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Analysis of Enterprise Budgeting and Profit Efficiency of Cassava Production in Nigeria

[1] Nwadiolu R. *[2]Ewododhe A.C.A [3] Kperegbeyi, J.I. [4]Doubra, B

[1, 2]Department of Agricultural Economics, Southern Delta University, Ozoro, Delta State

[3]Department of Animal Production, Southern Delta University, Ozoro, Delta State

[4]Department of Agronomy, Southern Delta University, Ozoro, Delta State

***Correspondence Author**

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ABSTRACT

This study evaluated the profitability and profit-efficiency of cassava production among registered sole producers in Delta State, Nigeria, and identified key drivers of per-unit profit. Using multistage random sampling, 300 cassava farmers were surveyed and enterprise budgets, sensitivity analysis, and a profit-function regression were applied. Aggregate results showed total revenue (TR) of ₦83.8 million, total cost (TC) of ₦59.7 million, and net farm income (NFI) of ₦24.03 million, yielding a mean NFI per farm of ₦100,110 and a total net return on investment (NROI) of 0.402 (40.2%); the profit margin (NFI/TR) averaged 28.7%. Late-planting farms recorded marginally higher gross margin and NFI per hectare than early-planting farms (gross margin: ₦101,020 vs ₦92,102; NFI/ha: ₦93,005 vs ₦85,101). Profit-function estimation (R2 = 0.657) identified per-unit output price (PPO, positive), per-unit labour price (PPL, negative), age (negative), household size (positive), education (positive), and farming experience (positive) as significant determinants of per-unit profit ($p < 0.10$ – 0.01). Sensitivity analysis revealed that a 10% decline in revenue reduced gross margin by 32% and NFI by 35%, indicating revenue shocks were more damaging than equivalent cost increases. Findings underscored the viability of cassava production while highlighting opportunities to raise profitability via price-and-market access, labor-saving technologies, human-capital investments, and revenue-risk mitigation (e.g., forward contracting). Results informed targeted extension, credit, and value-chain interventions to improve smallholder returns in line with national and international policy priorities

Key words: Profit function, farming experience, output, unit price, Gross margin.

INTRODUCTION

The agricultural sector of the nation's economy holds the key to any meaningful economic development in the country especially in areas of food provision, poverty alleviation, employment creation, income generation and supply of raw materials to industries (FAO, 2019). According to the World Bank (Alain De Janvy and Sadoulet, 2020), agriculture remains central to addressing hunger, extreme poverty and social restiveness in Nigeria and other African countries.

The agricultural sector accounted for between 37 and 41.7% of the Gross Domestic Product (G.D.P) of Nigeria between 1981 and 2011 (National Bureau of Statistics, 2021). In addition, it provided paid and self-employment for over 70 percent of the population. The crop sub sector of the agricultural sector comprised food crops and cash crops, with the former being predominantly cultivated. The major food crops, namely, rice, maize, yam, cassava, cocoyam, sorghum, millet and beans and vegetables contributed about 28 percent of the G.D.P and represented over 75% of the agricultural sector contribution to G.D.P (National Bureau of Statistics, 2021).

Cassava (*Manihot esculenta Crantz*) is a woody shrub of the Euphorbiaceae family and genus Manihot. Apart from food, cassava products have good uses in many other areas ranging from animal feed production to the

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pharmaceutical industry. According to Wasiu (2018), cassava products can be used in the following areas, namely: production of composite flour for the bakery industry; distillation of beverages, medical and industrial alcohol; thickening and glazing of confectionaries; production of sweeteners from cassava glucose and fructose for use in fruit juice and jam industries. Other uses include acting as binding and filling agents in the manufacturing of pharmaceutical tablets, making of glues and gums, starch for textile and paper industries, manufacturing of biodegradable polymers for replacement of polythene as packaging materials and livestock feed production among others.

