PROFITABILITY ANALYSIS AND DETERMINANTS OF PRO VITAMIN A CASSAVA PRODUCTION IN ENUGU STATE, NIGERIA

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ABSTRACT

This study assessed the profitability and determinants of pro-vitamin A cassava production in Anambra State, Nigeria. A multi-stage random sampling technique was used to select 120 respondents for the study. Structured questionnaires were employed to collect primary data. Percentage response, multiple regression analysis, and gross margin analysis were utilized to address the study's objectives. The results indicate that pro-vitamin A cassava farming is profitable in the study area, with a net farm income of ₦899,000 and a benefit-cost ratio of 1.92. The key determinants of profitability for the pro-vitamin A cassava variety were the cost of improved cassava cuttings and farm size. Additionally, the main constraints to pro-vitamin A cassava production were limited access to credit, poor access to extension services, and high labour costs. Enhancing farmers' access to credit, extension services, and labour-saving devices is recommended.

***Keywords**:* Profitability, Pro Vitamin, Cassava, Gross margin

INTRODUCTION

Agriculture, according to Reuters (2022), is one of the most important sectors of the economies of developing countries. In the crop production sector of agriculture, cassava is among the crops cultivated in Nigeria. Cassava is the sixth most important crop in the world, following wheat, rice, maize, potato, and barley (Anyanwu, 2015). Cassava has intrinsic features that endear it to farmers, including the ability to store matured edible roots in the ground for up to two years and consume them as needed. It tolerates adverse climatic conditions, serves as an inexpensive source of energy in human nourishment (Khadijat, 2021), is a major source of energy in the diet, can be produced with very low inputs, contributes significantly to food security, and provides raw material for the processing industry. Additionally, it gives the highest yield of all root crops with relatively simple cultivation (Food and Agriculture Organization, 2013).

However, due to vitamin A deficiency, especially among pregnant women and children under five years in most rural areas of the country that frequently consume cassava, pro-vitamin A cassava varieties were developed (NRCRI, 2013; National Root Crops Research Institute, 2020). These improved varieties include NR07/0326, NR07/0506, NR07/0497, NR07/0499, NR07/0427, and NR07/0432 (Egesi & Eke-Okoro, 2013; NRCRI, 2013). These cultivars, apart from having the above characteristics, also feature high dry matter content, high leaf retention in the dry season, and high-quality flour for confectioneries (Egesi & Eke-Okoro, 2013; Onunka, Ume, Ekwe, & Silo, 2017).

There have been several studies on pro-vitamin A cassava production in Nigeria and abroad, focusing on technical efficiency (Ume, Uloh, Onyeke, & Nwose, 2020) and adoption of the crop (Anyanwu, 2015). Available literature shows studies on the efficiency of pro-vitamin A cassava (Ume & Kaine, 2021) and its adoption (Nzeako & Ume, 2021). However, limited research has been conducted on the costs and determinants of net returns in the crop enterprise, especially in Anambra State, Nigeria. Consequently, this study aims to fill this literature gap in the study area

METHODOLOGY

Enugu State, Nigeria, was the study area. It is located between latitudes 6°30'N and 7°10'N of the Equator and longitudes 6°35'E and 7°30'E of the Greenwich Meridian. The state has an estimated population of about 4.167 million people (National Population Commission [NPC], 2006) and a land area of 16,727 square kilometres.

Enugu State has four agricultural zones: Enugu West, Enugu East, Enugu North, and Enugu South. The state is bounded to the west by Anambra State, to the east by Abia State, to the south by Imo State, and to the north by Benue State. Enugu State is characterized by a wet climatic zone with an annual rainfall of about 1800mm to 2500mm, a temperature range of 29°C to 35°C, and a relative humidity of 68%. The state is agrarian, and the inhabitants also engage in other non-agricultural activities such as trading, vulcanizing, salon services, auto mechanics, and civil service.

