True Cost Accounting of Smallholder Avocado Production
in Southern Kaduna, Nigeria

Assessing Income Gaps and Environmental Externalities using the True Price Methodology

Grows In Rows (RootNote Initiative)
In collaboration with:
True Price

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GROWS IN ROWS True Price™ NFP Netherlands Food Partnersh

TRUE COST ACCOUNTING OF SMALLHOLDER AVOCADO PRODUCTION

Southern Kaduna, Nigeria

Prepared by
Grows In Rows Ltd

In Collaboration with
True Price BV

For
Netherlands Food Partnership (NFP)

April 2026
Abuja, Nigeria

DISCLAIMER

This report presents the findings of a baseline true cost accounting assessment of smallholder avocado production in Southern Kaduna, Kaduna State, Nigeria. The analysis is based on primary data collected from 150 farmers between October and December 2025 and modelled using the True Price methodology.

The results reflect the defined geographic scope, sampling framework, and methodological assumptions described in this report. Findings should not be interpreted as nationally representative of Nigeria's avocado sector, nor extrapolated beyond the specified study area without further validation.

All calculations rely on self-reported field data, enumerator-supported conversions of local trade units to standard weight measures, and established monetisation factors applied within the True Price framework. While care has been taken to ensure accuracy and internal consistency, the analysis is subject to the limitations outlined in section 2.7 of this report.

Currency conversions, benchmark references, and monetisation factors correspond to 2025–2026 reference values unless otherwise stated.

The interpretations and conclusions contained herein represent the analytical work of Grows In Rows in collaboration with True Price and do not necessarily reflect the official positions of the Netherlands Food Partnership or other supporting institutions.

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ACRONYMS & ABBREVIATIONS

ASN — AVOCADO SOCIETY OF NIGERIA

CDA — CENTRE FOR DRYLAND AGRICULTURE

GIR — GROWS IN ROWS LTD

HH — HOUSEHOLD

KG — KILOGRAM

LGA — LOCAL GOVERNMENT AREA

NFP — NETHERLANDS FOOD PARTNERSHIP

NIHORT — NATIONAL HORTICULTURAL RESEARCH INSTITUTE

TCA — TRUE COST ACCOUNTING

TP — TRUE PRICE

€ — EURO

KEY FINDINGS AT A GLANCE

Study Overview

Item	Description
Location	Southern Kaduna, Nigeria
LGAs	Kaura, Jema'a, Zangon Kataf
Farmers surveyed	150
Method	True Price framework
System boundary	Production stage including transportation to local markets

Market Price vs True Price

Component	€ / kg
Farm-gate price	€0.30
Income gap	€1.91
Environmental impacts	€0.94
True price	**€3.15**

The environmental impacts in the assessment are land occupation, climate change, air pollution, soil pollution, water pollution, fossil fuel depletion, and scarce water use, following the impact modules defined in the True Price methodology. Land occupation represents the dominant environmental impact category in the analysis.[1]

Price Context Across Markets

Location	₦ / kg	€ / kg
Farm-gate (Southern Kaduna)	~₦500	~€0.30
Abuja markets	~₦1,000	~€0.61
Lagos markets	~₦2,000	~€1.21

Urban prices reflect transport, aggregation and retail margins, not the internalisation of external costs.

Structural Observations

The study identified several structural characteristics shaping avocado production in the surveyed communities:

• Avocado trees are typically integrated within mixed smallholder farming systems

• Most farmers rely on traditional tall avocado varieties

• Orchard management practices remain limited. Production systems are predominantly low-input and rain-fed.

• Marketing occurs through informal trader networks

• Producer coordination and aggregation structures are minimal

These factors contribute to low productivity, **fragmented market participation** and a **significant income gap relative to living income benchmarks**.

[1] *All monetary values expressed per kilogram (€/kg) of avocado.*

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EXECUTIVE SUMMARY

1. Integrated Context and Rationale

Avocado production in Nigeria has expanded in recent years, with emerging commercial interest driven by domestic urban demand and growing awareness of export market potential. Southern Kaduna represents one of the country's active smallholder production clusters, where avocado cultivation contributes to household income alongside other crops and livelihood activities. Despite this growth trajectory, market prices for avocados primarily reflect traded value and do not capture the broader social and environmental conditions under which production occurs.

Smallholder farmers operate within systems where household labour, land use, and income sufficiency are not fully internalised in commodity pricing. As a result, the market price per kilogram does not provide a complete account of the economic, social, and environmental realities embedded in production. True Cost Accounting offers a framework to quantify these hidden costs and make them visible within a structured analytical model.

This study applies the True Price method to establish a baseline True Cost Accounting assessment of the true cost of smallholder avocado production in Southern Kaduna. By quantifying income gaps and environmental externalities alongside observed market prices, the analysis provides an evidence-based foundation for understanding the indicative cost profile of the value chain at farm level.

The study successfully developed a monetised estimate of the true price of avocado production based on primary data collected from smallholder farmers, providing an evidence base for identifying structural inefficiencies and informing future interventions.

These findings were validated through stakeholder workshops and informed the co-development of recommendations with value chain actors.

2. Study Scope and Methodology

This assessment is based on primary field data collected from 150 smallholder avocado farmers across selected Local Government Areas in Southern Kaduna between October and December 2025. The sample was designed as a pilot baseline within defined budget parameters and mapped to areas of known avocado concentration. Data collection was undertaken using a structured survey instrument developed by True Price in collaboration with GIR which covered yields, production costs, household income composition, labour allocation, input usage, and water use.

The analysis applies the True Price method to quantify social and environmental externalities associated with farm-level avocado production. Social impacts were assessed through comparison of observed household income with an established living income benchmark[2], with the avocado crop's proportional contribution to total household income accounted for in the calculation of income gaps. Environmental impacts in scope are land occupation, climate

[2] Anker Research Institute (2025) Anker Reference Value Annual Update 2025: Rural Nigeria.

change, air pollution, soil pollution, water pollution, fossil fuel depletion, and scarce water use. These were quantified and monetised using recognised conversion factors and True Price Foundation Monetisation Factors.

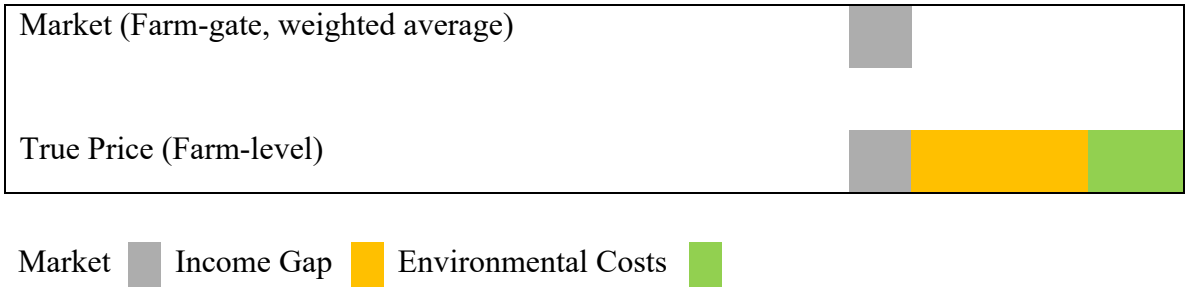
The True Price method quantifies relevant social and environmental impacts associated with production and converts these impacts into monetary values using established monetisation factors. This allows external costs to be expressed in the same units as market prices and compared directly.

3. Key Findings

A key finding of this study is that the estimated true price gap of approximately €2.85 per kilogram is more than nine times the observed farm-gate price of €0.30 per kilogram. This indicates that the current market value of avocado production captures only a fraction of its true economic cost when social and environmental externalities are considered.

The dominant driver of this gap is under-earning, meaning that a significant proportion of farmers are unable to generate sufficient income to meet living income benchmarks. In practical terms, this reflects structural constraints including low productivity, limited market access, price-taking behaviour, and fragmented value chains.

