RADINKA JOURNAL OF SCIENCE
AND SYSTEMATIC LITERATURE REVIEW

ISSN 2988-5825

https://www.rjupublisher.com/ojs/index.php/RJSLR

Profitability Analysis of Pepper (Capsicum Species) Production in Okene Local Government Area, Kogi State, Nigeria

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Abstract

This study investigates the economic viability of and challenges faced by pepper farmers in the region. As a globally significant spice crop of immense culinary and economic importance, pepper contributes to nutritional health and accounts for approximately 40% of vegetable consumption in Nigeria, which yielded 762,174 tonnes of green chilies and peppers in 2020. The research aimed to describe the socio-economic characteristics of chili pepper farmers, assess profitability, and identify production constraints within Okene Local Government Area. Employing a multi-stage sampling technique, data were gathered from 99 respondents using structured questionnaires, personal visits, and interviews. Findings reveal that pepper production in Okene LGA is, on average, profitable, yielding a mean Net Farm Income (NFI) of ₦749,303.03, though significant variability exists, with some farmers experiencing losses. Key constraints identified include sole reliance on pepper farming, limited access to formal credit, and a lack of off-farm employment opportunities. Consequently, the study recommends targeted policy interventions—such as accessible microfinance, improved farm inputs, and stronger agricultural extension services—while emphasizing gender-sensitive development and income diversification to enhance rural sustainability and livelihoods.

Keywords**:** Pepper production, profitability analysis, net farm income, Okene Local Government Area, Kogi State, agricultural economics.

Acknowledgments: The authors would like to express their sincere gratitude to the pepper farmers in Okene Local Government Area, Kogi State, for generously sharing their time, experiences, and valuable data during the interviews and questionnaire administration. Special thanks are also extended to the local agricultural extension agents and institutional authorities whose support and cooperation greatly facilitated the smooth execution of this research.

For citation:

Mamman, M. O., Mubarak, S.O, and Jibril, A.H. (2026). Profitability Analysis of Pepper (Capsicum Species) Production in Okene Local Government Area, Kogi State, Nigeria. *Radinka Journal of Science and Systematic Literature Review, 4*(2), 987-998.

Introduction

Pepper a globally significant spice crop is highly valued for its culinary and economic importance yet ranked as the second most vital vegetable after tomatoes and however has contributed immensely to human nutritional health and accounts for approximately 40% of vegetable consumption (Dodocioiu et al., 2025; Aït-Kaddour et al., 2024). Economic and nutritional value is diverse with applications in pharmaceuticals, culinary preparations, and confectioneries. Reported to be rich in vitamins A, B, C, B1, B2 and B3 as well as excellent sources of potassium, folic acid and fiber peppers have some potential to generate foreign exchange earnings and reduce unemployment (Habib et al., 2025; Devirgiliis et al., 2024). The study aims to determine the profitability of pepper cultivation in Okene Local Government Area, addressing the knowledge gap on costs, returns, and challenges faced by farmers. The research seeks to answer key questions, including describing the socio-economic characteristics of chili pepper farmers, assessing the level of profitability, and identifying the primary constraints to pepper production in the study area. By generating actionable insights, the study aims to bolster the sustainability and economic viability of pepper farming in the region. The aim of this research is to conduct a comprehensive profitability analysis of pepper production in Okene Local Government Area and To achieve this aim, the study seeks to explore the following specific objectives (Akinola et al., 2020; Ahmed et al., 2024): To describe the socio-economic characteristics of pepper farmers in the study area; To determine the level of profitability among chilli pepper production in the study area; To describe the determinants of poverty among chilli pepper crop farmers in relation to pepper production in the study area (Frankowska et al., 2019; Truong et al., 2019).