Structured questionnaires and informal or oral interviews were used to collect primary data. The objectives of the study were addressed using percentage responses, multiple regression, gross margin analysis and principal component analysis were used to address the objectives of the study.

Model Specification

Gross margin analysis.

Gross margin =G.M.=TR -TVC……………………………………………………(1)

$$\text{i.e.G.M} = \sum_{1-1}^{n} P_1 Q_1 - \sum_{j-i}^{m} r_i x_i \quad \text{………………………………………….……………. 2}$$

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

$$\text{NFI} = \sum_{1-1}^{n} P_1 Q_1 - \left[\left(\sum_{j-i}^{m} r_i x_i \right) + k \right] \text{…………………………………...……………3}$$

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.

Ordinary Least Squared Regressions Method,

Four functional forms of the multiple regressions were employed in order to select the one that has provided the best fit. The functional forms tried were:

Linear function $Y = b_0 + b_1 x_1 b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + ei$ ……………. (4)
Double log function:-$\ln(y) = \ln b_0 + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + b_4 \ln x_4 + b_5 \ln x_5 + ei$ …(5)
Semi log ; $Y = \ln b_0 + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + b_4 \ln x_4 + b_5 \ln x_5 + ei$ ………………… (6)
Exponential function; $\ln Y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + ei$……………….…(7)
The choice of the best functional form was based on the magnitude of the R^2 value, the high number of significances, size and signs of the regression coefficients as they conform to *apriori expectation*

In the ordinary least-squared regressions method, the explicit production function was estimated by
$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + e$ ……………………… (8)
Where:
Y = value of cassava output (₦), X_1 = Gender (Dummy), X_2 = Age of the farmer,
X_3 = Educational level (Years), X_4 = Farming experience(Years) X_5 = Cost of labour (N), X_6 = Cost of fertilizer(N), X_7 = Cost of improved cassava cutting(N) X_8; Farming experience (Years) X_9 = Household size(No)

$x_1 - x_9$ = coefficient of the parameters to be estimated, while e_1 was the error term and b_0 was the coefficient

Principal Component Analysis (PCA).

The Model of Principal Component (PCA) is stated thus:
x= $x^{1,2}, x^3, \ldots, xp$……………………………………………………………………………(8)

$$\propto_k = \propto_{1k1}, \propto_2 K, \propto_3 k, \ldots, \propto pk \quad \ldots\ldots(9)$$

$$\propto_K^T x = \sum_{j=1}^{p} \propto_{KjXj} \quad \ldots\ldots(10)$$

$Var = [\propto_K^T X]$ is maximum………… (11)

Maximise subject to

$$\propto_K^T \propto_K = 1 \quad \ldots\ldots(12)$$

$$\mathrm{Cov} = [\propto_1^T \propto - \propto_2^T \propto] = 0 \quad \ldots\ldots(13)$$

The Variance of each of the Principal Components:

$$Var[\propto_k X] = \lambda_k \quad \ldots\ldots(14)$$

$$S = \frac{1}{n-1}(X - \bar{X})(X - \bar{X})^T \quad \ldots\ldots(15)$$

$$S_i = \frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X}_i)(X_I - \bar{X}_i) \quad \ldots\ldots(16)$$

Where: X = vector of 'P' Random Variables; $\propto k$ = Vector of 'P' Constraints; λk= Eigen Value; T = Transpose; S = Sample Covariance Matrix.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of the Farmers

The socioeconomic characteristics of the farmers such as age, educational level, farming experience, farm size and household size were discussed herein.

Table 1: Distribution of Respondent According to Socioeconomic Characteristics

Variables	Frequency	Percentage
Gender		
Male	28	25
Female	92	75
Age		
Less than 20	3	2.5
21-40	35	29.17
41-60	60	50
62 and above	22	18.33
Level of Education		
No formal education	35	29.17
Primary school	60	50
Secondary school	20	16.67
Tertiary	5	4.17
Farming Experience		
1-10	11	9.17
11-20	26	21.67
21-30	52	43.33
31-40	31	25.83
Household Size		
1-5	22	18.3
6-10	35	29.2
11-15	34	28.3
16-20	17	14.2
Farm size		
0.01-1.00	40	33.3
1.01 – 2.00	30	25
2.01 – 3.00	18	15
3.01 – 4.00	15	12.5
4.01 – 5.00	12	10
> 5.00	5	4.2

Sources: Field survey, 2024.