Despite growing demand for cassava products (fresh roots, garri, starch and industrial derivatives), smallholder producers often face volatile prices, high input costs and weak value-chain linkages that limit returns to production (Reardon et al., 2019; World Bank, 2020). Enterprise budgeting—detailed accounting of costs, returns and profit margins for a production enterprise—provides a transparent basis for comparing enterprises, allocating resources and identifying where efficiency gains are feasible (Price, 2022). Complementing budgeting with profit-efficiency analysis (e.g., stochastic frontier approaches) allows researchers to separate technical and allocative inefficiencies from market and environmental constraints and thus to quantify how much of the gap between observed and potential profit is due to managerial or structural factors (Amare et al, 2025; Ortega et al, 2025).

Despite cassava's prominence, empirical evidence suggests that many producers do not realize potential profits because of inefficient input use, poor access to timely finance, low adoption of improved varieties and limited access to value-adding technologies and markets (Adaigho et al, 2025; FAO, 2019, Nwadiolu et al, 2025). In Delta State anecdotal reports and limited surveys point to high variability in net returns across farms, but rigorous enterprise budgets and profit-efficiency studies that quantify the magnitude and sources of inefficiency are scarce. Without enterprise-level budgets, farmers and extension agents lack clear, comparable benchmarks for profitability, and policymakers cannot easily identify whether low returns are driven by prices, technical inefficiency, scale effects or governance failures in value chains (Reardon et al., 2019; World Bank, 2020). Moreover, the literature on profit efficiency in Nigerian crop production shows that farm-level inefficiencies can be substantial and responsive to management practices, credit access and extension services (Price, 2022; Amare et al, 2025), yet specific, up-to-date evidence for cassava in Delta State is limited. This knowledge gap constrains targeted policy and private investments aimed at increasing farm incomes and improving the competitiveness of local cassava value chains.

MATERIALS AND METHODS

The study population was made up of all 1,559 registered sole cassava farmers in Delta State. Multistage and random sampling techniques was used to select 307 respondents for the study using Cochran formula. This comprised 150 early planting and 157 late planting cassava farmer. This formula was expressed as:

$$n = \frac{n_0}{1+\frac{(n_0-1)}{N}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. Equation\ 1$$

$$n_0 \frac{Z^2pq}{e^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ Equation\ 2$$

Where

N represent sampling frame

n represent the sampling size with a finite population

n_0 is the sample size for infinite population

Z is the critical value (1.96) of the required 95% confidence level

P is the specified proportion in the population (0.50), assuming maximum variability

q =1-p, and e is the desired level of accuracy (5%)

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Data was analyzed using Net farm income, profit function and sensitivity analysis. This was expressed as follows:

1. Net farm income, profit function and multiple regression model were used to analyse the data. This was expressed as:

Net farm income (NFI) = GM – TC or TR – TC

Where GM = Gross Margin

TC = Total cost

TR = Total Revenue

2. The profit function model is implicitly specified as follows

$$\pi = \pi(PPO, PPC, PPF, PPL, AGE, EDU, HHS, EXT)$$

Where

$\pi =$ Amount of maximum variables profit (₦)

PPO = Per unit price of output (₦)

PPC = Per unit price of cassava (₦)

PPF = Per unit price of fertilizer (₦)

PPL = Per unit price of labour (₦)

AGE = Age of farmer (Year)

EDU = Educational level of farmer (years)

FAE = Farming experience

HHS = Household size (number)

EXT = Extension visits

RESULT AND DISCUSSION

Enterprises Budgeting Analysis for Cassava Production

Result in Table 1 revealed that the cost of production for early season farms stood at ₦30,227,926 and were slightly higher than late season farms which stood at ₦29,511,377. The total variable cost for both seasons were found to be similar with each accounting for about 96% of total cost. Labour cost for early season farm (₦19,501,946) were however higher than that of late season which stood at ₦17,544,836. The higher labour cost during early planting season were traced to competitive demand for limited labour force by producers of other arable crops like yam, maize and rice at the onset of the rains. Other cost items such as fertilizer, herbicides and transport were however similar among the two seasons.