The research question (iii) focuses on "identifying the constraints to pepper production," while objective (iii) refers to "describing the determinants of poverty among chilli pepper crops farmers to pepper production. This research holds substantial importance as it contributes to the existing body of knowledge on Pepper production is a significant economic activity in Nigeria, with the country being the third-largest exporter globally. C, potassium, and other essential minerals, with anti-bacterial, anti-carcinogenic, and anti-diabetic properties. A study on pepper production in Okene, Kogi State, Nigeria, found that it is a profitable venture, but faces challenges such as limited access to formal credit and dependence on a single crop. The global demand and supply of chili peppers have demonstrated a consistent upward trend, with world production estimated at 14-15 million metric tons annually. Between 2000 and 2007 as reported by Business Day 2007 (Rachmaniah et al., 2022; Ambarwati et al., 2026; Lukas et al., 2024). Chilli peppers have significant economic importance globally, particularly in Nigeria, where they generate foreign exchange and provide income for farmers and industries (Adebukola Adeyanju et al., 2022); (El-Saadony et al., 2025). They are a valuable crop with nutritional and health benefits, rich in vitamins A and C, potassium, and capsaicin, which has antibacterial, anti-carcinogenic, and anti-diabetic properties (Dhamodharan et al., 2023); (Faisal & Mustafa, 2025); (García-Gurrola et al., 2024) With their versatility and widespread use in food processing, pharmaceuticals, and culinary purposes, chili peppers offer potential for generating foreign exchange and promoting health, making them attractive for farmers, industries, and consumers alike (Bal et al., 2022; Al-Habsi et al., 2025).

Chilli peppers have medicinal uses due to the presence of capsaicin, which exhibits astringent, counter-irritant, and analgesic properties (Ansari et al., 2025). Capsaicin is used in

ointments, rubs, and tinctures to treat conditions such as arthritic pain, post-herpetic neuropathic pain, and sore muscles. Scientific studies have also shown that capsaicin has anti-bacterial, anti-carcinogenic, analgesic, and anti-diabetic properties, and can contribute to reducing LDL cholesterol levels in obese individuals (Yang et al., 2019; Jayan et al., 2025). Efficiency in agricultural production refers to the capacity to produce a given level of output at the lowest possible cost. The stochastic frontier approach is widely used to measure firm-specific efficiency, and the stochastic profit frontier function incorporates farm-level prices and input usage into the frontier production function [8,11,12,33,34]. Efficiency encompasses both technical and allocative efficiency, which can be analyzed within a production function framework.

Methodology

The study was conducted in Okene Local Government Area (LGA) of Kogi State, Nigeria. Okene is situated between Latitude: 7° 33' 4.39" N and Longitude: 6° 14' 9.20" E. Geographically, most parts of the Okene Senatorial Zone are characterised by hilly terrain. The LGA spans an area of 328 km² and had a population of 320,260 according to the 2006 census.Okene experiences a tropical climate, distinctly marked by two primary seasons: the rainy season, which extends from March to October (lasting 7-8 months), and the dry season, occurring between November and February (lasting 4-5 months). The annual rainfall in the area is recorded at 1016mm. Agricultural activities are sustained throughout both seasons, with over 80% of the total populace engaging in traditional agricultural practices, leveraging the rich soil and favourable agricultural climate. Trade and commerce in agriculture, food processing, and handcrafts constitute approximately 20% of the informal sector. Administratively, the current Okene LGA comprises Okene and Okengwe districts, further subdivided into 11 wards: Bariki, Otutu, Orietesu, Lafia/Obessa, Okene-Eba, Idoji, Onyukoko, Obehira-Eba, Obehira-Uvete, Abuga/Ozuja, and Upogoro/Odenku.

Sampling Procedures, Sample Size and Data collections

The target population for this study consisted of rural women in Kogi State. A multi-stage sampling technique was employed to select the respondents. In the first stage, Okene LGA was purposively selected from the twenty-one Local Government Areas of Kogi State, primarily due to its high volume of pepper production. The second stage involved the random selection of three villages within Okene LGA: Adu, Oguda, and Okuha Obanyi. In the final stage, a sample size of sixty rural women was originally planned for selection, based on a list of registered rural farmers obtained from the Kogi State Agricultural Development Programme (KADP), utilising the Taro Yamane (1967) sampling determination formula. The formula is expressed as: n=N/(1+N(e)2), where 'n' represents the sample size, 'N' is the total population, '1' is a statistical constant, and 'e' denotes the margin of error (precision level of 0.05). However, it is important to note a discrepancy between the stated planned sample size and the actual data provided for analysis. While the methodology outlined a target sample of sixty rural women, the dataset available for this report comprises 99 unique observationsi. I. e (99 respondents) hence the analysis will proceed with the 99 available data points. Primary data were collected for this study through the administration of structured questionnaires, complemented by personal visits, direct contacts, and interviews. Following data collection, the information was subjected to both descriptive and inferential statistical analyses.