Table 1 indicates that 75% of the respondents were females, while only 25% were males. This implies that cassava production in the study area is gender-specific. However, the trend is fast changing as males are increasingly engaging in cassava cultivation due to recent economic challenges (Ume & Kaine, 2021). Additionally, 68.33% of the respondents were above 41 years old, while 31.67% were below 41 years. This suggests that most of the sampled farmers were aged. Literature shows that aged farmers often use resources efficiently to enhance their productivity and profit.

The majority (71.93%) of the sampled farmers were literate, while 29.17% had no formal education. Educational attainment enhances individuals' access to information, boosting their productivity and profits (Ume & Kaine, 2021). Anyanwu (2015) also reported that the educational status of farmers makes them more objective in evaluating innovations, positively influencing their production.

Furthermore, 69.16% of the respondents had farming experience of 21-40 years, while the least (30.84%) had experience of 1-20 years. Years of farming experience help farmers set realistic targets to boost their production and productivity (FAO, 2013). Moreover, 29.2% of the respondents had household sizes of 6-10 people, while the least (14.2%) had household sizes of 16-20 people. Household members of the labour age can be used as hired labour to generate income to procure farm inputs, boosting farm production and profit for their household head (Nzeakor & Ume, 2021).

Table 1 also indicated that the majority (33.3%) of the farmers studied cultivated farm sizes ranging from 0.01 to 1.00 hectares, while the least (4.2%) cultivated above 5 hectares. This implies that cassava production in the study area was at a small scale. Nzeakor and Ume (2021) reported that farm size plays an important role in farm success because it reflects the availability of capital, access to credit, and good management ability.

Costs and Return of Pro Vitamin A Cassava Production

The costs and return on pro-vitamin A cassava production are presented in Table 2. The cost elements in cassava production include cassava stem cuttings, fertilizer, and tools. No attempt was made to value the land, as minimal or no rent was paid. This is because most lands in the study area are communally owned, with meagre fees charged to the users. The farm tools (cutlasses, spades, baskets, and hoes) used were depreciated.

Regarding the cost of inputs, the average quantity of cassava stem cuttings per hectare used was 80 bundles (50 sticks per bundle, costing N800 per bundle), totalling N64,000. Additionally, eight bags of fertilizer (NPK) costing N120,000 at N15,000 per bag were applied to a hectare of cassava. The total cost of physical inputs was N214,000.

For labour costs, the hours worked by men, women, and children were converted into a common frame following FAO (2013). A total of 89 man-days were used to produce one hectare of cassava, with mounding and ridging constituting the highest labour cost (18.9%), while the least was the cost of transportation (0.32%). The high number of man-hours for mounding and ridging could be attributed to the tedious and energy-sapping nature of the operation, especially in peasant farming where mechanization is nearly zero, thus requiring many people to accomplish a given area compared to other labour types in farming (Ume et al., 2021).

The total cost of labor was N678,000, constituting 71.2% of the total cost of production. The high total cost of cassava production could be correlated to the high cost of hired labour, especially during the peak farming season (FAO, 2015). The Net Farm Income (NFI) was N899,000. The high Net Farm Income result coincides with Nzeako and Ume (2022).

