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RECEIVED 29 January 2026
REVISED 28 February 2026
ACCEPTED 09 April 2026
PUBLISHED 28 April 2026

CITATION
Opute OH, Arabomen O and Jimoh SO
(2026) Harvesting and economic
potential of *Irvingia gabonensis*
(Aubry-Lecomte ex O'Rorke)
Baill. In Edo State, Nigeria.
Front. Ecol. Evol. 14:1799425.
doi: 10.3389/fevo.2026.1799425

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Harvesting and economic potential of *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill. In Edo State, Nigeria

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Introduction: Non-timber forest products such as bush mango (*Irvingia gabonensis*) are critical to rural economies in West Africa, yet their harvesting remains poorly understood in terms of economic returns and sustainability.

Methods: This study assessed the harvesting and economic potential of *I. gabonensis* in Edo State, Nigeria, using a purposive survey of 79 harvesters. Data were analysed through descriptive statistics, correlation, and regression, complemented with thematic analysis of qualitative responses.

Results: The results showed that harvesting is predominantly male-driven (68%), with a mean respondent age of 41 years, an average household size of 6, and a mean harvesting experience of 11 years. The activity was seasonal, occurring mainly from June to September, with an average weekly harvest volume of 124 kg per household. Regression analysis indicated that household size ($\beta = 0.28$, $p < 0.05$), years of experience ($\beta = 0.32$, $p < 0.01$), and access to productive trees ($\beta = 0.41$, $p < 0.01$) were significant predictors of profitability ($R^2 = 0.47$). Profitability analysis indicated that on average, each household earned a gross margin of ₦103,800 (USD 71.5) per season, corresponding to a rate of return on investment of 91%. Constraints included limited access to trees (63%), declining yields (56%), and overdependence on wild stocks (72%).

Discussion: These findings highlight that sustainable harvesting and domestication of *I. gabonensis* can serve as Nature-Based Solutions (NbS), enhancing ecosystem services and promoting climate-resilient livelihoods in forest-dependent communities. The study concludes that *I. gabonensis* harvesting is economically viable but ecologically vulnerable, and that it requires domestication, sustainable practices, and improved access rights to secure its future contribution to rural incomes.

KEYWORDS

climate change adaptation, ecosystem-based adaptation, forests, nature-based solutions, provisioning service, sustainability, trade-offs, wild mango

¹ ₦ is the Nigerian currency Naira @ USD1 = ₦1 450.

1 Introduction

Non-timber forest products (NTFPs) remain central to the livelihoods of millions of rural households across tropical regions, where forests serve as a critical source of food, medicine, and income (Awono et al., 2010; Shackleton et al., 2015). Globally, millions of rural households depend on NTFPs for subsistence and cash income, particularly where agriculture alone cannot guarantee food sufficiency (Awono et al., 2010). In West and Central Africa, leafy vegetables, fruits, nuts, and medicinal plants are integral to rural livelihoods and are traded across local and regional markets. Studies have also highlighted their role in poverty alleviation, nutritional diversity, and as buffers against economic shocks (Ingram and Schure, 2010).

Among these, *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill., commonly known as the African bush mango, is one of the most economically valuable species in West and Central Africa. Belonging to the family Irvingiaceae, the species is highly valued for its edible fruit pulp and kernels. The kernels, when processed, yield a mucilaginous substance that serves as a popular soup thickener across Nigeria, Cameroon, and Gabon and is widely traded across urban and rural markets, while its fruits, bark, and leaves also feature in local diets and traditional medicine (Onyekwelu et al., 2015; Ainge and Brown, 2001). Beyond its subsistence role, the species contributes to cash income, thereby sustaining rural economies and supplementing agricultural earnings in forest-adjacent communities (Ingram and Schure, 2010). Nigeria represents one of the largest producers and consumers of *I. gabonensis*, where demand for its kernels continues to rise due to expanding urban markets and cultural dietary preferences (Leakey et al., 2022; Awono et al., 2010).