Specific analytical methods were employed for each l: Objective i, which aimed to describe the socio-economic characteristics of the chilli pepper farmers, was addressed using frequency counts and percentages; Objective ii, focused on determining the level of profitability of pepper production, was achieved through the application of farm budgeting techniques; Objective iii, which sought to identify the constraints to pepper production, was actualised using mean score analysis. The study ensured the validity of its data collection tool through face and content validity

tests, carefully designing the questionnaire to align with the study's objectives. The questionnaire measured both dependent and independent variables, including socio-economic characteristics (age, gender, family size, education, etc.) as independent variables, and profitability (Net Farm Income) as the dependent variable. Perceived constraints were measured using Likert-scale responses related to household economic indicators, providing a systematic approach to data collection and analysis.

Data Analysis/Calculation and use of a Farm Budgeting Model

The profitability of pepper production was determined using the Farm Budgeting Model, which calculates Net Farm Income (NFI). The formula applied is: NFI = GFI – TVC – TFC.
Where:
NFI = Net Farm Income (₦)
GFI = Gross Farm Income (₦)
TVC = Total Variable Cost (₦)
TFC = Total Fixed Cost (₦)

In the context of the provided data, "Production, sales, and revenue of last pepper farming" was interpreted as the Gross Farm Income (GFI) for each farmer. The "Total production cost last pepper farming season" was considered the sum of Total Variable Cost (TVC) and Total Fixed Cost (TFC). Therefore, Net Farm Income (NFI) for each farmer was calculated by subtracting the Total Production Cost from the Gross Farm Income.

Mean Analysis Using Likert-Scale

To identify the problems associated with pepper production (Objective iii), mean score analysis was employed, utilising a Likert-scale rating technique. The study's methodology described a four-point Likert scale: Strongly Agreed (SA), Agreed (A), Disagree (D), and Strongly Disagree (SD). However, the values present in the provided dataset for the relevant columns ("Increase in non working individuals in pepper household", "Household with additional income", "Household relying solely on pepper farming", "Household having members contributing income from off farm inventories", "Household lack employment opportunitie") range from 1 to 5. Given this observed range, the analysis proceeded by assuming a five-point Likert scale, where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. The inclusion of a "Neutral" category is implied by the data's range, despite not being explicitly stated in the textual description of the scale.

For the interpretation of constraints: For variables such as "Increase in non working individuals in pepper household" and "Household lack employment opportunitie", a higher mean score indicates a greater perceived severity or prevalence of that factor as a constraint; Conversely, for variables like "Household with additional income" and "Household having members contributing income from off farm inventories", higher mean scores suggest a greater degree of income diversification, which acts as a mitigating factor against reliance on pepper farming. Therefore, a higher score for these indicates less of a constraint in terms of household income stability; For "Household relying solely on pepper farming", a higher mean score signifies a greater dependence on a single crop, which inherently increases vulnerability to price fluctuations or crop failures and is thus considered a significant constraint. It is also critical to note that the data for these Likert-scale variables were only consistently available for the first 44 rows of the dataset. Consequently, the mean score analysis for perceived constraints was conducted on this subset of 44 respondents, rather than the full sample of 99. This limitation in data availability for this specific section should be considered when interpreting the findings related to constraints.

Results

Socio-Economic Characteristics of Chilli Pepper Farmers

This section presents the descriptive statistics outlining the demographic and operational profiles of the surveyed pepper farmers in Okene Local Government Area. These characteristics provide essential context for understanding the profitability and constraints associated with pepper production in the region. The analysis is based on the 99 respondents for whom complete socio-economic data were available.