Table 2 Costs and Return of Pro Vitamin A Cassava Production

Item	Unit	Quantity	Price/unit	Cost/value
Revenue				
Roots	Kg	6000	300	1,800,000
Sales of cassava stem cutting	Bundle (50 cuttings)	30	800	24000
Total Revenue				1,824,000
Total Physical input				
stem cutting	Bundle	80	800	64,000
Fertilizer	Kg	8	15000	120, 000
Miscellaneous				30,000
Total				214,000
Clearing	Md	12	5000	60,000
Mounding / ridging	Md	30	6000	180000
Cutting and planting of stem	Md	5	3000	15,000
Fertilizer application	Md	7	3000	21000
Weeding	Md	20	4000	80000
Harvesting / Bagging	Md	15	3500	52000
Transportation				3,000
Total labour costs				678,000
Gross margin (TR - TVC)				932,000
Depreciation of fixed assets excluding land				20,000
Total cost (TVC+TFC)				952,000
Farm income (TR-TC)				899,000
Benefit cost ratio				1.92

Field Survey2024

Furthermore, the Benefit-Cost Ratio (BCR) was 1:1.92, implying that for every naira spent, N1.92 was realized. The Gross Margin was N932,000.

4.3 Estimated Multiple Regression Production Function

The estimated multiple regression production function for pro vitamin A cassava variety is shown in Table 3

Table 3: Estimated Multiple Regression Production Function for Pro Vitamin A Cassava Variety

Variable	Linear	Exponential	Double Log	Semi Log
Constant	9.064(5.344)***	7.0064(4.229)***	5.201(6.511)***	5.229(3.818)***
Age	0.470(0.167)	0.523(0.3541)	0.541(-2.481)**	1.621(-0.629)
Education	0.553(-0.366)	0.537(2.607)**	0.236(0.521)	-2.774(2.404)**
Cost of labour	0.712(3.149)***	0.438(4.916)***	0.043(0.126)	-0.295(0.623)
Costof Fertilizer	-0.494(2.753)**	-0.189(-0.626)	0.027(4.018)***	0.504(0.129)
Farm size	0.482(1.109)*	0.327(4.316)***	0.163(1.046)*	-0.307(0.003)
Farming experience	0.502(3.039)***	0.188(2.726)**	0.463(-1.225)**	-0.269(0.253)
Cost of improved	0.243(-0.516)	0.297(2.207)**	0.636(4.041)***	-2.422(2.077)**
cutting Household size	0.234(1.312)*	-0.76(0.009)	0.213(0.007)	1.098(0.091)
F ratio	5.243(5.518)	4.743(4.519)	6.443(7.500)	5.223(4.006)
R2	0.5823	0.4834	0.8858	0.3458

Source: Field Survey, 2024
*****, **, *** significant at 1.0%, 5.0% and 10.0% levels of probability respectively
The figure in parenthesis is the t-ratio

Based on statistical criteria, the Cobb-Douglas model was chosen as the lead equation. The coefficient of multiple determination, (R^2), was 0.8858, implying that 88.58% of the variation in the dependent variable was accounted for by the variables included in the model, while the remaining 11.42% was due to the error term. The coefficient for the age of the farmer had a negative association with the dependent variable and was significant at the 5% probability level. The negative sign of this variable could be correlated to the conservative attitude of older farmers towards technology adoption, leading to low farm output and, consequently, low profitability (Anyanwu, 2015). This finding contrasts with Ume et al. (2020), who reported that younger farmers are innovative and adaptable, resulting in enhanced farm output and higher farm profit. Additionally, the coefficient for the cost of labour, as expected, had an indirect correlation with farm profit in improved cassava production at the 1% probability level. The negative sign of this variable could be linked to the scarcity and high cost of labour observed at the farm level in the study area, caused by the migration of able-bodied men in search of white-collar jobs (Nzeakor & Ume, 2021).

Furthermore, the coefficient for improved cassava cuttings was positive and significant at the 5% alpha level. Improved cassava varieties are among the most economical and efficient inputs for improving cassava productivity and profitability. However, Ume and Kaine (2021) noted that the scarcity and high cost of improved cassava varieties have compelled many farmers to abandon their use in favour of local varieties, thus affecting their income due to lower production. Additionally, the farm size coefficient had a direct relation with the dependent variable and was significant at the 95% confidence level. Farm size affects adoption costs, human capital, and risk perception, leading to higher farm income.