On cost of production per hectare, early season farms had higher average total cost (ATC) of N200,578 as against ₦187,414 for late season production and ₦193,966 for all farms. These figures broadly accorded with more recent regional cost studies and extension service reports (Weli and Baje, 2017; Wasiu ,2018). The slightly higher cost of production per hectare of early season planting were likely the result of higher labour wage during the early season caused by competition for limited labour force by growers of other crops such as yam and rice.

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Again, the less frequent weeding in late cassava owing to the onset of the dry season reduced cost of labour and hence total cost per hectare (Weli and Baje, 2017).

As indicated in the Table 1, the total revenue obtained by all farms, early season and late season farms were ₦83,765,583, N42,119,086 and ₦41,646,497, respectively. The gross margin, net farm income, mean net farm income and net returns on investment for all farms were ₦ 26,334,625, ₦24,026,340, ₦100,109.50 and 0.40, respectively. The figures for early season farms were ₦13,038,972; ₦11,891,160, ₦99,093 and 0.40, respectively, while those of late season farms were ₦13,295,680, ₦12,135,120, ₦102,126 and 0.41, respectively.

This cassava farming in the study area, having recorded positive net farm income and return on investment for the different production seasons, was adjudged as profitable. The profitability of cassava production has been confirmed in recent empirical studies and sector reviews (Wasiu, 2018; Issa et al, 2025). The net return on investment (NROI) figures of 0.40 and 0.41 recorded by early season and late season producers, respectively, implied that ₦0.40 and ₦0.41 were returned for every ₦1.00 invested in the enterprise. The NROI shortfall of ₦0.60 for cassava production in the area indicated that there was still room for improvement on the present profit level. This could be achieved through adoption of improved farming practices, use of mechanization in place of manual labour, improved access to credit and more efficient marketing of produce — recommendations echoed in recent policy and technical briefs (Alan De Janvy and Sadoulet, 2020; Issa et al, 2025).

On gross margin and net farm income per hectare, early season planting recorded ₦92,102 and N85,101 respectively as against ₦101,020 and ₦93,005 for late season production. The result therefore indicated that cassava production was profitable in the study area. However, the higher gross margin and net profit from late season farms were attributable to production cost differentials, particularly labour cost. The finding were consistent with several recent field studies that reported positive gross margins and net farm incomes (Odekina et al, 2021; Oyotomhe et al, 2025)

Table 1: Estimated profit for cassava production in Delta State, Nigeria

Variable	**All Farms**		**Early Planting**		**Late Planting**	
	Amount (₦)	%	Amount (₦)	%	Amount (₦)	%
Total Revenue (TR)	83,765,688		42,119,086		41,646,497	3.71
Variable Cost						
Cassava Stem	2,103,688	3.52	1.007,770	3.30	1,093,918	3.71
Fertilizer	11,100,752	18.58	4,988,702	16.50	6,112,050	20.71
Herbicide	4,451,347	7.45	2,270,187	7.51	2,181,160	7.34
Labour	37,046,582	62.01	19,501,746	64.52	17,544,836	59.45
Transport	2,728,562	4.57	1,309,709	4.33	1,418,853	4.81
Total Variable Cost (TVC)	57,430,931	96.14	29,080,114	96.20	28,350,817	96.06
Fixed Cost						
Dep. On hoes	360,680	0.60	173,129	0.59	187,557	0.64
Dep. On Cutlass	401,556	0.67	200,300	0.66	201,256	0.68
Dep. On Whel barrow	423,186	0.71	200,986	066	222,200	0.75