This gap is more than a theoretical construct; it highlights a fundamental misalignment between value creation and value capture within the avocado value chain. Addressing this imbalance represents a critical opportunity for targeted interventions.



Component	€ per kg
Market Price (Farm-gate, weighted average)	0.30
Income Gap	1.91
Environmental Costs	0.94
True Price	3.15

Figure 1. Market Price and Estimated True Price of Avocados (€/kg)

Overall True Price Gap

The average market price observed at farm level was significantly below the estimated true price.

- The total true price gap was estimated at **€2.85 per kilogram** of avocado produced.

- Social impacts account for the majority of this gap, representing approximately 67% of the total true price gap, while environmental impacts contribute the remaining 33%. This distribution highlights that the primary sustainability challenge within the value chain is economic in nature, with environmental impacts playing a secondary but still material role.
- All values are based on the baseline TCA assessment conducted under this project and validated through stakeholder consultations.

Social Externalities – Income Gap

- The dominant driver of the true price gap is insufficient household income relative to a living income benchmark. The analysis indicates that a large share of avocado-producing households in the surveyed communities are likely to earn below the estimated living income threshold.
- Average income levels derived from avocado production are significantly below the benchmark required to support a decent standard of living. This gap reflects structural limitations in productivity, access to improved planting material and market integration, which together constrain farmers' earning potential.
- The income gap accounts for approximately 67% of the total true price gap, making it the largest contributor to the gap. This highlights that the primary sustainability challenge within the avocado value chain is economic in nature, rather than environmental.
- The monetised income gap attributable to avocado production was estimated at **€1.91 per kilogram**.
- This reflects structural under-earning at household level rather than crop-specific inefficiency alone.
- For farmers, the income gap translates into continued reliance on diversified livelihood strategies, where avocado production contributes to household income but does not serve as a primary pathway to economic security.
- This implies that improvements in yield, price realisation, and market integration are necessary but not sufficient on their own. Structural interventions that enhance value capture—such as aggregation, quality differentiation, and access to premium markets—are required to meaningfully close the income gap.

Environmental Externalities

- Land occupation impacts were estimated at €0.80 per kilogram, representing the primary environmental cost component and accounting for the majority of total environmental externalities. This reflects the relatively low productivity of the production system, where avocado trees are typically dispersed within mixed farming systems and yields per tree remain modest.
- Survey observations indicate that avocado production is generally not managed as a dedicated orchard system, with trees often integrated alongside staple crops and receiving limited agronomic attention. As a result, output per unit of land remains relatively low, increasing the land requirement per kilogram of avocado produced.
- This dynamic is a key driver of land occupation impacts within the True Cost Accounting framework. Improving productivity through better orchard management practices and access to improved planting material could reduce land occupation per unit of output by increasing yields without necessarily expanding cultivated area.

- Additional environmental impacts, including greenhouse gas emissions and water use, were present but comparatively smaller in magnitude within the study scope which denotes a good environmental performance on several indicators.

Avocado production across the surveyed farms is predominantly rain-fed, with very limited use of irrigation. This reduces reliance on externally sourced water inputs and associated water use impacts within the production system. In a global context where irrigation in avocado production has attracted increasing scrutiny due to its contribution to water stress in major producing regions, the rain-fed nature of production in Southern Kaduna represents a relative environmental advantage.

Potential positive externalities associated with agroforestry systems , including biodiversity, soil health improvements and carbon sequestration, were not within the scope of this assessment

These findings indicate that the largest externality embedded within current market prices is income insufficiency among smallholder producers, with environmental costs present but less dominant in relative terms.

These findings were validated with stakeholders during dedicated validation workshops and informed the prioritization of recommendations.

4. Analytical Interpretation

The findings indicate that the primary externality embedded within current avocado prices in Southern Kaduna is structural income insufficiency at household level. While avocado production contributes to total household earnings, it operates within diversified livelihood systems in which farmers derive income from multiple sources, including staple crop cultivation (such as maize, beans and yam), small-scale trading, livestock rearing and casual labour. Despite this diversification, overall household income remains below established living income benchmarks. The monetised income gap therefore reflects broader economic conditions rather than crop-specific inefficiency alone.

From a production systems perspective, smallholder avocado cultivation in the study area is characterised by relatively low external input intensity. Limited use of synthetic fertilisers and agrochemicals contributes to comparatively modest environmental cost components, particularly in relation to greenhouse gas emissions. However, land occupation remains a material factor, reflecting the opportunity cost associated with land use and the monetisation approach embedded within the True Price framework[3].

Yield variability across farms also influences the true price profile. Lower productivity increases the per-kilogram burden of fixed environmental and income-related costs, while higher yields improve cost distribution without fully eliminating the underlying income gap.

[3] True Price is currently revising its methodology to account for the environmental costs of land use at regional and local level (primarily by farming systems), that integrates a planetary boundaries and ecosystem services lens, instead of a land occupation accounting approach.
the current land occupation approach at true Price is available here:
https://www.truepricefoundation.org/publications/land-use-land-use-change-biodiversity-and-ecosystem-services/

This suggests that productivity improvements alone may reduce but not entirely close the identified true price gap.

Taken together, the results illustrate that the true price gap in this context is primarily income-driven, shaped by structural economic conditions, while environmental externalities reflect land use dynamics more than input intensity.

5. Validation and Confidence

The preliminary findings of the analysis were subjected to a structured validation process through a stakeholder workshop conducted within the study area in March 2026. Participants included sampled farmers, community representatives and local agricultural stakeholders. The session provided an opportunity to review key assumptions, production patterns and market observations reflected in the modelling outputs, and to confirm the alignment of model outputs with observed field realities.

Feedback from participants confirmed several structural characteristics captured in the survey data, including the treatment of avocado as a secondary crop, limited use of irrigation and external inputs, varietal differences affecting productivity and the predominance of informal marketing channels. Stakeholders also provided additional context on post-harvest handling practices, price variability across markets and constraints affecting farmer coordination.

While the validation process was qualitative in nature, it enhanced confidence in the interpretation of results by ensuring alignment between modelled findings and field realities. The combination of primary survey data, established modelling frameworks and stakeholder validation provides a robust basis for interpreting the true price estimates presented in this report.

6. Implications

The findings of this assessment have several implications for production systems, income pathways, and broader value chain development.

Production Systems

The relatively modest environmental cost profile, particularly in relation to input intensity, suggests that smallholder avocado production in the study area is not currently characterised by high chemical dependency. However, land occupation remains a material component of the environmental externality profile. Improvements in productivity per unit of land may reduce the per-kilogram burden of both environmental and income-related costs, though such improvements alone are unlikely to eliminate the identified income gap.

Income Pathways

The dominance of insufficient household income within the true price gap indicates that interventions targeting productivity or price premiums in isolation may not fully address structural income deficits. The findings suggest that broader income diversification strategies, market access improvements, or value addition mechanisms may be required to materially influence the income-related externality profile.

Policy Considerations

The results highlight the importance of incorporating income sufficiency into agricultural policy discussions. While environmental sustainability remains relevant, the primary quantified externality in this context is social rather than ecological. Policymaking that focuses exclusively on environmental metrics without addressing income adequacy may overlook the central structural constraint identified in this assessment.

Investment Considerations

For investors and development finance actors, the quantified true price gap provides visibility into risk dimensions not captured in market pricing alone. Income instability at farm level may affect supply reliability, reinvestment capacity, and long-term value chain resilience. Transparent cost visibility can support more informed capital allocation decisions.

7. Limitations

This assessment reflects the defined geographic scope, sample size, and methodological boundaries described in the full report. The study is based on primary data collected from 150 farmers within selected areas of Southern Kaduna and is not nationally representative of Nigeria's avocado sector.

Yield, income, and cost data were self-reported by participating farmers and converted to standardised weight measures using enumerator-supported unit adjustments. While consistency checks were applied, the analysis remains subject to recall bias and reporting variability.