Despite its recognised economic potential, the harvesting of African bush mango is still largely based on wild collection, exposing the resource to pressures from overexploitation, poor regeneration, and land-use change (Ndoye et al., 2019). Studies in Cameroon and Gabon have underscored that intensification of harvesting without parallel domestication initiatives threatens forest biodiversity and undermines rural incomes dependent on NTFPs (Ingram and Schure, 2010). In Nigeria, reports suggest that limited domestication and poor access to planting materials constrain sustainable production (Adewale et al., 2024; Onyekwelu et al., 2015).

These pressures are particularly pronounced in states such as Edo, where forest ecosystems are under intense competition from agriculture and urban expansion. Without deliberate management, the growing commercialisation of African bush mango may undermine both its ecological sustainability and the incomes of those who depend on it.

Research on African bush mango in Nigeria has tended to emphasise its nutritional and medicinal properties, or its potential role in agroforestry systems (Leakey, 2017; Okafor and Lamb, 1994). Fewer studies have focused on the actual practices and economics of harvesting, particularly within the Nigerian context, where local dynamics such as access rights, seasonality, and household labour play a decisive role in shaping outcomes. Moreover, while profitability studies exist for other NTFPs, there is limited empirical analysis of the factors influencing harvesting intensity and

returns in the bush mango sector. This represents a critical gap, as understanding these drivers is essential for designing strategies that balance economic benefits with long-term conservation.

In the context of climate change and environmental degradation, African bush mango based production systems can be conceptualized as a forest-based Nature-Based Solution (NbS) that integrates livelihood support with ecosystem conservation. Nature-Based Solutions are defined as actions that protect, sustainably manage, and restore natural ecosystems while addressing societal challenges such as climate change, food security, and poverty alleviation (International Union for Conservation of Nature (IUCN), 2020; Seddon et al., 2020). Sustainable harvesting, domestication, and enrichment planting of African bush mango enhance ecosystem services including carbon sequestration, soil fertility improvement, and biodiversity conservation, while simultaneously providing climate-resilient income opportunities for rural households. As a perennial indigenous tree species adapted to humid tropical environments, African bush mango contributes to ecosystem-based adaptation (EbA) by buffering households against climate-induced agricultural risks and seasonal income fluctuations (Reid et al., 2018; Quandt et al., 2017). Framing bush mango production within an NbS perspective highlights its dual role in strengthening rural livelihoods and supporting climate adaptation strategies in forest-dependent communities of the Global South.

The conceptual lens guiding this study is anchored in the interaction between harvesting practices, economic outcomes, and sustainability trade-offs. This interaction is further interpreted through a Nature-Based Solutions framework, where African bush mango harvesting and domestication are viewed as ecosystem-based interventions that simultaneously enhance environmental resilience and household adaptive capacity to climate change (Seddon et al., 2020). Harvesting practices, influenced by household characteristics such as age, education, labour availability, and access rights, directly affect both the volume and quality of African bush mango collected (Adewale et al., 2024). These practices, in turn, shape profitability, measured through gross margin and return on investment as demonstrated in studies of non-timber forest products across West and Central Africa (Leakey et al., 2022). However, economic gains are moderated by ecological and institutional constraints, including overdependence on wild stocks, tenure insecurity, and weak market structures which have been widely reported as limiting sustainable NTFP exploitation (Sunderland et al., 2014; Ingram et al., 2017). Thus, the framework posits that while harvesting of African bush mango offers significant economic potential, long-term benefits depend on addressing sustainability concerns and strengthening institutional support. This approach allows the study not only to document harvesting and economic returns but also to analyse the underlying factors influencing outcomes, thereby generating evidence relevant for both policy and community-level interventions.

Therefore, the study was conducted in Edo State, southern Nigeria to provide an in-depth assessment of African bush mango harvesting and its economic potential. Specifically, the study aim was to (i) assess the harvesting practices of African bush mango, focusing on methods, seasonality, and labour organization; (ii) evaluate the economic potential of harvesting African bush

mango using gross margin and profitability measures; (iii) analyze the specific factors influencing harvesting intensity and profitability, including demographic and institutional variables and (iv) identify the key challenges and sustainability concerns associated with the continued harvesting of African bush mango. The findings are expected to enrich the literature on NTFPs in Nigeria and to provide evidence-based insights for promoting the sustainable utilisation of these species.