Dep. On Headpan	300,912	0.50	150,556	0.50	150,356	0.51
Dep. On bicycle/motor bike	401,588	0.77	235,410	0.78	226,168	0.59
Interest on Loan	360,444	3.86	1,147,812	3.80	1,160,560	3.93
Total Fixed Cost (TFC)	2,308,372	3.86	1,147,812	3.80	1,160,560	3.93
Total Cost (TC)						
(TC=TVC+TFC)	59,739,303	100	30,227,926	100	29,511,377	100
Average Total Cost (ATC)	193,966		200,578		187,414	
Gross Margin (TR-TVC)	26,334,652	-	13,038,972		13,295,680	
Net Farm Income (NFI)						
(NFI=TR-TC)	24,026,340		11,891,160		12,135,120	
Mean NetFarm Income						
(MNFI=NFI/n)	100,109.75		99,093		102,126	
Net Return on Investment						
NROI – NFI/TC	0.40		0.40		0.41	
Gross Margin per hectare	96,526		92,102		101,020	
Net Farm Income per hectare	89,053		85,101		93,005	

Source: Field survey, 2025 Note: Dep = Depreciation

Profit Efficiency Ratio

The Figure 1 showed consistently healthy but closely clustered profit-efficiency metrics across the sample with an overall profit margin (NFI/TR) of 0.287 (28.7%), a net return on inputs/costs (NROI, NFI/TC) of 0.402 (40.2%), and a gross margin ratio of 0.314 (31.4%). These levels indicated that, on average, cassava stem cuttings retained roughly 29% of revenue as net farm income and earned about 40% relative to their total costs, which suggested reasonably efficient conversion of revenue into profit for this enterprise type (Jimoh et al, 2023). The gross margin ratio around 31% corroborated that variable-cost control was a key driver of profitability in cassava stem nursery operations (Mauki et al., 2023).

Comparing early- versus late-planting groups, late-planting enterprises showed slightly higher indicators with profit margin of 0.291 (29.1%) versus 0.282 (28.2%), NROI 0.411 (41.1%) versus 0.392 (39.2%), and gross margin 31.9% versus 31.0%. While these differences were small (on the order of 0.8–1.9 percentage points), they pointed to a modest advantage for the late-planting cohort. Recent studies suggested such timing-related differentials might arouse from better synchronization with labour availability, lower plantlet mortality, or timing sales into more favourable input/output price windows (Borah and Halim, 2021; Palemo et al., 2024). However, because the gaps were small, formal significance testing and controls for scale, input prices, and management practices were required before concluding a robust planting-time effect (Jimoh et al., 2023).

From a managerial viewpoint, the results implied that incremental gains in profit efficiency were most likely captured by tightening variable-costs and improving throughout rather than by major structural changes. Various authors emphasized that modest improvements in substrate use, land preparation efficiency, weed control, and labour productivity could meaningfully lift unit margins in young cassava plants (Mdoda and Sikweda, 2025; Gbigbi and Chuks-Okonta, 2021). The roughly 40% NROI suggested there were room to optimized cost composition (e.g., reducing non-value-adding activities or negotiating bulk input prices) to convert a greater share of gross margin into net income.

Sustainability measures could also reinforce profitability. Recent work showed that investments in water-saving irrigation, waste recapture, and better stem nursery quality assurance often pay back through lower operating costs and higher field-survival rates, which in turn strengthened long-term margins (Van-Touch et al, 2024; Okoye et al., 2023). Given the modest margin differences in the table, adopting best-practice resource efficiencies might be a higher-return option than attempting to change planting timing alone.

