamin A cassava production in the study area. The gross margin analysis was calculated by using the formula below:

$$GMA = TR - TVC \qquad (10)$$

$$TC = TFC + TVC \qquad (11)$$

$$NPM = TR - TC \qquad (12)$$

Where, TC = TFC +TVC
GM = Gross Margin, TR = Total Revenue, TC = Total Cost, TFC = Total Fixed Cost, TVC = Total Variable Cost and NPM = Net Profit Margin

3.3.2. Multiple Regression Analysis

The multiple regression analysis was used to determine factors influencing the profitability of provitamin A cassava production.

The implicit function relating to the gross margin can be expressed as:

$$Z=f(X_i, U) \qquad (13)$$

Double-log model was used for the multiple regression analysis. The explicit function is expressed as follows:

$$\ln Z = \ln B_0 + B_1 \ln X_1 + B_2 \ln X_2 + B_3 \ln X_3 + B_4 \ln X_4 + B5 \ln X5 + U \qquad (14)$$

Where: Z= Net Profit, X_1 = Age in years, X2 = Marital status (1=married, 0=Others), X3 = years of schooling, X4 = Household size in number of persons, X5 = Years of experience and U=error term.

4. Results and Discussions

4.1. Socioeconomic Characteristics Vitamin A cassava Farmers

The socioeconomic characteristics of the farmers as shown in table 1 indicated that the average age biofortified cassava farmers in study area was 53 years with average years of 3.5 years in the production of biofortified cassava.

Table 1. Socioeconomic characteristics of vitamin A cassava farmers.

Socioeconomic Variable	Frequency	Percentage
Age (years)		
1-14	13	13.0
15- 64	66	66.0
Above 65	21	21.0
Total	100	100.00
Mean (Std. Dev.)	53.25 (9.76)	
Gender		
Male	82	82.0
Female	18	18.0

Socioeconomic Variable	Frequency	Percentage
Total	100	100.00
Household Size (#)		
Below 5	17	17.0
5-10	58	58.0
Above 10	25	25.0
Total	100	100.0
Mean (Std. Dev.)	6.2 (1.8)	
Years of Education (years)		
No Education	13	13.0
Primary Education	49	49.0
Secondary Education	25	25.0
Tertiary Education	13	13.0
Total	100	100.0
Mean (Std. Dev.)	4.36 (1.36)	
Farming Experience (years)		
Below 10	35	35.0
11-20	33	33.0
Above 21	32	32.0
Total	100	100.0
Mean (Std. Dev.)	3.5 (1.68)	
dMarital Status		
Married	85	85.0
Farm Size (ha)		
Below 1	6	6.0
1-5	86	86.0
Above 5	8	8.0
Total	100	100.0
Mean (Std. Dev.)	2.3(0.78)	

Source: Field survey, 2015.

This implied that farmers were neither too young nor too old, and they have ample level of experience in the production the cassava since the cassava was introduced to Nigeria in 2011. The result further showed that an average household among the farmers had more than six (6) members. It is also important to note 85% of the farmers sampled were married. These have a lot of health implications on farmers' households in term of the availability of micronutrients required for healthy living. The average year of education among the farmers was 4.36 years.

This implied that the farmers would be able to understand, adopt and implement biofortified cassava innovation for optimum yield. Average farm size used for the production of the cassava among the farmers was 2.3ha. This implied that the farmers were still getting familiar with the cassava variety and as such they were not dedicating a substantial proportion of their farmland to it compared to the already known varieties. The result also showed that both men and women farmers were involved in the production of biofortified cassava. However, the gender proportion among the farmers followed the a priori expectations.

4.2. Farm Level Efficiency Among Vitamin A Cassava Farmers

The maximum likelihood estimates (MLE) of the parametric stochastic frontier analysis (SFA) were shown in Table 2. The production function was estimated using stochastic frontier model. The inefficiency factors considered were age, gender, households' size, and access to planting material (stem). All the independents variables (land labour and capital (cost)) were significant at 1% and 5% level. This implied that all the production parameters played active role in determining the productivity of biofortified cassava enterprise in the study area. The average technical efficiency score among the farmers was 78.73%. This implied that biofortified cassava farmers in the area were operating below the production frontier and as such, they could still increase their efficiency level by 21.27%. Among the inefficiency factors considered, only access to planting material was significant ($p > 1$). This implied that access to planting material was critical to the productivity of biofortified cassava farmers in the study area. The gamma diagnostics further confirmed that 97% of the inefficiency observed among the farmers was as result of the inefficiency factors considered.