2 Methodology

2.2 Study area

The study was conducted in Edo State, in the South-South geopolitical zone of Nigeria. Edo State lies between latitudes 5°44' and 7°34' N and longitudes 5°04' and 6°43' E, with Benin City serving as the administrative capital. The state covers approximately 17,802 km² and is bordered by Kogi State to the north, Delta State to the south, Ondo State to the west, and Anambra State to the east. The climate is humid tropical, characterised by two distinct seasons: the rainy season (April to October) and the dry season (November to March). Annual rainfall ranges between 1,500 and 2,500 mm, while mean annual temperature varies from 25 °C to 29 °C (NIMET (Nigerian Meteorological Agency), 2022). The vegetation is dominated by moist lowland rainforest, interspersed with secondary regrowth and derived savanna in more degraded areas (Oni et al., 2015). Edo State is ethnically diverse, with the Bini, Esan, Etsako, Owan, and Akoko-Edo as the major groups. Farming is the primary occupation, with yam, cassava, maize, plantain, and rice forming the staple crops. Non-timber forest products, including African bush mango, play a complementary role in household food security and cash income, especially during peak fruiting seasons when households harvest wild stocks from farmlands, fallows, and forest patches. Given ongoing pressures from agricultural expansion, urbanisation, and logging, harvesting African bush mango in Edo State faces ecological challenges, making the state a suitable location for examining the economic potential and sustainability of the species.

2.3 Sampling and data collection

The study employed a multistage sampling technique. First, major African bush mango producing communities including Uhumwode, Igueben, and Esan West LGAs in Edo State, were purposively selected based on their prominence in bush mango harvesting. Within these communities, households engaged in harvesting were identified with the assistance of local leaders and extension agents, with a total of approximately 150 households initially identified as active harvesters. From this pool, 79 respondents were selected using the Yamane (1967) formula for finite populations at a 95% confidence level and 5% margin of error, ensuring representativeness of the target population. Data were collected using a combination of structured questionnaires, key informant interviews, and direct field observations during the peak fruiting season. Key informants included local community leaders, experienced harvesters, and officials from the Edo State Ministry of

Agriculture and Natural Resources. Structured questionnaires were administered to the selected household heads or primary individuals responsible for African bush mango harvesting activities. Information collected included socio-economic characteristics, harvesting practices, labour use, volumes collected, costs and returns, and constraints. Although the sample size of 79 households may appear modest, it was selected to represent the major African bush mango producing communities in Edo State, and the purposive-random sampling approach ensures that the findings reflect the practices and economic realities of the most active harvesters in the region.

2.4 Data analysis

Data were analyzed using both descriptive and inferential methods. Descriptive statistics such as frequencies, means, and percentages were used to summarise socio-economic characteristics and harvesting practices. To evaluate profitability, a budgetary technique was applied: Gross Margin (GM) and Rate of Return on Investment (RORI) (Equations 1, 2), which are widely used in the enterprise analysis of NTFPs (Angelsen et al., 2014). In addition, correlation analysis was used to explore the relationships between socio-economic variables (such as age, household size, and education) and harvesting intensity. Multiple regression analysis was further employed to identify the socio-economic and institutional factors significantly affecting profitability, following approaches adopted by Ingram and Schure (2010) and Ndoye et al. (2019). The choice of regression was justified because it allows the estimation of the relative influence of multiple independent variables on a continuous dependent variable (profitability), making it more robust than bivariate tests like the Chi-square test when the objective is to model determinants. Finally, thematic analysis was used to synthesize qualitative data from interviews, particularly on constraints and sustainability concerns. This mixed-methods approach ensured that both quantitative relationships and qualitative insights were captured, providing a holistic understanding of African bush mango harvesting in the study area.

Mathematical representation:

$$GM = TR - TVC \quad (1)$$

Where: GM = Gross Margin; TR = Price per unit × Quantity sold; TVC = Costs that vary with production.

$$RORI(\%) = \frac{GM}{TVC} \times 100 \quad (2)$$

Where: RORI = Rate of Return on Investment; GM = Gross Margin; TVC = Costs that vary with production.

3 Results and discussion

3.1 Socio-economic characteristics of respondents

The socio-economic profile of respondents indicated that men constituted the majority of African bush mango harvesters in Edo

TABLE 1 Socio-economic characteristics of respondents engaged in *Irvingia gabonensis* harvesting.