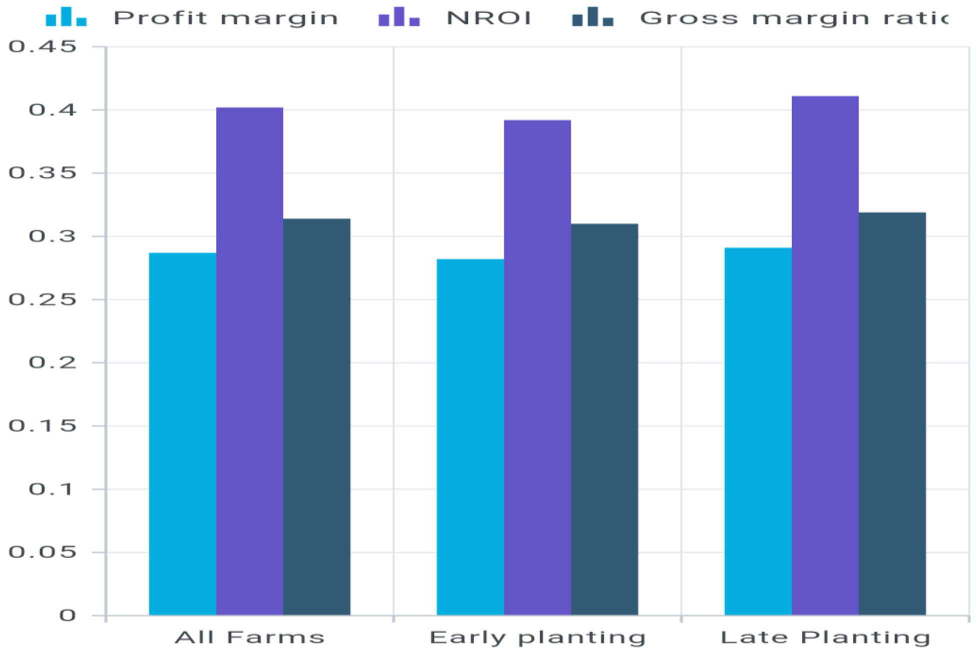

Figure 1: Profit-efficiency metrics across Early planting, Late planting and all farms

Profit Function Regression Analysis

The profit function in Table 2 was used to estimate the effect of prices of individual resource inputs and output as well as the effect of socio-economic factors of the respondents on per unit profit (PUP). The nine independent variables included in the model were per unit price of output (PPO), per unit price of cassava stems (PPS), per unit of fertilizer (PPF), per unit price of labour (PPL) and socio-economic factors of age (AGE), educational level (EDU, faring experience (FAE), household size (HHS) and extension visits (EXT).

The profit function equation was as follows:

PUP = 15.8 + 1.56 PPO – 0.290 PPF – 0.699 PPL + 0.0022 PPS – 4.73 AGE + 0.927 HHS – 0.044 EDU + 0.994 FAE + 0.0135 EXV.

Result of analysis, as shown in Table 2, indicated that five of the nine variables, namely per unit price of output, per unit price of labour, age, household size, educational level and farming experience were statistically significant at the 5% level. Per unit price of output had a positive and significant relationship with profit at 10%. This relationship was in accordance with a priori expectations and implied that higher output prices would lead to higher income and subsequently increased profit from cassava production. The finding was in consonance with recent sectoral analyses and empirical studies that linked output prices and market access to farm profitability (Issa et al, 2025; Tolba et al., 2020).

The coefficient of per unit price of labour was statistically significant at the 10% level and negative. The finding was in tandem with a priori expectations and implied that high labour costs led to increased production costs

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which in turn reduced gross margin and net farm income (profit). Moreover, the cost analysis of the study indicated that cost of labour were the highest cost item, accounting for 12% of total production cost, which further substantiated the above claim. This result aligned with more recent empirical work showing strong negative effects of rising labour costs on smallholder profitability in labour-intensive value chains (Ezeudu and Obimbua, 2024; Ilesanmi et al, 2021).

The coefficient of age was statistically significant at the 5% level and negative. The implication was that with increases in farmers' age their productivity and net farm income decreased. This result was consistent with findings from contemporary farm-level studies that document declining productive capacity and adaptive investment with advancing age in some contexts (Fronda, 2023; FAO, 2020). Again the coefficients of educational attainment and farming experience were statistically significant and positive at the 5% and 1% levels respectively and were also in line with *a priori* expectations. The implication was that higher educational attainment and greater farming experience among cassava farmers would enhance their net farm income, a conclusion supported by recent analyses linking human capital and on-farm learning to higher returns. The coefficients of the remaining three variables (per unit price of fertilizer, per unit price of cassava stem and extension visits) were not statistically different from zero.