Table 2. *Technical Efficiency of vitamin A cassava.*

Productivity

Variable	Coefficient	Standard error	t- ratio
Constant	8.0417	0.1883	42.7134*
Land (X_1)	0. 2189	0.0433	5.0576*
Labour (X_2)	-0.0529	0.0232	-2.2858**
Cost (X_3)	0. 4512	0.0579	7.7968*
Inefficiency variables			
Constant (Z_0)	-1.7503	1.6636	-1.0521
Gender (Z_1)	-2.1184	1.6842	-1.2578
Age (Z_2)	0.0551	0.0434	1.2699
Family size (Z_3)	-0.9015	0.6423	-1.4035
Access to Planting Material (Z_4)	0.2578	0.0679	3.7975*
Diagnostic statistics			
Sigma squared (δ^2)	2.1463	1.2926	1.6604
Gamma (γ)	0. 9679	0.0176	54.9495
Log likelihood function	42.0505		
LR Test	22.6471		
Mean Technical Efficiency	78.73%		

*,**,*** Significant level at 1%, 5% and 10% respectively. Source: Field survey, 2015.

4.3. Profitability of Vitamin A Cassava Production

The distribution of the various costs incurred and returns to biofortified cassava were presented in Table 3. Results showed that average total variable cost (TVC) was ₦69,732. However, it is important to note that cost of planting material accounted for 13.48% of the total variable costs.

This was probably due to the fact that the cassava variety was relatively scarce because it was newly introduced to the country. Average total revenues was ₦261,511.90 while the average gross margin and net profit analyses showed on the average, biofortified cassava farmers made ₦191,779.10 and ₦176,957.70 respectively from their cassava enterprise in the last production season. The return on investment (ROI) analysis indicated that every ₦1.00 spent by actors on biofortified cassava production yielded ₦2.09.

***Table 3.** Profitability Analysis for vitamin A cassava.*

Variable Cost(s)	Amount (₦)	Percentage of Total Variable Cost
Land Preparation	33428.78	47.94
Planting Material	9401	13.48
Pesticides and Herbicides	3050	4.37
Fertilizer	1200	1.72
Harvesting	9343	13.40
Labour Cost	13310	19.09
Total Variable Costs (TVC)	69732.78	100.00
Fixed Cost(s)	Amount(₦)	Percentage of Total Fixed Cost
Depreciation on Land	12885	86.94
Sprayers	671.4	4.53
Wheelbarrow	704	4.75
Water Tank	161	1.09
Other Fixed Cost	400	2.70
Total Fixed Cost (TFC)	14821.4	100.00
Total Cost (TFC+TVC) (₦)	84554.18	
Total Revenue (TR) (₦)	261511.90	
Gross Margin (TR –TVC) (₦)	191779.1	
Net Profit Margin (TR-TC) (₦)	176957.7	
Return on Investment (ROI)	209%	

Source: Field survey, 2015.

This implied that biofortified cassava production is profitable in the study area.

4.5. Factors Influencing Profitability of Vitamin A Cassava Production

Multiple regression estimates showed the level of significance of variables which were considered to be important factors influencing profitability of biofortified cassava enterprise in the study area (see Table 4). R^2 indicators showed that 73.7% of the changes in the level of profit among biofortified cassava farmers were explained by the factors included in the analysis. The result of this analysis showed that household size and farm size dedicated to biofortified cassava production were the major factors that significantly influencing its probability in the study area.

***Table 4.** Factor Affecting the Profitability of vitamin A cassava.*

Variable	Coefficient	t- value	Significant
Gender(X_1)	-0.015	-0.275	0.784
Age (X_2)	-0.004	-0.054	0.957
Household size (X_3)	0.185	2.890	0.005**
Farm size cultivated(X_4)	0.856	14.736	0.002*
R^2	0.737		
Adjusted R^2	0.726		
F- value	66.494		

*, ** mean significant level at 1%, 5% respectively. Source: Field survey, 2015.

4.6. Constrain to Vitamin A Cassava Production in the Study Area

The constraint faced by the farmer was analyzed using descriptive analysis. Table 5, shows that about 41% of the farmers faced the challenges of poor sales of product, 33% faced low level of awareness which is applicable to the consumers and some farmers, 15% have financial problem, 6% are faced with the scarcity of stem and 2% with the deterioration of the product after one year [13].

***Table 5.** Constraints to vitamin A cassava among Farmers.*

Constraints	Frequency	Percentage
Access to Finance	15	15.0
Low Level of Awareness	33	33.0
Tuber Quality Diminishes after a year	2	2.0
Scarcity of Planting Materials (Stem)	6	6.0
Total	100	100.00

Source: Field survey, 2015.

5. Conclusion and Recommendation

This study examined the socio-economic characteristics; analyzed the performance of vitamin A cassava production in the study area; determined the factors affecting the performance of vitamin A cassava and examined the constraint of pro- vitamin A performance among smallholder farmers in Oyo state. Findings from the study showed an

average age of 53 years with average years of experience of 3.5 years among vitamin A cassava farmers. Average farm size used for the production of the vitamin A cassava in the study area was 2.3ha. The study concluded that vitamin A cassava production in the study area was efficient and profitable. Farm size, labour used and cost of production were the major determinants of farm level efficiency while access to planting materials was a significant factor contributing to inefficiency among the farmers. Household size and farm size were the major factors affecting the profitability of vitamin A cassava cassava farmers in the study area. The study therefore recommended that more farm land should be dedicated to biofortified cassava production and that access to planting materials should be improved in order to increase the profitability and farm level efficiency respectively among provitamin A cassava farmers in the study area.

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