Table 1. Socio-Economic characteristics of pepper farmers in Okene LGA (N=99 NB:99 respondents were complete for the socio-economic characteristics)

Characteristic	Category	Frequency	Percentage (%)
Age Range	18-25	21	21.2
	18-26	2	2.0
	18-27	1	1.0
	26-35	28	28.3
	26-36	2	2.0
	36-45	25	25.3
	46-55	16	16.2
	46-56	3	3.0
	56-60	2	2.0
	56-61	1	1.0
Gender	Male (M)	40	40.4
	Female (F)	59	59.6
Family Size	1-3	15	15.2
	4-6	57	57.6
	7-10	23	23.2
	>10	4	4.0
Education	Level 1	99	100.0
Marital Status	Married	52	52.5
	Single	47	47.5
Source of Farmland	Inherited/Owned (0)	68	68.7
	Rented/Leased (1)	31	31.3
Farm Size (hectare)	2	51	51.5
	3	26	26.3
	4	22	22.2
Farming Experience (years)	2-5	25	25.3
	6-10	47	47.5
	11-15	9	9.1
	16-20	18	18.2
Source of Capital	Personal Savings (0)	65	65.7
	Credit/Loans (1)	34	34.3

Characteristic	Category	Frequency	Percentage (%)
Access to Farm Equipment	No Access (0)	20	20.2
	Access (1)	79	79.8

Research Field survey 2025: Mamman.M.O. et al., 2025

The socio-economic profile of pepper farmers in Okene LGA reveals a predominantly young to middle-aged farming population, with the largest proportion (28.3%) falling within the 26-35 age range, followed closely by 36-45 years (25.3%) and 18-25 years (21.2%). This indicates a relatively active and potentially adaptable workforce engaged in pepper cultivation. The study's findings highlight the significant role of female farmers in pepper production, with 59.6% of respondents being female, underscoring their critical contribution to local food production and rural livelihoods. The majority of farmers (68.7%) cultivate on inherited or owned land, while 31.3% use rented or leased land, indicating a mix of secure and less secure land tenure arrangements. Farm sizes are generally small, with 51.5% of respondents cultivating 2 hectares, reinforcing the characterisation of these farmers as smallholders. The farming population is seasoned, with 47.5% having 6-10 years of experience and 18.2% having 16-20 years, indicating accumulated traditional knowledge. The study also reveals potential disparities in access to resources, particularly finance, with only 34.3% of farmers accessing credit or loans, and the majority (65.7%) relying on personal savings. Given the higher proportion of female farmers, this limited access to formal credit facilities may disproportionately affect them, highlighting the need for gender-sensitive agricultural policies. Additionally, while 80% of farmers report access to farm equipment, the nature and type of equipment are unclear, suggesting a potential need for more advanced mechanisation to improve efficiency. These findings underscore the importance of tailored interventions, such as micro-finance and accessible inputs, to support small-scale farmers in the region.

Profitability Analysis and Constraints to Pepper Production among chilli pepper farmers

This section presents the financial performance of pepper production in Okene LGA, based on the calculation of Net Farm Income (NFI) for each farmer. The analysis provides insights into the economic viability of pepper farming in the study area.

Table 2. Summary of profitability analysis for pepper production in Okene LGA (N=99)

Financial Metric (₦)	Minimum	Maximum	Average	Standard Deviation
Gross Farm Income (GFI)	100,000	1,000,000	857,070.71	139,183.96
Total Production Cost (TC)	10,000	174,000	107,767.68	20,404.79
Net Farm Income (NFI)	-25,000	900,000	749,303.03	141,614.99

The profitability analysis reveals a wide range of financial outcomes for pepper farmers in Okene LGA. The Gross Farm Income (GFI), representing the total revenue from pepper sales, ranged from a minimum of 100,000 Naira to a maximum of 1,000,000 Naira, with an average of 857,070.71 Naira. This substantial range indicates varying scales of operation or market access among farmers. Total Production Cost (TC) varied from 10,000 Naira to 174,000 Naira, averaging 107,767.68 Naira. The calculated Net Farm Income (NFI), which is the profit after deducting total production costs from gross income, ranged significantly from a loss of 25,000 Naira to a profit of 900,000 Naira, with an average NFI of 749,303.03 Naira. The wide spread in NFI, as indicated by the large standard deviation of 141,614.99 Naira, highlights considerable variability in profitability among farmers. While the average NFI suggests that pepper farming is generally profitable in Okene, the existence of farmers operating at a loss (minimum NFI of -25,000 Naira)