Variable	Category	Frequency	Percentage (%)	Mean
Gender	Male	54	68.4	
	Female	25	31.6	
Age group (in years)	< 30	7	8.9	
	31 - 40	29	36.7	
	41 - 50	24	30.4	
	> 50	19	24.0	
Education level	No formal education	20	25.3	
	Primary	36	45.6	
	Secondary	23	29.1	
Household size	–	–	–	6
Years of harvesting	–	–	–	11
Monthly income (₦)	–	–	–	32, 800 (SD = 12, 450)

Field survey, 2025; n = 79; ₦ is the Nigerian currency *Naira*.

State, representing 68% of the 79 respondents, while women accounted for 32% (Table 1). The mean age of respondents was 41 years, with the highest proportion (37%) between 31 and 40 years, followed by 30% between 41 and 50 years. Education levels were modest: 25% had no formal education, 46% had primary education, and 29% had secondary education. Household sizes² were moderately large, averaging six members per household. The respondents reported an average of 11 years of experience in harvesting African bush mango, suggesting that it is a stable livelihood activity. The average monthly income derived from harvesting was estimated at ₦32 800 (SD = ₦12 450), though this varied across households.

The dominance of men in harvesting activities reflects the labour-intensive nature of fruit collection, which requires climbing tall trees or wielding long poles to dislodge fruits. This result contrasts with other non-timber forest product (NTFP) value chains in West and Central Africa, where women often dominate processing and trade (Awono et al., 2010; Nforinkah et al., 2021). However, it is consistent with observations by Ainge and Brown (2016) that harvesting of African bush mango is traditionally male-dominated due to the physical demands involved, while women and children contribute mainly to fruit gathering and post-harvest handling. The male dominance in harvesting (68%) has important gender and climate justice implications. Climate change-driven resource scarcity may increase labour burdens on men, while women and children, primarily involved in gathering and post-harvest tasks, may face heightened workloads and reduced income opportunities. Promoting domestication, enrichment planting, or agroforestry-based Nature-Based Solutions could reduce the physical drudgery associated with harvesting and create more equitable participation across genders, enhancing both livelihood security and social resilience in these communities (Reid et al., 2018; Seddon et al., 2020). The age distribution, concentrated between 31 and 50 years, confirms that bush mango harvesting is driven by active

middle-aged household members who combine physical capacity with long-term experience. Similar trends were reported by Ayuk et al. (1999) in Cameroon and Angelsen et al. (2014) in southwestern Nigeria, who noted that this age group is most involved in forest product exploitation due to their energy and household responsibilities. Education levels were modest, reflecting broader rural development challenges in southern Nigeria, where limited schooling often constrains access to credit and the adoption of innovations (Ingram et al., 2017).

3.2 Harvesting practices of *Irvingia gabonensis*

Harvesting of African bush mango in Edo State was reported as a seasonal activity, with the main fruiting season occurring between June and September (Table 2). Respondents indicated that harvesting begins once the fruits mature and continues for about 8 to 10 weeks, depending on rainfall patterns and tree productivity. The methods employed varied: the majority (62%) used long poles to knock fruit down from tall trees, 28% climbed trees to pluck or shake fruit directly, and 10% collected fruit that had naturally fallen to the ground. Labour organisation differed across households. About 71% of respondents relied primarily on family labour, particularly for gathering fallen fruit, while 29% hired labour for climbing and pole-harvesting, especially in households with fewer able-bodied members. The average harvesting household collected about 124 kg of fruit per week during the peak season, although volumes varied depending on the number of accessible trees and the size of the household labour force.

Harvesting practices remain largely traditional, with pole-harvesting and tree climbing dominating. This aligns with reports from Central Africa, where traditional methods persist due to limited investment in improved technologies (Sunderland et al., 2011). While these methods sustain household incomes, they pose ecological risks, particularly when destructive climbing techniques damage branches and reduce long-term productivity. The seasonality of harvesting from June to September underscores the importance of

² All family members who normally reside together and may contribute, directly or indirectly, to harvesting activities.