4.4 Constraints to Cassava Production

The results of the principal component analysis on constraints to cassava production are represented in Table 4

Table 4. Results of the Principal Component Analysis on Constraints to Cassava Production

Constraints	**Eigen-Value**	**Difference**	**Proportion**	**Cumulative**
Credit problem	3.0032	0.39764	0.2567	0.3612
High cost of labour	3.4311	1.15632	0.3466	0.3412
Poor soil fertility	2.2931	0.3558	0.2006	0.4532
Poor access to land	2.1778	0.3098	0.0091	0.4424
Poor access to information	2.0009	0.2789	0.2689	0.8112
High cost of fertilizer	2.0532	0.2609	0.2450	0.4567
Poor access to extension services	1.0678	0.24509	0.1577	0.8055
Bad Road	0.0372	0.22378	0.0587	0.8773
KMO	0.8773%			
Chi-Square	3.0076***			
Rho	1.00000			

Bartlett Test of Sphericity ; 3.2276***

Source; Field Survey, 2024

The results in Table 4 show that the number of principal components retained using the Kaiser-Meyer criterion was four, in line with Eigen-values greater than 1. The retained components explained 87.73% of the variance of the components integrated into the model. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy contributed a value of 0.8123, and the Bartlett test of sphericity yielded a value of 3.2276***, which was significant at the 1% alpha level. This suggests the importance of utilizing the set of information for factor analysis.

The problem of credit access had an Eigenvalue of 3.0032 and was ranked 1st in order of importance as reported by respondents. Poor access to credit may be linked to ignorance of loan facilities and methods of loan repayment (Ume et al., 2020). This was followed by the high cost of labour, with an Eigenvalue of 3.4311. The high cost of labour could be related to the urban drift of youths to urban areas in search of greener pastures, with the few remaining charging high rates for survival, especially given the recent economic recession in the country (Ume & Kaine, 2021).

The least significant factor was bad roads, with an Eigenvalue of 0.0372, ranked 8th. Most rural areas, especially those linking urban markets, are in very deplorable conditions for the inflow and outflow of farm inputs and outputs, respectively, hence negatively affecting farmers' outputs and income.

CONCLUSION AND RECOMMENDATIONS

Pro-vitamin A cassava farming is profitable in the study area, with a net farm income of ₦899,000 and a benefit-cost ratio of 1.92. The key determinants of profitability for the pro-vitamin A cassava variety were the cost of improved cassava cuttings and farm size. However, the main constraints to pro-vitamin A cassava production in the study area were limited access to credit, poor access to extension services, and high labour costs.

Based on these findings, the following recommendations are proposed:

1. There is a need to expose farmers to labour-saving devices, such as hand-driven ploughs, to significantly reduce production costs.
2. Policies aimed at encouraging farmers to form cooperatives or associations should be advocated.
3. Government and relevant stakeholders should ensure farmers have access to credit through microcredit institutions and other financial entities.
4. There should be the provision of extension agents with mobility and other incentives to improve their effectiveness.
5. Government should implement policies to improve farmers' access to educational programs, such as adult education workshops and seminars.

REFERENCES

Anyanwu, K. C. (2015). Factors affecting the adoption of new technologies of cassava in Imo State of Nigeria. *Bulletin of Agronomic Research of Benin,* 36-39.

Egesi, C., & Eke-Okoro. (2013). Addressing Vitamin 'A' Deficiency Syndrome (VADS) in Nigeria. *Roots: Quarterly Newsletter of NRCRI, Umudike*, 1(1), 15-16.

Ekwe, K. C. (2013). "Pro-vitamin A" Cassava: Hope Rise for Nigerian Children. *Roots: Quarterly Newsletter of National Root Crops Research Institute, Umudike*, 1(1), 26-33.