or with very low profits indicates that the overall average masks significant underlying disparities in financial performance. This variability suggests that while some farmers are achieving substantial economic returns, others are struggling to cover their costs, raising questions about the sustainability of their operations. This observation points to the need for targeted interventions rather than blanket policies, as the factors driving profitability differ across farmers. Further investigation into the determinants of this variability, potentially linked to differences in farm size, farming experience, access to capital/equipment, or management practices, would be beneficial.
The average Net Farm Income of 749,303.03 Naira suggests that pepper farming can be a financially viable enterprise in Okene LGA. However, if this average NFI is considered in relation to household size and the cost of living, it raises questions about whether pepper farming alone is sufficient to lift smallholder farmers out of poverty, particularly for those at the lower end of the profitability spectrum. This finding reinforces the need for either significant improvements in farming efficiency to boost individual farmer profits or the development of complementary off-farm income opportunities. The quantitative basis provided by this analysis is crucial for advocating for support mechanisms such as subsidies, improved market access, or value-addition initiatives that can enhance the overall economic viability and sustainability of pepper farming in the region. This section identifies and ranks the key constraints perceived by pepper farmers in Okene LGA, based on their responses to Likert-scale questions. As previously noted, this analysis is based on a subset of 44 respondents for whom complete data on these variables were available. The Likert scale was interpreted as a five-point scale, where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

Table 3. Perceived constraints to pepper production by chilli pepper farmers in Okene LGA (N=44 NB only 44 respondents are complete and used for this Likert scale analysis)

Perceived Constraint/Factor	Mean Score	Rank
Household relying solely on pepper farming	4.68	1
Household having members contributing income from off farm inventories	4.09	2
Household lack employment opportunities	3.48	3
Increase in nonworking individuals in pepper household	2.00	4
Household with additional income	1.84	5

The analysis of perceived constraints reveals critical socio-economic vulnerabilities among pepper farming households. The most prominent perceived constraint, with a mean score of 4.68, is "Household relying solely on pepper farming". This high score indicates that farmers strongly agree or perceive that their households are highly dependent on pepper cultivation as their sole source of income. This singular reliance on a crop known for its price volatility makes these households extremely vulnerable to market fluctuations, crop failures, or other production shocks, thus representing a significant economic risk. Closely related, "Household having members contributing income from off farm inventories" received a mean score of 4.09. Interpreted on the 5-point scale, this indicates that farmers generally agree that household members *do* contribute income from off-farm activities. While this might seem contradictory to the first constraint, it suggests that while some diversification exists, it may not be sufficient or widespread enough to significantly mitigate the overall reliance on pepper farming, or that the contributions are minor. If households generally *do* have off-farm income, then the high score for "relying solely on pepper farming" might reflect a desire for greater diversification or the primary importance of pepper income despite other minor streams. "Household lack employment opportunities'" is ranked third with a mean score of 3.48. This indicates a moderate level of agreement among farmers that there is a scarcity of alternative employment opportunities in the area and it has directly underscore the

vulnerability associated with sole reliance on pepper farming, as it limits avenues for income diversification and alternative livelihoods (Dey & Roy, 2025); (Dickson & Ogbonnaya Okechukwu Ukegbu, 2024). The interplay between these factors paints a picture of extreme vulnerability: if households are highly dependent on pepper farming and there are limited off-farm employment opportunities, any negative shock to pepper production can have severe consequences for household income and food security. "Increase in nonworking individuals in pepper household" received a mean score of 2.00, indicating disagreement or a lower perception of this as a major constraint.

This suggests that the dependency ratio (non-working individuals) is not perceived as a significant burden by the surveyed farmers (Ateş Akkaya et al., 2026; Jokinen, 2018). Similarly, "Household with additional income" scored 1.84, indicating disagreement that households generally have additional income. This reinforces the finding that households are heavily reliant on pepper farming and that income diversification is not a widespread mitigating factor (García Castellanos et al., 2026). A high perceived reliance on pepper farming, coupled with a lack of off-farm employment opportunities, creates a precarious economic situation for many households (Gutierrez et al., 2026; Yusriadi et al., 2026). This suggests that addressing constraints requires a holistic approach that extends beyond purely agricultural interventions (Wan et al., 2016); (Fenibo & Matambo, 2025). It is not merely about improving farm inputs or techniques but also about fostering broader rural development strategies that include creating off-farm employment opportunities, promoting vocational training, and potentially establishing social safety nets to reduce the burden of dependency. This move towards diversified income streams would reduce the inherent risk associated with relying on a single, price-volatile crop like pepper, thereby indirectly improving the long-term sustainability and economic viability of pepper farming by buffering against its inherent risks (Sridhar et al., 2026); (Oliveira et al., 2025).