TABLE 2 Harvesting practices of African bush mango.

Harvesting attribute	Category/Indicator	Frequency	Percentage (%)
Harvesting season	June - September	–	100
Harvesting method	Pole harvesting	49	62.0
	Tree climbing	22	27.8
	Ground collection	8	10.2
Labour source	Family labour	56	70.9
	Hired labour	23	29.1
Average weekly harvest volume	124 kg (mean across households)	–	–

Field survey, 2025; n = 79.

African bush mango as a seasonal income source, complementing agricultural activities during the farming cycle (Ndoye et al., 1997).

3.3 Economic potential of *Irvingia gabonensis* harvesting

The profitability analysis of African bush mango harvesting in Edo State revealed that the activity is economically viable for respondents (see Table 3). The average total revenue per season was estimated at ₦158 000 (SD = ₦47, 500) per harvester, derived from the sale of fresh fruits and kernels. The average variable cost incurred, mainly for hired labour, transportation, and minor equipment (poles, baskets, ropes), was ₦54 200 (SD = ₦18, 300) per season. This yielded an average gross margin of ₦103 800 (SD = ₦32, 400) per harvester. The Rate of Return on Investment (RORI) was calculated at 91%, indicating that for every ₦1 invested in harvesting, respondents earned ₦0.91 as profit. Variation existed across households: harvesters with greater access to productive trees and larger household labour forces recorded higher returns, while those dependent on hired labour recorded lower margins. Despite these variations, the results confirm that bush mango harvesting remains a profitable seasonal enterprise in the study area.

Beyond its economic viability, income derived from African bush mango harvesting represents an important livelihood diversification and risk-spreading strategy in predominantly rain-fed farming systems. Seasonal earnings from bush mango provide a buffer against climate-induced agricultural shortfalls such as crop failure associated with irregular rainfall and prolonged dry spells. This supplementary income enhances household adaptive capacity by reducing dependence on climate-sensitive crops and enabling continued access to food and basic needs during periods of climatic stress. From a Nature-Based Solutions perspective, sustainable harvesting and domestication of African bush mango can therefore be understood as an ecosystem-based adaptation strategy that strengthens both economic resilience and environmental sustainability in forest-dependent communities (Reid et al., 2018; Seddon et al., 2020; Quandt et al., 2017).

Profitability analysis confirmed that African bush mango harvesting is not only a viable enterprise (RORI = 91%) but also a key source of livelihood diversification for households. This aligns with

TABLE 3 Cost–return analysis of *Irvingia gabonensis* harvesting.

Item	Average value (₦)	SD (₦)	% of total cost/revenue
Revenue			
Sale of fruits/kernels	158 000	47 500	100.0
Variable Costs			
Hired labour (climbing/poles) ³	24 500	9 200	45.2
Transportation	18 700	6 500	34.5
Equipment (poles, baskets)	6 000	1 900	11.1
Miscellaneous ⁴	5 000	1 500	9.2
Total Variable Costs (TVC)	54 200	18 300	100.0
Gross Margin (TR – TVC)	103 800	32 400	
RORI (%)	91.0		

Field survey, 2025; n = 79; RORI = Rate of return on investment; TR = Total revenue; ₦ is the Nigerian currency Naira.

earlier studies documenting the economic significance of bush mango harvesting and trade in Nigeria and Cameroon (Adewale et al., 2024; Leakey et al., 2022; Awono et al., 2010). However, reliance on wild stocks and limited domestication, raises sustainability concerns. The thematic findings that respondents perceive “trees no longer fruit like before” underscore broader ecological and resource management challenges, including overharvesting, forest degradation, and insufficient knowledge or adoption of sustainable practices (Shiembo, 1999). Framing these issues through a Nature-Based Solutions lens highlights the potential of domestication, enrichment planting, and community-based management as strategies to enhance both economic resilience and environmental sustainability.