FAO. (2022). Data on cassava production. Available at https://www.fao.org/faostat/en/#data/QCL/visualize. Accessed on December 23, 2022.

FAO. (2013). An Assessment on the productivity of cassava in Africa. *Food and Agricultural Organization of the United Nations*, 11, 17.

Food and Agriculture Organization Statistical Database (FAOSTAT). (2019). Available at http://www.faostat.org/site/339/default.aspx. [Retrieved 23 September, 2019].

FAO. (2015). FAO statistical data. Available at http://www.fao.org.

Khadijat, K. (2021). Cassava, Yam, Maize rank top ten crops produced in Nigeria but NOT top 10 crops exported. Available at https://www.google.com/amp/s/www.dataphyte.com.

National Population Commission (NPC). (2006). The Population Census of the Federal Republic of Nigeria Analytical Report, Abuja.

N.R.C.R.I. (2020). National Root Crops Research Institute, Annual Report, Umudike, Abia State, Nigeria, 14(11), 36-38.

NRCRI. (2019). Annual report of National Root Crops Research Institute, Umudike, Umuahia.

Okoye, F. U., Okoye, A. C., & Ume, S. I. (2021). Consumption behavior analyses of cassava products among rural households in Ebonyi State, Nigeria. *Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension*, 20(2), 14-19.

Olutosin, A. O., & Otekunrin, B. S. (2019). Cassava, a 21st century staple crop: How can Nigeria harness its enormous trade potentials? *Acta Sci. Agric.*, 3, 194-202.

Onunka, B. N., Ume, S. I., Ekwe, P. K., & Silo, B. J. (2017). Attitude of farmers towards “pro-vitamin A” cassava production technologies in Abia state, Nigeria. *Life Science Archives (LSA)*, 3(3), 1050-1059.

Owoseni, K. P., Okunlola, O., & Akinwalere, B. (2021). Effect of adoption of improved cassava variety TME 419 on farmers’ livelihood in Ekiti State, Nigeria. *Journal of Agricultural Extension and Rural Development*, 13(4), 265-272.

PWC. (2020). Harnessing the economic potentials of cassava production in Nigeria. Available at https://www.howwemadeitinafrica.com/harnessing. Accessed on May 1, 2022.

Reuters. (2022). Thai exports of cassava products surge as Ukraine war disrupts grain supplies. Available at https://www.reuters.com/article/thailand-cassava-idNL4N2Y71LB. Accessed on December 24, 2022.

Salau, S. A., Nofiu, N. B., & Jimoh, T. A. (2019). Effect of Cassava Product Consumption on Food Security of Farming Households in Kwara State, Nigeria. *Department of Agricultural Economics and Extension Services, College of Agriculture, Kwara State University, Malete, Nigeria*.

The Guardian. (2020). Taking advantage of Nigeria's strength in cassava production. Available at https://guardian.ng/features/taking-advantage-of-nigerias-strength-in-cassava-production/. Accessed on November 19, 2022.

Ume, S. I., Uloh, E. V., Onyeke, A. C., & Nwose, D. I. (2020). Technical Inefficiency of Pro Vitamin A Cassava Varieties Farmers in South East, Nigeria (Using Normalized Trans-Log Production Frontier Function Model); Bridging Agriculture and Nutritional Divide in Rural Areas of Sub-Saharan Africa. *International Journal of Science and Healthcare Research*, 5(3), July-Sept. 2020.

Ume, S. I., & Kaine, A. I. N. (2021). Technical efficiencies of TMS cassava varieties by farmers in Ebonyi State, Nigeria. *AKSU Journal of Agriculture and Food Science*, 5(3), 141-159.

Ume, S. I., Okoye, F. U., Onwujiariri, U. J., & Achebe, U. (2020). Analysis of Intensity of Adoption of Odourless Fufu Processing Technology by Pro vitamin A Cassava Variety Processors in Anambra State of Nigeria. *International Journal of Science and Healthcare Research*, 5(3), July-Sept. 2020.