Discussion

Pepper production in Okene Local Government Area is a profitable venture, but its benefits are not evenly distributed, with some farmers facing financial difficulties. The main challenge is the dependence on a single crop, limited access to formal credit, and lack of off-farm employment opportunities. To address these issues, the study recommends policy interventions that provide accessible micro-finance schemes, quality farm inputs, and strengthened agricultural extension services, with a focus on gender-sensitive development. The study also recommends that farmers adopt improved practices, form cooperatives, and explore value-addition opportunities to increase income streams and reduce post-harvest losses (Wang & Xu, 2025); (Maru et al., 2026) . Future research should focus on detailed cost component analysis, impact assessment of policy interventions, market dynamics, and gender-disaggregated profitability analysis.

By implementing these recommendations, policymakers and farmers can work together to enhance the profitability, sustainability, and economic viability of pepper production in the region, ultimately improving the livelihoods of smallholder farmers (Zhu & Wang, 2024); (Sehlola & Malahlela-Kgasago, 2026). The study examined the socio-economic characteristics, profitability, and constraints of pepper farmers in Okene Local Government Area, Kogi State, Nigeria. The findings revealed that pepper farmers are predominantly young to middle-aged females, operating small farm sizes with considerable experience, but reliant on personal savings for capital (Lin et al., 2026); (Szallasi, 2022).. The average Net Farm Income was 749,303.03 Naira, indicating overall profitability, but with significant variability among farmers. The major constraints identified were reliance on pepper farming as the sole income source and limited alternative employment opportunities, making households vulnerable to market shocks and crop failures (Panchal et al., 2018); (Nemzer & Kalita, 2023)..

Conclusion

Pepper production in Okene Local Government Area is on average profitable agricultural enterprise contributing significantly to the livelihoods of many smallholder farmers. However, the profitability is not uniformly distributed and a notable segment of the farming population faces financial inadequacy. The primary challenge to the sustainability and economic viability of pepper for farming in the region which stems from the overwhelming dependence of households on this single crop exacerbated by limited access to diverse off-farm employ opportunities and formal credit. While farmers possess valuable experience and a basic level of education. Systemic barriers related to capital access and market diversification hinders the full realization by limited access which can be addressed by dealing with the economic vulnerabilities that is paramount for enhancing the resilience and long-term prosperity of pepper farmers in Okene. The study recommends policy interventions to enhance pepper production's profitability and sustainability in Okene Local Government Area, including establishing accessible micro-finance schemes, providing quality farm inputs, strengthening agricultural extension services, promoting income diversification, and implementing gender-sensitive policies. Farmers are also advised to adopt improved practices, form cooperatives, and explore value-addition opportunities. Future research should focus on detailed cost component analysis, impact assessment of policy interventions, market dynamics, and gender-disaggregated profitability analysis to improve the efficiency, profitability, and sustainability of pepper farming in the region.

Conflicts of interest

No conflicts of interest.

Funding

This research received no external funding.

Author contributions

M. M. O: Conceptualization, Methodology, Software, Data curation, Writing-original draft preparation.: M. S. O: Visualization, Investigation, Supervision, Software.: J. A. H. Validation, Writing-reviewing, and editing. All authors have read and agreed to the published version of the manuscript.

Declaration of generative AI in scientific writing

The authors acknowledge the use of generative artificial intelligence (AI) tools exclusively for language editing, grammar refinement, and enhancing the academic phrasing of this manuscript. The AI assistance was utilized solely to polish the text and improve readability. The authors reviewed, edited, and verified all final content to ensure accuracy and take full responsibility for the integrity of the research.

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