Environmental externalities were quantified and monetised by True Price following the True Price Assessment method. As with all modelling approaches, results are sensitive to benchmark assumptions, yield levels, and reference values. The findings should therefore be interpreted as a structured baseline estimate rather than a definitive valuation applicable across different contexts.

8. Conclusion

This study presents a baseline True Cost Accounting assessment of smallholder avocado production in Southern Kaduna, Nigeria. By quantifying income-related and environmental externalities alongside observed market prices, the analysis provides structured visibility into the indicative cost profile embedded within farm-level production.

The results indicate that the dominant externality within the current price structure is insufficient household income relative to established living income benchmarks. Environmental costs, while present, are comparatively smaller and are primarily associated with land occupation rather than high input intensity. However, it is important to note that potential positive externalities associated with agroforestry systems — such as biodiversity

support, soil health improvements and carbon sequestration — were not within the scope of this assessment.

As such, the analysis may underrepresent the full range of environmental contributions associated with mixed cropping systems observed in the study area. Further research could explore these dimensions in more detail.

These findings reflect the structural characteristics of smallholder production systems within the defined study area. As a baseline assessment, this report establishes a reference point for future monitoring, comparative analysis, and informed value chain dialogue. It does not provide a comprehensive national valuation, nor does it prescribe specific interventions. Rather, it offers an evidence-based foundation for continued engagement on income adequacy, production efficiency, and sustainable value chain development within the avocado sector.

The report concludes with a structured roadmap outlining priority actions and pathways for future interventions and investment in the value chain. This report serves as a baseline assessment of the true cost of avocado production in Southern Kaduna, establishing a reference point for future interventions and measurement of progress over time.

Beyond quantifying the true price gap, the study identifies key structural constraints within the value chain and highlights actionable entry points for improving farmer incomes and system efficiency.

As such, the findings are intended not only as an analytical output, but as a decision-making tool for stakeholders seeking to design, fund, and implement targeted interventions within the avocado value chain.

1. INTRODUCTION

1.1 Nigeria's Avocado Value Chain

Avocado production in Nigeria has expanded steadily in recent years, driven by favourable agro-ecological conditions, increasing domestic consumption, and emerging export interest. Production is largely smallholder-based, characterised by mixed-crop farming systems and limited formal aggregation structures. Marketing channels remain predominantly informal, with farm-gate sales feeding into local traders and urban retail markets across Kaduna, Abuja, Lagos, and other consumption centres.

Despite this growth, the sector remains structurally under-analysed. Data on yields, income sufficiency, and environmental performance are limited. Market prices reflect transactional exchange but do not necessarily capture the broader social and environmental dimensions embedded in production systems. As interest in sustainable sourcing and inclusive agricultural development increases, the need for structured cost transparency becomes more pronounced.

1.2 Rationale for True Cost Accounting

True Cost Accounting (TCA) provides a framework for quantifying externalities that are not reflected in market prices. These externalities may include both negative impacts, such as insufficient household income relative to living income benchmarks and environmental pressures including land occupation, greenhouse gas emissions and water use, as well as positive contributions that may arise from agricultural production systems.

In this study, the application of TCA follows the True Price methodology, which focuses specifically on the monetisation of negative externalities and compares these to prevailing market prices.

By translating such externalities into monetary values per unit of output, TCA enables a comparison between observed market price and estimated true price. This approach does not prescribe price adjustments but instead offers analytical visibility into hidden costs within production systems. For smallholder-dominated sectors such as avocado production in Nigeria, this visibility is particularly relevant for policymakers, investors, and value chain actors seeking informed decision-making.

1.3 Focus on Southern Kaduna

Southern Kaduna was selected as the study area due to its concentration of avocado-producing smallholders and favourable agro-climatic conditions. The region represents a meaningful production cluster within Kaduna State and provides an appropriate context for examining farm-level income and environmental characteristics.

The study focuses on smallholder production systems within selected Local Government Areas, reflecting the dominant structure of avocado cultivation in the region. While the findings are not nationally representative, Southern Kaduna provides a relevant case study for understanding structural cost dynamics within Nigeria's emerging avocado sector.

Figure 2. Study area map (Southern Kaduna LGAs)

1.4 Study Objectives

The primary objective of this study is to establish a baseline True Cost Accounting assessment of smallholder avocado production in Southern Kaduna.

Specifically, the study seeks to:

a) Quantify the gap between observed farm-gate prices and living income-related shortfalls
b) Estimate selected environmental externalities associated with avocado production.
c) Calculate the estimated true price per kilogram of avocado at farm level.
d) Provide a structured reference point for future monitoring and comparative analysis.

1.5 Project Partners

The project was implemented by Grows In Rows Limited (GIR) in collaboration with True Price BV, with technical and contextual engagement from the Centre for Dryland Agriculture (CDA) and relevant research stakeholders including NIHORT. The initiative was supported under the Netherlands Food Partnership framework.

Each partner contributed distinct expertise, including field coordination, methodological modelling, contextual validation, and stakeholder engagement.

1.6 Report Structure

This report is organised into a series of sections that progressively present the analytical framework, empirical findings, and their implications for the avocado value chain in Southern Kaduna.

a) **Section 2** outlines the study design and methodological approach, including the analytical framework, system boundaries, sampling strategy, and modelling assumptions applied in the True Cost Accounting assessment.
b) **Section 3** presents the results of the analysis, including observed market prices, quantified income gaps, environmental externalities, and the estimated true price of avocado production at farm level.
c) **Section 4** provides an interpretation of the results, examining the structural drivers of the true price gap and the underlying characteristics of the production system and value chain.
d) **Section 5** summarises findings from the stakeholder validation workshop, highlighting how field-level insights align with and contextualise the modelled results.
e) **Section 6** discusses the broader implications of the findings for production systems, farmer income pathways, policy considerations, and potential investment strategies.
f) **Section 7** concludes the report by synthesising the key findings and situating them within the wider context of agricultural value chain development and sustainability.
g) **Section 8** presents targeted recommendations aimed at addressing the primary drivers of the true price gap, with a focus on improving farmer income and strengthening value chain efficiency.
h) **Section 9** outlines a phased roadmap for future action, identifying short-, medium-, and long-term priorities for stakeholders seeking to build on the findings of this assessment.
i) **Section 10** introduces an intervention prioritisation framework designed to support decision-making by aligning potential interventions with their expected impact, feasibility, and relevance to the identified constraints within the value chain.

The report is supported by appendices and annexes that provide additional detail on the survey instrument, modelling assumptions, and contextual field findings underpinning the analysis.

2. STUDY DESIGN & METHODOLOGY

2.1 Analytical Framework

This assessment applies the True Price methodology as a practical True Cost Accounting (TCA) framework to estimate the "true price" of avocados produced by smallholder farmers in Southern Kaduna. The purpose of the framework is to make visible—using a structured quantification and monetisation approach—selected social and environmental costs that are not captured in conventional market pricing.

Figure 3. Simplified Avocado Value Chain Structure

What the framework measures

Within the scope of this study, the analysis distinguishes between two components:

1. **Observed market price (farm-gate):**

   The price farmers receive at the point of sale at farm level, expressed per kilogram. This represents the monetised value captured through current transactions.

2. **Externalities (monetised):**

   Costs associated with production that are not reflected in the farm-gate price but are borne by households, society, or the environment. In this study, externalities are estimated in monetary terms per kilogram and grouped into:

   - **Social externality:** insufficient household income relative to a living income benchmark (income gap)

- **Environmental externalities:** land occupation, greenhouse gas emissions, and water use (within the modelling boundaries and available data)

Definition of true price used in this study

For the purposes of this report, the "true price" is defined as:

True Price (€/kg) = Market Price (€/kg) + Social Externality (€/kg) + Environmental Externalities (€/kg)

This definition is used strictly as an analytical tool. The resulting value is not presented as a recommended selling price. Rather, it provides a structured estimate of the magnitude and composition of hidden costs associated with production at farm level.