The R2 value of 65.7% indicated that about 65.7% of the variation in profit was accounted for by variations of the independent variables while the remaining 34.3% was due to random disturbances. The F-statistic and Durbin–Watson statistic values were acceptable, indicating overall significance of the regression and negative first order autocorrelation among the repressors' residuals.

Table 2: Estimated profit function regression output

Predictor	**Coefficient**	**StDev**	**T-ratio**	**Probability**
Constant	15.840	2.27	6.98	0.000
PPO	1.562	0.94	1.67*	0.097
PPE	-0.290	0.67	-0.43	0.667
PPL	-0.699	1.81	-0.86*	0.019
PPS	0.002	0.01	0.20	0.844
AGE	-4.733	2.39	-12.22*	0.000
HHS	0.927	0.15	5.99*	0.000
EDU	0.045	0.11	0.39*	0.000
FAE	0.994	0.11	8.76*	0.000
EXT	0.013	0.02	0.69	0.492
R^2	65.7%			
R^2 (adjustment)	64.3%			
F-Statistics	46.56			
DF	F(9,243)			
Durbin-Watson Statistics	2.76			

Source: Field survey, 2025. Note: * = Significant at 1% level, ** = significant at 5% level, *** significant at 10% level.

Sensitivity Dimension for all Farm Scenario

The sensitivity result in Table 3 showed that total revenue (TR), total variable cost (TVC), total fixed cost (TFC), total cost (TC), gross margin (GM), net farm/net functional income (NFI), profit margin, net return on investment (NROI) and the GM/TR ratio for a base case and several stressed scenarios. Under the base case, the operation posts TR = 83.8 million, TVC = ₦57.4 million, GM = ₦26.3 million, NFI = ₦24.0 million and a profit margin of 28.7%. The "best case" combined a roughly +10% revenue with a roughly −10% TVC and raised GM to ₦40.45 million (a 53.6% increase over base) and profit margin to 41.4%; conversely the "worst case" (−10% revenue and +10% TVC) reduced GM to ₦12.22 million (a 53.6% fall) and profit margin to 13.1%. These symmetric swings made clear that simultaneous adverse moves in price/yield and variable costs could rapidly erode profitability, while favorable moves amplified returns (Prentzas et al., 2025).

Comparing the single-factor sensitivity rows quantifies which levers matter most. A 10% fall in revenue alone reduced GM from ₦26.33M to ₦17.96M (−31.8%) and NFI from ₦24.03M to ₦15.65M (−34.9%), while a 10% rise in TVC alone reduces GM to ₦20.59M (−21.8%) and NFI to ₦18.28M (−23.9%). In other words, the revenue shock cuts profitability substantially more than the same proportional increase in variable costs (10% revenue decline reduces NFI by 34.9% whereas a 10% TVC increase reduces NFI by only 23.9%). This asymmetry indicated that revenue-side risks (market prices, yield losses) were more damaging to net returns than equivalent proportional increases in variable input costs — a point echoed in recent sensitivity and farm-risk studies (Jimoh et al, 2023; Zelingher et al, 2021). Also, 10% reduction in TVC (achievable through mechanization of land preparation or weeding) would improve NFI by nearly 24% under the base revenue scenario. Multiple reviewers kept finding the same thing: when human hands were swapped out for machines in the field, work got done faster. Plowing, sowing, reaping, even hauling the harvest in — every step chewed up fewer hours That meant each sack of grain cost less to produce, and the whole farm could churn out more before the season ended (Zou et al, 2024; Havigimana et al, 2025).