3.4 Factors influencing harvesting intensity and profitability

The correlation and regression analyses were conducted to identify the socio-economic and institutional variables influencing harvesting outcomes (Table 4). Harvesting intensity, measured by the average quantity of fruits collected per household per week, was positively correlated with household size ($r = 0.41$, $p < 0.05$) and years of harvesting experience ($r = 0.36$, $p < 0.05$). This indicates that households with more members and greater experience were able to mobilise more labour and local knowledge, thereby increasing harvest volumes. In contrast, the age of respondents showed a

³ Family labor was excluded from variable costs due to the difficulty of assigning a monetary value; only hired labor costs were included in TVC. Gross margin and RORI are therefore calculated per household per season based on actual expenditures on hired labor and other variable costs.

⁴ Miscellaneous costs include expenses on refreshments and unexpected expenditures during harvesting.

TABLE 4 Factors influencing harvesting intensity and profitability of African bush mango.

Variable	Correlation with harvesting intensity (r)	Regression coefficient (β)	p-value
Age	-0.12	-0.08	0.318
Education	0.18	0.09	0.267
Household size	0.41**	0.28*	0.032
Years of experience	0.36**	0.32**	0.008
Gender	-0.09	-0.05	0.411
Access to trees	0.44**	0.41**	0.004

Model summary: $R^2 = 0.47$, Adjusted $R^2 = 0.43$, $F = 6.82$, $p < 0.001$.

Field survey, 2025; (n = 79); significance levels * $p < 0.01$; ** $p < 0.05$.

weak negative correlation ($r = -0.12$, $p > 0.05$), suggesting that younger respondents were not necessarily more active harvesters. In addition, a multiple regression model was fitted to determine factors affecting profitability (Gross Margin). The model explained 47% of the variation in profitability ($R^2 = 0.47$). Years of experience ($\beta = 0.32$, $p < 0.01$), access to productive trees ($\beta = 0.41$, $p < 0.01$), and household size ($\beta = 0.28$, $p < 0.05$) were significant predictors of profitability (Table 4). Education level ($\beta = 0.09$, $p > 0.05$) and gender ($\beta = -0.05$, $p > 0.05$) were not significant, suggesting that harvesting returns were more strongly influenced by resource access and labour than by demographic attributes.

The regression results revealed that household size, years of experience, and access to productive trees significantly influenced harvesting intensity and profitability. These findings echo those of Ahenkan and Boon (2011), who emphasised the roles of household labour and access to tenure in shaping NTFP returns. The strong influence of access to trees underscores the critical role of land tenure in determining benefits from forest resources, a theme widely recognised in forest product research across West Africa (Laird et al., 2010). Beyond its economic implications, limited access to productive trees represents a governance barrier that constrains the effective implementation of Nature-Based Solutions. Secure tenure and clear access rights are essential for communities to sustainably manage and benefit from

African bush mango as a climate-resilient resource. Strengthening community-based governance, alongside targeted education and capacity building in domestication techniques, can empower households to overcome technical constraints in propagating and managing African bush mango. Evidence shows that inadequate skills and knowledge in tree propagation and sustainable harvesting impede natural regeneration and long-term productivity of NTFPs (Adewale et al., 2024). When combined with enabling policy environments and awareness raising, these interventions can improve both ecological sustainability and livelihood benefits associated with bush mango resources. Education and gender, by contrast, did not significantly affect profitability, suggesting that resource access and ecological conditions are more decisive determinants.

3.5 Constraints and sustainability concerns in African bush mango harvesting

The most prominent issue was overdependence on wild stocks, reported by 72% of respondents, while 63% highlighted limited access to productive trees due to farmland expansion and tenure restrictions (Table 5). Declining fruit yield compared to a decade ago was acknowledged by 56%, and 41% cited labour shortages during peak harvests. Transportation difficulties, linked to poor rural roads and high costs of moving fruits to market, were reported by 38%. Thematic analysis of qualitative responses clustered around three dominant themes: access insecurity, labour drudgery, and declining yields. Harvesters often described exclusion from trees on private farmland, the physically demanding nature of climbing and pole-harvesting, and visible reductions in fruit production, which many attributed to forest degradation.

Beyond the effects of harvesting pressure and forest degradation, the observed decline in fruit yield may also reflect the influence of climate variability on African bush mango productivity. Respondents' perceptions that trees "no longer fruit like before" can be interpreted as forms of local ecological knowledge, indicating changes in rainfall timing, increased rainfall unpredictability, and temperature stress affecting flowering and fruiting cycles. Previous studies have shown that the fruiting phenology of tropical tree species is highly sensitive to shifts in rainfall regimes and prolonged dry periods, which can disrupt

TABLE 5 Constraints and sustainability concerns in *Irvingia gabonensis* harvesting.