Unit of analysis and reporting

All outcomes are reported in:

- **Euros per kilogram (€/kg)** to support international comparability and consistency with the modelling framework.
- **Farm-level production stage** only. The analysis does not include downstream margins or costs at aggregation, wholesale, or retail stages.

Scope of impacts included

The impact categories included in the framework were selected based on:

- relevance to smallholder production conditions,
- feasibility of measurement through the deployed survey instrument, and
- alignment with the True Price method approach.

Accordingly, the scope of impacts modelled in this assessment is limited to:

- income gap relative to living income,
- land occupation,
- greenhouse gas emissions, and
- scarce water use.

Biodiversity impacts are considered within the scope of this study through the land occupation indicator, which serves as a proxy for potential biodiversity loss in line with the True Price methodology. Given the smallholder and low-input nature of the system, these impacts are present but relatively limited in magnitude compared to income-related externalities.

2.2 Scope and Boundaries

Geographic Scope

The assessment focuses exclusively on selected Local Government Areas within Southern Kaduna, Kaduna State, Nigeria. The region was identified based on active smallholder avocado production and accessibility within the project timeframe.

The findings are specific to the surveyed production cluster and should not be interpreted as nationally representative of Nigeria's avocado sector. Differences in agro-ecological conditions, production intensity, market access, and household income structures across other states may result in materially different true price estimates.

Value Chain Boundaries

The analysis is limited to the farm production stage of the value chain.

Included:

- Cultivation and harvest at farm level
- Farm-gate sales
- Transport to local markets
- Household-level income and cost structure related to avocado production

Excluded:

- Aggregation and collection costs
- Transportation beyond local markets
- Wholesale and retail margins
- Export handling, packaging, and logistics
- Post-harvest processing
- Downstream waste and spoilage

The true price calculated in this report therefore reflects **production-stage externalities only** and does not represent the full value chain true price.

Temporal Scope

Primary data collection was conducted between October and December 2025. Production and income data reflect the most recent full production cycle as reported by farmers during this period.

Benchmark values, exchange rates, and monetisation factors correspond to 2025 reference values unless otherwise stated.

Seasonal price variation beyond the reporting window was not modelled separately but is acknowledged as a contextual factor.

Analytical Boundaries

The model assumes:

- Production volumes as reported by farmers
- Standardised conversion from fruit count to kilogram equivalent
- Revenue based allocation of household income gap to avocado production

Sensitivity to yield variability and benchmark assumptions is acknowledged and addressed in Section 2.7.

2.3 Sampling Strategy

The sampling strategy for this assessment was designed to provide structured, farm-level insight within defined budgetary and operational constraints. The study was not designed as a statistically representative national survey but as a pilot-level baseline assessment focused on a defined production cluster.

Sample Size

A total of 150 smallholder avocado farmers were surveyed.

The sample size was determined based on:

- Available project budget under the True Pricing Seed Fund framework
- Feasibility within the implementation timeframe
- Enumerator capacity and supervision structure
- Mapping of farmer availability within identified production areas

The objective was to generate a sufficiently large dataset to allow structured farm-level modelling while maintaining data quality and consistency.

Geographic Distribution

Farmers were selected from identified avocado-producing communities within selected Local Government Areas in Southern Kaduna.

The selection of LGAs was informed by:

- Known concentration of avocado cultivation
- Accessibility within the project timeframe
- Engagement with local networks and stakeholders

Within each selected area, farmers were identified through cluster mapping and referrals from local producer networks. The approach prioritised active producers with at least one productive avocado cycle within the reporting period.

All monetary values presented in this report are expressed in 2025 euros (€) to ensure consistency with the True Price monetisation factors. Local data collected in Nigerian naira

were converted using the prevailing exchange rate during the analysis period. The conversion allows for comparability across the different environmental and social cost categories estimated in the model.

Farmer Profile

The surveyed farmers represent smallholder production systems characterised by:

- Mixed-crop cultivation
- Household labour participation
- Variable orchard maturity levels
- Predominantly rain-fed production

No minimum landholding threshold was imposed beyond active avocado production.

Representativeness and Limitations

The sampling approach was cluster-based and purposive, rather than randomised at population level. As such:

- The results provide structured insight into farm-level production conditions within the surveyed cluster.
- The findings should not be extrapolated statistically to all avocado producers in Kaduna State or Nigeria.

The purpose of the sampling strategy was to establish a structured baseline for modelling and stakeholder dialogue, rather than to generate statistically representative national estimates.

System Boundaries

The system boundaries for this assessment are defined to include smallholder avocado production at the farm level in Southern Kaduna, Nigeria. The analysis focuses on production activities up to the farm-gate, including input use, labour, and on-farm practices.

Post-harvest handling, transportation, processing, and downstream value chain activities are not included in the quantitative assessment, but are considered qualitatively in the interpretation of results and recommendations.

The assessment reflects conditions during the study period and is based on available primary and secondary data.

Key Assumptions

The analysis is based on a number of key assumptions derived from available data and standard True Price methodology. These include assumptions related to average yields per hectare, farm-gate prices, labour inputs and valuation, and the use of environmental valuation factors to estimate external costs.

Where primary data was limited, proxy values and secondary data sources were applied. All assumptions were reviewed for consistency with local conditions and validated, where possible, through stakeholder engagement.

3. TRUE PRICE RESULTS

This section presents the monetised true price results of the true pricing model applied to avocado production in Southern Kaduna.

The analysis distinguishes clearly between observed market prices and monetised externalities. Urban retail prices are presented for contextual comparison but are not used in the modelling baseline, which is restricted to farm-gate conditions in line with the defined system boundary.

The results presented in this report represent average values across the surveyed farms. However, substantial variation exists between individual farms due to differences in farm size, tree density, yield levels, and management practices. These factors influence both the economic performance of farms and the environmental impacts associated with avocado production.

In this analysis, the living income benchmark is derived from nationally established reference values for rural households. Given that avocado is not the primary crop for most farmers, the income gap is calculated based on the proportion of time and resources allocated to avocado production relative to total household livelihood activities.

This ensures that the estimated income gap reflects the role of avocado within a diversified farming system, rather than attributing the full household income requirement to a single crop.

Summary of True Price Results

Component	Value (€ / kg)	Share of Total Gap
Observed farm-gate price	€0.30	—
Income gap	€1.91	~67%
Environmental impacts (combined)	€0.94	~33%
Total true price	**€3.15**	—
True price gap	**€2.85**	100%

Environmental impact breakdown

Environmental category	€ / kg
Land occupation	€0.80
Climate change	€0.04
Air pollution	€0.03
Soil pollution	€0.03
Water pollution	€0.01
Fossil fuel depletion	€0.01
Scarce water use	€0.01

3.1 Market Price Structure Across Locations

Avocados are sold at materially different price levels depending on geographic location within the value chain.

At farm-gate level in Southern Kaduna, large avocados are typically sold at approximately ₦500 per kilogram. Using the exchange rate of ₦1,652 per euro, this corresponds to approximately €0.30 per kilogram.

In contrast:

• Abuja market price ≈ ₦1,000 per kilogram ≈ €0.61 per kilogram

• Lagos market price ≈ ₦2,000 per kilogram ≈ €1.21 per kilogram

The spatial spread between farm-gate and Lagos retail therefore exceeds 300 percent.

However, this spread does not reflect internalisation of external costs. It reflects value chain margins, transport costs, aggregation, retail mark-ups and urban demand dynamics. The modelling baseline remains the farm-gate price because the assessment boundary is production-stage only.

This distinction is critical: higher urban prices do not imply that externalities are priced in.

3.2 Total True Price Gap

The model identifies a true price gap of €2.85 per kilogram.

This figure represents the aggregate monetised value of unpriced social and environmental impacts associated with current avocado production systems within the surveyed cluster.

It is not an abstract ratio. It is the quantified difference between:

Observed farm-gate price (€0.30/kg)

and

The price that would reflect selected income and environmental costs.