From a practical management perspective, the results implied a two-pronged priority such as protecting and stabilizing revenue, and tightly controlling variable costs. Because revenue reductions produced the largest proportional hit to GM and NFI, measures such as yield protection (improved planting material and agronomy), quality improvements that command better prices, and forward sales/contracting to hedge price risk should be primary strategies. At the same time, process improvements that reduced TVC such as more efficient fertiliser application, labour productivity gains, and substrate/waste minimization in early planting stage, would improve margins and buffer against smaller shocks (Mvodo and Mbey, 2020; Gbigbi and Chuks-Okonta, 2021).

The sustainability dimension was tightly linked to these efficiency choices. Best-case performance in the table required both higher revenue and lower variable cost; many recent authors point out that resource-efficient practices (water and energy savings, reduced input wastage, waste valorization) both cut costs and make the operation more marketable under sustainability standards, thereby supporting revenue. In short, sustainability investments could be value-creating when they lower operating intensity and/or enable access to premium markets — but they must be chosen and staged so CAPEX and working capital remain affordable (Van Touch et al, 2024; Shahzard, et al, 2025).

Finally, the sensitivity outcomes underlined the need for routine scenario planning and KPI monitoring. The symmetrical deterioration between best and worst cases showed how volatile outcomes can be; adopting a rolling forecast, stress-testing for combined shocks, and monitoring leading indicators (price trends, input cost indices, seedling survival rates) would let managers act before profits collapse. In short, numerous literature prioritize revenue protection strategies and demand-driven capacity planning, while pursuing cost efficiencies and sustainable practices that simultaneously lower TVC and strengthen market positioning (Palemo et al., 2024; Sithole and Olorunfemi, 2024; Borah and Halim, 2021).

Table 3: Sensitivity analysis results for all farm scenario

	TR ₦	TVC ₦	TFC ₦	TC ₦	GM ₦	NFI ₦	Profir margin	NROI	GM/TR
Base	83,765,688	57,430,931	2,308,372	59,739,303	26,334,757	24,026,385	28.7%	40.2%	31.4%
Best case	92,142,256	51,687,838	2,308,372	53,996,210	40,454,418	38,146,046	41.4%	70.7%	43.9%
Worst case	75,389,119	63,174,024	2,308,372	65,482,396	12,215,095	9,906,723	13.1%	15.1%	16.2%
Revenue - 10% only	75,389,119	57,430,931	2,308,372	59,739,303	17,958,188	15,649,816	20.8%	26.2%	23.8%
TVC + 10% only	83,765,688	63,174,024	2,308,372	65,482,396	20,591,668	18,283,292	21.8%	27.9%	24.6%

Note; The ‘best case’ assumes a 10% increase in revenue and a 10% decrease in TVC simultaneously, while the ‘worst case’ assumes the opposite.

2. A 10% reduction in TVC (achievable through mechanization of land preparation or weeding) would improve NFI by nearly 24% under the base revenue scenario.

CONCLUSION AND RECOMMENDATIONS

Cassava production in Delta State was profitable but exhibited modest returns and sensitivity to revenue and variable-cost shocks. Average net farm incomes and positive gross margins indicated viable enterprises, yet labour and seasonality drive cost differentials that constrained higher profitability. Larger household size, farming experience and education improved per-unit profits, while rising labour costs and price volatility eroded them. Policy and managerial priorities should therefore focus on protecting revenue through improved planting material, market linkages and price risk management by lowering variable costs via labor-saving practices, input efficiency and targeted mechanization. Strengthening access to timely credit, extension services and market information could raise profit efficiency and encourage adoption of value-adding practices. Routine scenario planning and investment in affordable sustainability measures would both buffer risks and open premium market opportunities. With these targeted interventions, cassava producers can enhance resilience, increase returns, and contribute more effectively to local economic development.

Disclosure of conflict of Interest

Authors declare no conflict of interest

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