Sustainability concern	Frequency	Percentage (%)	Thematic Insights
Dependence on wild stocks only	57	72.2	We rely only on wild trees; no one is planting new ones.
Limited access to productive trees	50	63.3	If the landowner sells or clears the farm, we lose the trees.
Declining fruit yield over time	44	55.7	These trees no longer fruit as they did before; many have been cut down; respondents perceive changes in rainfall and temperature as affecting fruiting.
Labour scarcity during peak season	32	40.5	Climbing and harvesting is hard work; we cannot always get enough help.
Transportation difficulties	30	38.0	Bad roads make it costly to take fruits to market.
Adoption of sustainable practices	15	19.0	A few of us leave some trees or avoid breaking branches, but not many.

Field survey, 2025; n = 79; multiple responses allowed.

pollination and reduce yields (Zuidema et al., 2012; Intergovernmental Panel on Climate Change (IPCC), 2022). In forest-dependent systems, such climate-induced stress interacts with overharvesting and land-use change to compound the decline in productivity. Framing these perceptions within a climate resilience perspective highlights that sustainable management and domestication of African bush mango can function as an ecosystem-based adaptation strategy by stabilizing production under increasing climate uncertainty and reducing reliance on vulnerable wild populations (Reid et al., 2018; Seddon et al., 2020). The identified constraints are structural challenges that mirror broader limitations in the governance of NTFPs in West Africa (Laird et al., 2010; Ingram et al., 2017). However, only a small proportion (19%) of respondents reported adopting deliberate sustainable harvesting practices, revealing a significant gap between awareness and implementation. This low level of adoption heightens vulnerability to climate-related stressors, as unmanaged wild populations are less able to withstand increasing rainfall variability and temperature extremes, thereby threatening the long-term viability of the resource.

4 Conclusion

This study has demonstrated that African bush mango remains an economically important non-timber forest product in Edo State, Nigeria, with harvesting contributing significantly to rural household incomes. The results showed that harvesting is primarily undertaken by men due to its physical demands, while women and children play supporting roles in fruit gathering and handling. The activity is seasonal and largely dependent on wild stocks, with traditional techniques such as pole-harvesting and tree climbing dominating. Profitability analysis confirmed that harvesting is financially viable, with high gross margins and a strong rate of return on investment, underscoring its value as a supplementary income source during the farming season. Beyond economic gains, sustainable harvesting and domestication of African bush mango represent a Nature-Based Solution that supports ecosystem services, promotes biodiversity conservation, and enhances climate-resilient livelihoods for forest-dependent communities. However, the study also revealed critical structural and ecological constraints. Limited access to productive trees, tenure insecurity, labour scarcity, and high transportation costs reduce efficiency, while overdependence on wild populations and declining yields raise concerns about long-term sustainability. Regression results highlighted that household size, experience, and access to trees were the strongest predictors of profitability, emphasising that ecological and institutional factors outweigh demographic attributes such as education and gender. Based on these findings, it is concluded that while African bush mango harvesting currently offers considerable economic benefits, its sustainability is threatened without deliberate interventions. Integrating these interventions within community-based management and agroforestry systems can strengthen adaptive capacity to climate variability, making bush mango harvesting not just an economic activity but a practical example of ecosystem-based adaptation in the Global South. Future strategies should therefore promote domestication and enrichment planting of African bush mango, improve harvesting practices to reduce tree damage, and strengthen community-based arrangements that secure access rights for harvesters.

Equally important is the need for infrastructural investment, particularly in rural roads, to reduce transportation costs and enhance market access. By aligning economic incentives with sustainable management, bush mango can continue to provide income while contributing to forest conservation in Edo State.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The participants [OR participants legal guardian/next of kin] provided their written informed consent to participate in this study.

Author contributions

OO: Methodology, Writing – review & editing, Investigation, Conceptualization. OA: Writing – original draft, Data curation, Writing – review & editing. SJ: Supervision, Writing – review & editing.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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