When the €2.85 gap is added to the farm-gate price of €0.30 per kilogram, the estimated true price becomes approximately €3.15 per kilogram. This result indicates that external costs exceed the current farm-gate price by more than ninefold. Put differently, for every euro received by producers at farm level, approximately nine euros of external costs remain unaccounted for within the transaction.

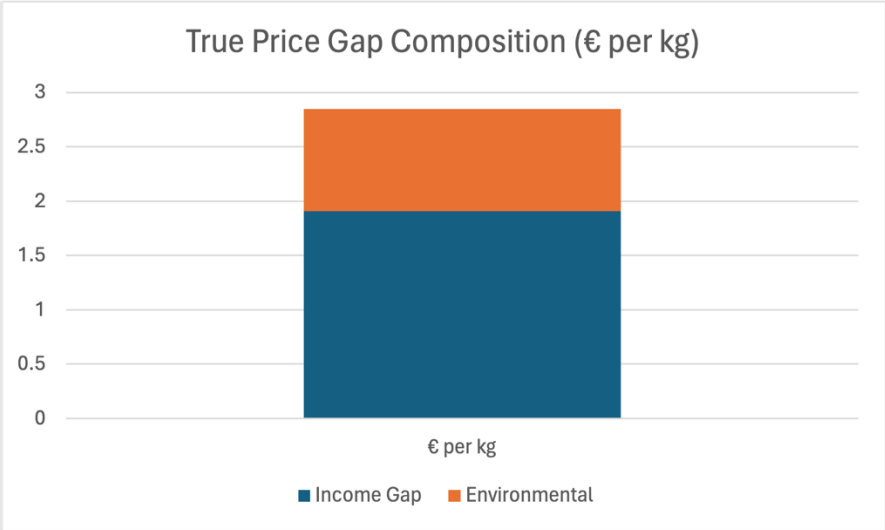


Figure 4: Composition of the True Price Gap per Kilogram of Avocado

Understanding the Living Income Gap in a Multi-Crop System

The living income benchmark represents the level of income required for a rural household to afford a basic but decent standard of living, including food, housing, education, and healthcare.

In this study, the living income gap is used to estimate the shortfall between actual household earnings and this benchmark.

As avocado production is typically one component of a diversified farming system in Southern Kaduna, the analysis does not assume that avocados alone should generate a full living income. Instead, the income gap associated with avocado reflects the share of time, land, and resources allocated to the crop relative to overall household livelihood activities.

The monetised income gap therefore captures the extent to which current production and market conditions for avocados contribute to overall household under-earning. This constitutes the largest component of the true price gap identified in the study.

Conceptually:
Living Income Gap (Avocado) ≈ (Living Income Benchmark × Share of effort allocated to avocado) – Income derived from avocado

Table 5: Understanding the Living Income Gap in a Multi-Crop System

3.4 Spatial Comparison with Urban Prices

Even when compared to Lagos retail prices of approximately €1.21 per kilogram, the estimated true price of €3.15 per kilogram remains substantially higher. This suggests that value chain margins between farm-gate and retail do not close the externality gap. In other words, higher consumer prices in urban centres do not imply that:

• Farmers are receiving sufficient income, or

• Environmental impacts are being internalised.

The majority of the €2.85 externality remains unpriced across the value chain.

This finding is particularly relevant in a context where production systems are predominantly smallholder-based and characterised by low-input practices.

3.5 Ratio Analysis

Examining the proportional relationship between components clarifies the structural imbalance:

Farm-gate price: €0.30

Income gap: €1.91

Environmental impacts: €0.94

Total true price: €3.15

Income gap alone is more than six times the observed farm-gate price. Environmental impacts alone are more than three times the observed farm-gate price. The combined externalities are nearly ten times the observed farm-gate price. This ratio framing is important for executive audiences, as it illustrates scale rather than only absolute numbers.

3.6 Interpretation Boundaries

These results reflect:

• The production-stage system boundary

• The surveyed farmer sample

• The living income benchmark applied

• The environmental impact categories modelled

• They do not imply that retail prices must equal €3.15 per kilogram.

• They do not incorporate downstream logistics impacts.

• They do not represent a policy prescription.

They quantify the divergence between observed production-stage pricing and a cost structure that includes income sufficiency and selected environmental impacts.

The scenarios below are illustrative and are intended to highlight directional relationships between productivity, income outcomes, and environmental impacts under different production pathways. They do not represent predictive modelling outputs.

Scenario	Production Characteristics	Yield Implication	Income Outcome	Environmental Implications
Current System	Low-input, rain-fed, limited management	Baseline (~67 kg/tree)	Low income, large gap	Low impact
Improved Management	Better pruning, spacing, harvesting	Moderate increase	Improved income	Slight increase
Intensified System	Improved varieties, irrigation, inputs	High increase	Higher income potential	Increased impact
Optimised System	Balanced productivity + market coordination	Efficient high yield	Improved income and price	Managed impact

Illustrative Scenarios: Productivity, Income and Environmental Trade-offs

4. INTERPRETATION OF RESULTS

The results presented in Section 4 provide a monetised estimate of the unpriced social and environmental impacts associated with avocado production within the surveyed farmer cluster in Southern Kaduna. While the numerical outputs quantify the magnitude of these externalities, interpretation is necessary to understand the structural drivers behind the observed distribution of impacts.

Two features of the results are particularly notable. First, the income gap associated with under-earning represents the dominant component of the true price gap. Second, environmental impacts, although present, constitute a comparatively smaller share of the total monetised externality. Understanding why this pattern emerges requires examination of the production system, labour structure and market characteristics of the value chain. Subsequent discussions with farmers during the validation workshop broadly confirmed the structural characteristics identified through the survey data.

Interpreting the True Price Gap

A key finding of this assessment is the magnitude of the true price gap relative to the current farm-gate price of avocados. The estimated gap, driven primarily by under-earning among farmers, is several times higher than the price currently received by producers.

This gap reflects a structural imbalance within the value chain, where the economic value required to achieve a living income for farmers is significantly higher than the value currently captured at the production level.

Importantly, the analysis indicates that this gap is not driven by high environmental costs, but rather by persistent income constraints linked to low productivity, limited access to improved planting material, and fragmented market structures.

This finding has important implications for intervention design. It suggests that closing the true price gap will require coordinated improvements across production systems and market access, rather than a singular focus on environmental sustainability measures.

In this context, the true price gap can be understood as a diagnostic indicator highlighting where value chain interventions are most urgently required to improve farmer livelihoods.

4.1 Dominance of the Income Gap

The analysis indicates that the income gap accounts for approximately two thirds of the total true price gap.

Avocado production within the surveyed area is largely undertaken by smallholder farmers operating mixed farming systems. Avocado is typically cultivated alongside other crops rather than within specialised orchard systems. As a result, production volumes per farmer remain relatively modest and the contribution of avocado income to total household earnings varies significantly across the sample.

Discussions during the validation workshop reinforced this production structure. Farmers confirmed that avocado is generally treated as a secondary crop within diversified farms and therefore receives limited active management compared to staple crops.

At the same time, the farm-gate price received by producers remains low relative to downstream market prices. With an average farm-gate price of approximately ₦500 per kilogram, producer revenue per unit of output is limited even in cases where yields are favourable. When compared to the living income benchmark used in the model, the resulting gap between realised earnings and income sufficiency amounts to €1.91 per kilogram of avocado produced on average across the sampled farms, representing the largest component of the overall true price gap.

This dynamic explains why the income gap emerges as the largest single contributor to the true price gap. The finding does not necessarily imply unusually high inefficiency within the production system. Rather, it reflects the broader economic reality faced by many smallholder agricultural systems in which market prices remain insufficient to support income levels consistent with a living income standard.

4.2 Environmental Impact Profile

While environmental externalities are present across several categories, their combined monetary value is substantially smaller than the income gap identified in the analysis. Environmental impacts account for approximately €0.94 per kilogram, representing roughly one third of the total true price gap.

Within this category, land occupation emerges as the largest environmental component. The monetised value associated with land occupation reflects the opportunity cost of land use and the environmental value attributed to land transformation under the modelling framework. In the context of the surveyed production systems, avocado cultivation typically occurs within mixed farming landscapes rather than intensive monoculture plantations. Trees are frequently integrated into existing agricultural plots or maintained as part of agroforestry-style systems that include other crops.

This form of production tends to moderate several environmental impact categories commonly associated with high-input horticultural systems. For example, fertiliser application rates remain relatively low across the surveyed sample, and mechanised operations are limited. As a result, the monetised contributions from climate change, air pollution and soil pollution remain comparatively small on a per-kilogram basis.

Similarly, water-related impacts appear limited in the model outputs. Avocado cultivation within the surveyed region is predominantly rain-fed, with very little evidence of irrigation infrastructure among the farmers interviewed. Consequently, scarce water use and water pollution contribute only marginally to the overall environmental cost profile.

These findings do not imply that environmental impacts are absent. Rather, they indicate that under the current production model — characterised by smallholder management, low external input use and mixed cropping systems — environmental externalities per unit of output remain modest relative to income-related impacts.

4.3 Structural Characteristics of the Value Chain

The observed distribution of true price impacts must also be interpreted within the broader structure of the avocado value chain in Southern Kaduna.

Production is largely decentralised and undertaken by smallholder farmers managing relatively small plots of land. Avocado trees are commonly interspersed with other crops, and harvesting practices are often seasonal and opportunistic rather than organised around formal orchard management systems. This production structure results in considerable heterogeneity in yields, harvest volumes and marketing channels across farmers.

Farmers participating in the validation workshop further emphasised that avocado marketing remains largely informal. Sales frequently occur through local traders who purchase fruit directly at farm level or within nearby markets. Because the product is highly perishable and farmers typically sell relatively small quantities, individual producers often have limited bargaining power during price negotiations.

This marketing structure helps explain the substantial difference observed between farm-gate prices and retail prices in urban markets. The price spread across the value chain reflects transport costs, aggregation margins, storage losses and retail mark-ups. However, these downstream margins do not necessarily translate into higher income for producers at the farm level.

4.4 Yield Variability and Its Effects

Yield variability represents another important factor shaping the true price results.

The survey data indicates substantial variation in production volumes across the sampled farmers. Differences in tree density, tree age, management practices and agroecological conditions all contribute to variability in harvest outcomes. Field data show considerable variation in the number of productive avocado trees across farms. Survey responses indicate that farmers maintain between 2 and 70 productive trees, with an average of approximately 7.8 trees per farm. This wide variation in tree stock contributes to significant differences in potential production volumes across the sampled farms.

During the validation workshop, farmers also highlighted varietal differences as an important factor influencing yields. The dominant trees in the region are tall traditional avocado varieties rather than improved grafted varieties. Farmers noted that the height and structure of these traditional trees can make harvesting more difficult and may also affect productivity.

Yield variability affects the relationship between production costs, revenue and the resulting income gap. Farmers with higher production volumes are able to generate greater avocado income from the same land base, thereby reducing the relative magnitude of income shortfalls when assessed against the living income benchmark. Conversely, farmers with lower production volumes experience more pronounced income gaps because the total revenue generated from avocado production remains limited.

In the context of the true pricing model, yield levels also influence the distribution of environmental impacts on a per-kilogram basis. Environmental impacts associated with land occupation or input use are effectively spread across the total volume of production. Higher

yields therefore tend to reduce the environmental cost per kilogram of output, while lower yields increase it.

The variability observed in the dataset therefore contributes to dispersion in both income and environmental impact estimates across the sample. However, when aggregated across all farmers, the structural dominance of the income gap remains clearly visible.

4.5 Comparative Observations from the Survey Data

Beyond the headline findings presented in the True Cost Accounting results, the survey data also provide several comparative observations that help contextualise the structural characteristics of avocado production within the study area. While the dataset was not designed to test causal relationships between specific production practices and productivity outcomes, patterns observed across the surveyed farmers nevertheless provide useful insights into the conditions shaping farmer income and production performance.

4.6 Production System Characteristics

Survey responses indicate that avocado production within the study communities operates largely as a low-input system. The majority of farmers reported managing avocado trees as part of broader mixed farming systems rather than as specialised orchard operations. Trees are typically interspersed with staple crops and often receive limited dedicated management compared with other crops within the farm household production portfolio.

This production structure helps explain several characteristics observed during the field survey. Agronomic practices such as pruning, spacing optimisation and systematic pest monitoring were reported only intermittently among respondents. Similarly, irrigation use appears to be relatively limited, indicating that most avocado trees depend primarily on rainfall rather than managed water systems.

These observations are consistent with the relatively low environmental externalities identified in the True Cost Accounting analysis. Because avocado production operates with limited use of external inputs such as irrigation infrastructure, fertilisers or pesticides, the environmental costs associated with production remain comparatively modest. However, the same structural characteristics also contribute to relatively low productivity levels and limited income generation from avocado cultivation.

4.7 Varietal Structure and Harvesting Constraints

Another pattern emerging from both the survey responses and the validation workshop discussions concerns the predominance of traditional avocado tree varieties within the surveyed communities. Farmers indicated that most avocado trees currently present on their farms consist of long-established local varieties rather than grafted varieties commonly used in commercial orchard systems.

These traditional trees often grow to considerable heights and typically require longer maturation periods before fruiting. Their height also introduces practical challenges during harvesting, as fruit is frequently collected after falling to the ground rather than being harvested directly from the tree. Participants in the validation workshop noted that this

practice often results in bruising and physical damage to the fruit, which can reduce the proportion of produce reaching market in saleable condition.

The limited presence of improved grafted varieties therefore represents an important structural constraint within the production system. Access to improved planting material could potentially contribute to improved productivity, more manageable tree structures and more consistent harvest cycles over time.

4.8 Fragmented Market Participation

The survey also revealed a highly decentralised marketing structure for avocado sales within the study area. Most farmers reported selling fruit individually through informal channels rather than through organised aggregation mechanisms. Sales typically occur either within nearby local markets or through itinerant traders who purchase fruit directly from farmers for onward transport to larger urban markets.

While this marketing structure provides an accessible outlet for avocado sales, it also limits farmers' bargaining power and reduces opportunities to benefit from scale advantages associated with larger supply volumes. Individual farmers often produce quantities that are too small to access higher-value buyers directly, and the absence of coordinated harvesting or aggregation systems increases per-unit transport costs.

This fragmented market participation represents an important structural factor influencing farmer income outcomes within the value chain. Strengthening coordination among producers could improve farmers' ability to consolidate production volumes, coordinate harvesting schedules and engage more effectively with buyers operating in regional markets such as Abuja and Lagos.

4.9 Post-Harvest Handling and Quality Preservation

Finally, the survey findings and workshop discussions highlight several post-harvest handling challenges that influence the quality of avocado fruit reaching market. Because harvesting often occurs from tall traditional trees, fruit is frequently allowed to fall to the ground before collection. This increases the risk of bruising and internal damage that may not be immediately visible but can accelerate spoilage during transport.

In addition, the absence of coordinated collection points or specialised packaging materials means that fruit is often transported in conditions that increase the likelihood of quality deterioration before reaching urban markets. Even relatively modest improvements in harvesting techniques, handling practices and transport coordination could therefore increase the proportion of fruit reaching market in saleable condition.

4.10 Implications for Value Chain Development

Taken together, these comparative observations reinforce several of the structural conclusions emerging from the True Cost Accounting assessment. The avocado production system within the surveyed communities operates as a largely low-input, smallholder-based system characterised by traditional tree varieties, limited orchard management practices and fragmented market participation.

While this structure contributes to relatively low environmental externalities, it also constrains productivity and farmer income outcomes. Addressing these structural characteristics will therefore require interventions that strengthen orchard management practices, improve access to reliable planting material, enhance coordination among producers and improve post-harvest handling systems within the value chain.

These observations provide an empirical basis for the strategic priorities and implementation roadmap presented in the subsequent sections.

5. VALIDATION WORKSHOP FINDINGS

5.1 Purpose of the Validation Workshop

Following the preliminary analysis of the farmer survey data, a validation workshop was convened with stakeholders from the surveyed communities in Southern Kaduna. The purpose of the workshop was to present the initial findings from the data analysis and to assess whether these findings accurately reflected the lived experience of avocado farmers in the region.

The workshop provided an opportunity to verify key assumptions emerging from the survey results, including production practices, yield constraints, price dynamics, and post-harvest losses. Participants were encouraged to discuss whether the patterns identified in the data corresponded with their practical experience in avocado production and marketing.

Rather than presenting the results as definitive conclusions, the session was designed as an open discussion to capture local insights, clarify contextual factors, and identify areas where the survey findings required further interpretation.

5.2 Participant Composition

The validation workshop was attended primarily by farmers and community representatives from the avocado-producing areas covered in the study. Participants included smallholder farmers cultivating avocado trees alongside other crops, local community leaders, and individuals with experience in marketing agricultural produce.

The discussion was facilitated by the project implementation team, including the field coordinator and project facilitator responsible for administering the farmer survey. The participants represented a cross-section of the farming communities within the study area, including individuals with varying numbers of avocado trees and differing levels of engagement in avocado production.

5.3 Confirmation of Production Characteristics

One of the central questions posed during the workshop was whether avocado production in the area is typically a primary agricultural activity or a secondary crop within diversified farming systems.

Participants broadly confirmed the survey finding that avocado cultivation is rarely treated as a primary crop. Most farmers indicated that avocado trees are integrated into farms primarily devoted to other crops. As a result, avocado production tends to receive less active management compared to staple or commercial crops such as maize or rice.

This confirmation supports the interpretation that avocado production in the region is largely opportunistic rather than structured around specialised orchard systems.

Participants also confirmed two additional observations from the survey data:

- Limited use of irrigation infrastructure
- Low application of agricultural inputs such as fertilisers and crop protection products

Farmers indicated that avocado trees are predominantly rain-fed and that input application is minimal, particularly because avocado is not currently perceived as a primary income-generating crop within the farming system. Participants noted that management practices for avocado trees are therefore relatively low-input compared with other crops grown on the farm. During the validation discussions, some farmers also indicated that improved management practices, including irrigation, could potentially increase productivity, but that such investments are currently limited by infrastructure availability and cost considerations.

5.4 Yield Constraints Identified by Farmers

Participants discussed several factors affecting avocado yields in the region.

A commonly cited constraint relates to the varieties of avocado trees currently present in the area. Farmers noted that the dominant variety in the region is the tall, traditional avocado tree, which differs from the shorter commercial varieties cultivated in other parts of Nigeria and internationally.

Participants highlighted that improved varieties such as the Hass avocado are less common locally. Some farmers reported that grafting improved varieties onto existing trees could significantly increase yields and reduce the time required for trees to reach productive maturity.

In addition to variety selection, farmers also identified challenges relating to the availability and quality of planting materials. Several participants reported difficulty obtaining reliable seedlings, noting that poor-quality seedlings often result in low germination rates or weak tree development.

These observations reinforce the importance of seedling quality and varietal selection as key factors influencing production outcomes.

5.5 Post-Harvest Handling and Losses

Another major theme emerging from the workshop discussion was post-harvest handling and losses.

Participants confirmed that avocado fruits are highly sensitive to physical damage during harvesting and transportation. Farmers noted that fruits are often harvested by plucking them directly from tall trees and allowing them to fall to the ground. This practice frequently results in bruising or damage, which reduces the marketable quality of the fruit.

Workshop participants discussed several potential practices that could reduce post-harvest losses, including:

- harvesting fruits before full ripening
- using crates rather than sacks for transport
- cushioning fruits during harvesting to reduce impact damage

Farmers also highlighted that limited knowledge of appropriate harvesting practices contributes to spoilage during handling and transport.

5.6 Marketing Challenges

The workshop discussion confirmed that marketing represents one of the most significant challenges faced by avocado farmers in the region.

Participants explained that avocado sales are often conducted through informal channels, with traders visiting farms or local markets to purchase produce. In many cases, farmers have limited bargaining power during price negotiations, particularly when they have small quantities of fruit available for sale.

Several participants also noted that transportation costs can make it difficult for individual farmers to access larger markets such as Abuja or Lagos, where avocado prices are substantially higher.

The lack of reliable buyers was also identified as a constraint. Farmers indicated that they are often unable to predict whether traders will be available to purchase their harvest, which discourages investment in improved production practices.

5.7 Lack of Collective Organisation

A recurring theme throughout the workshop was the absence of organised farmer structures specifically focused on avocado production.

While other agricultural commodities in the region are supported by farmer cooperatives or producer groups, participants noted that no similar structure currently exists for avocado producers.

Participants suggested that improved coordination among farmers could help address several of the challenges identified during the discussion. For example, collective organisation could enable farmers to:

- aggregate produce for sale to larger buyers
- share information about improved production practices
- coordinate harvesting and transport logistics
- access training or extension services more effectively

The lack of organised farmer networks therefore appears to be an underlying factor contributing to several of the value chain challenges identified during the workshop.

5.8 Overall Validation Outcome

Overall, the validation workshop confirmed that the key findings from the survey data broadly reflect the experiences of farmers within the study area.

Participants confirmed that avocado production is typically treated as a secondary agricultural activity, that yields remain relatively low due to limited input use and variety constraints, and

that marketing and post-harvest handling challenges significantly affect the value farmers are able to capture from the crop.

The workshop also generated additional contextual insights regarding seedling quality, varietal differences, harvesting practices, and the importance of collective organisation among producers.

These insights will inform the interpretation of the survey results and the co-development of recommendations presented in the final section of this report.

6. IMPLICATIONS

The results of the True Cost Accounting assessment provide insights not only into the magnitude of external costs associated with avocado production, but also into the structural conditions shaping the economic and environmental performance of the value chain.

The findings presented in the preceding sections indicate that the most significant constraint affecting avocado producers in the surveyed communities is not primarily environmental degradation, but rather the economic limitations associated with smallholder production systems characterised by low productivity, fragmented market participation and limited access to improved planting material.

At the same time, the analysis highlights several structural features of the production system that influence both productivity and income outcomes. These observations have implications for production practices, farmer income pathways, policy support mechanisms and potential investment strategies within the value chain.

The following subsections examine these implications in turn.

6.1 Production Efficiency Implications

The analysis suggests that improvements in production efficiency represent one of the most direct pathways through which both farmer income outcomes and environmental performance could be strengthened.

Survey responses and discussions during the validation workshop indicate that avocado production within the study area currently receives relatively limited agronomic attention. Avocado trees are typically integrated into mixed farming systems and often managed alongside staple crops that receive greater priority within household production strategies. As a result, orchard management practices such as pruning, spacing optimisation and pest monitoring are applied inconsistently across farms.

A second factor influencing productivity relates to varietal characteristics. Participants in the validation workshop noted that most avocado trees present within the surveyed communities are traditional tall varieties rather than improved grafted varieties commonly used in commercial orchard systems. These traditional trees often require longer maturation periods before fruiting and present practical harvesting challenges due to their height.

The introduction of improved planting material therefore represents a potential pathway for enhancing production efficiency. Grafted varieties adapted to local agroecological conditions could reduce time to fruiting, improve yield consistency and simplify harvesting practices. However, access to reliable seedlings remains limited for many farmers, and any transition toward improved varieties would require careful consideration of nursery capacity, seedling quality assurance and farmer adoption dynamics.

Beyond varietal improvements, several basic agronomic practices could contribute to improved productivity outcomes. These include improved tree spacing, pruning techniques,

pest and disease monitoring and harvesting methods that reduce physical damage to fruit during collection.

At the same time, productivity improvements should not be interpreted solely through the lens of yield maximisation. The true pricing results indicate that the current production system exhibits relatively low environmental externalities per unit of output. Intensification strategies that rely heavily on external inputs could therefore introduce environmental impacts that are currently limited within the system.

Importantly, improvements in productivity may also have implications beyond yield increases alone. By increasing output per tree and per unit of land, enhanced orchard management practices could improve land-use efficiency within existing farming systems. This, in turn, may reduce the need for expansion into additional land areas, thereby lowering land occupation impacts and contributing to a reduction in the overall true price gap.

A more appropriate pathway may therefore involve gradual improvements in orchard management practices that increase productivity while preserving the low-input characteristics currently observed in the production system. Such improvements could simultaneously enhance farmer revenues and reduce environmental impacts per kilogram of output by distributing land occupation and other resource-related externalities across higher production volumes.

This suggests that incremental improvements in orchard management practices could generate disproportionate benefits in terms of both income and environmental efficiency, provided that such improvements are aligned with the existing low-input nature of the production system.

6.2 Income Pathway Implications

The results of the True Cost Accounting assessment indicate that the most significant structural challenge facing avocado producers within the surveyed communities is the income gap associated with underearning. Addressing this gap requires consideration not only of production practices, but also of the mechanisms through which farmers participate in the value chain and capture value from their output.

An additional dimension relevant to interpreting the income gap is the role of avocado within overall household income portfolios. Survey responses and validation discussions indicate that avocado typically represents a supplementary income source rather than a primary livelihood activity, with farmers relying on a combination of staple crops, other cash crops and non-farm income sources.

This has important implications for farmer decision-making. Because avocado currently contributes only a limited share of total household income, it is often not prioritised in terms of labour allocation, input use or management intensity. This, in turn, reinforces the low-productivity equilibrium observed in the production system.

At the same time, the findings suggest that avocado production may hold unrealised potential within these farming systems. If productivity, market access and price realisation can be improved, avocado could represent a more significant income stream, thereby justifying increased farmer investment in orchard management and expansion.

However, the extent to which farmers can reallocate attention and resources toward avocado production depends on several enabling conditions. These include access to improved planting material, availability of agronomic knowledge, reduced post-harvest losses and more reliable market channels. Without improvements in these areas, the incentives for farmers to increase investment in avocado production are likely to remain limited.

Survey responses and discussions during the validation workshop suggest that avocado sales currently occur primarily through informal and highly decentralised marketing channels. Farmers typically sell fruit either within nearby local markets or to itinerant traders who aggregate produce for transport to larger urban centres such as Abuja and Lagos. While this system provides an accessible outlet for production, it also limits farmers' ability to negotiate prices or benefit from scale advantages associated with larger supply volumes.

In this context, the income gap identified in the analysis cannot be interpreted solely as a function of low yields or production inefficiency. It also reflects the fragmented nature of market participation among smallholder producers. Individual farmers often produce quantities that are too small to access higher-value markets directly, and the absence of coordinated aggregation structures reduces their bargaining position within the value chain.

Discussions during the validation workshop reinforced this structural challenge. Participants noted that avocado farmers within the surveyed communities rarely operate within organised producer groups dedicated specifically to avocado production. As a result, opportunities for collective marketing, shared transport logistics and coordinated harvesting remain limited.

Strengthening forms of collective organisation among producers could therefore represent an important pathway for improving farmer income outcomes. Aggregation mechanisms that allow farmers to combine production volumes may increase their ability to engage with larger buyers, reduce per-unit transport costs and improve price realisation within regional markets.

Such coordination may also create opportunities to improve quality consistency and post-harvest handling practices across participating farmers. Because avocado fruit is highly sensitive to physical damage during harvesting and transport, coordinated handling systems could reduce spoilage and increase the proportion of fruit reaching market in saleable condition.

Importantly, collective organisation does not necessarily require the formation of large formal cooperatives. Smaller farmer clusters or producer groups may be sufficient to coordinate harvesting schedules, consolidate produce and facilitate market access. The key structural shift involves moving from highly fragmented individual sales toward more coordinated participation in the value chain.

From the perspective of the true pricing results, improvements in farmer income through stronger market integration could contribute directly to reducing the magnitude of the income gap identified in the analysis. While such changes alone may not fully eliminate the gap relative to the living income benchmark, they represent a meaningful step toward strengthening the economic sustainability of avocado production within the region.

Given that income gaps dominate the total true price, interventions targeting productivity and pricing are likely to have the greatest impact.

Taken together, these findings indicate that the income gap observed in the analysis is not solely a function of low productivity, but also of structural constraints in how farmers participate in the value chain. Addressing the income gap will therefore require coordinated improvements in both production practices and market access, rather than isolated interventions focused on yield alone.

6.3 Policy Considerations

The findings of this study also carry several implications for agricultural policy and institutional support mechanisms within the region. These implications should not be interpreted as prescriptive policy recommendations, but rather as observations regarding the enabling conditions that influence the economic and environmental performance of the avocado production system.

While the analysis highlights significant income gaps among avocado-producing households, issues related to social protection mechanisms or gender dynamics were not a central focus of the data collection process. These areas may warrant further investigation in future studies examining livelihood resilience within the avocado value chain.

A key observation emerging from both the survey data and the validation workshop discussions is that avocado production currently occupies a relatively informal position within the agricultural landscape of Southern Kaduna. Unlike several staple crops, avocado cultivation does not appear to benefit from dedicated extension services, organised input supply systems or structured producer networks. As a result, farmers typically manage avocado trees within broader mixed farming systems without access to specialised technical guidance.

This institutional context partly explains several of the production characteristics observed during the study, including the continued reliance on traditional tree varieties and the limited adoption of improved orchard management practices. Farmers participating in the validation workshop also noted that access to reliable seedlings remains inconsistent, while information regarding improved varieties is limited within many communities.

Improving access to high-quality planting material may therefore represent an important enabling factor for future productivity improvements. Nursery certification systems and extension support focused on grafted avocado varieties could help address some of the varietal constraints identified during the study, provided that such initiatives are aligned with local agroecological conditions and farmer adoption capacity.

Another policy-relevant observation concerns the fragmented nature of avocado marketing within the region. The absence of organised producer structures or aggregation mechanisms limits the ability of farmers to coordinate supply, negotiate prices and access higher-value markets. While such coordination often emerges through private sector initiatives, policy frameworks that support farmer group formation or cooperative development can play an important role in enabling more structured participation in value chains.

At the same time, the relatively low environmental impact profile identified in the study suggests that future policy support should prioritise productivity improvements that preserve the existing low-input characteristics of the system. Smallholder-based agroforestry-style production systems may offer environmental advantages compared with more intensive

plantation models, and policy approaches should therefore aim to strengthen farmer incomes without encouraging production practices that significantly increase environmental externalities.

Taken together, these observations suggest that policy engagement in the avocado value chain may be most effective when focused on enabling conditions rather than direct production interventions. Strengthening seedling systems, improving access to agronomic knowledge and supporting farmer coordination mechanisms may provide a foundation for more resilient and productive avocado production systems within the region.

6.4 Investment Considerations

The findings of this study also highlight several areas in which targeted investment could contribute to strengthening the economic viability of avocado production within the surveyed communities. While the True Cost Accounting assessment focuses primarily on the production stage of the value chain, the results reveal structural characteristics that suggest opportunities for investment across multiple points within the broader system.

One of the most significant observations emerging from the study is the fragmented nature of avocado production and marketing. Farmers typically produce relatively small quantities of fruit and sell individually through informal channels. This structure limits their ability to access higher-value markets, increases per-unit transport costs and weakens bargaining power during price negotiations.

Investments that facilitate aggregation and coordination of supply may therefore represent an important pathway for improving value chain efficiency. Relatively simple mechanisms such as collection points, coordinated harvesting schedules or shared transport arrangements could enable farmers to consolidate production volumes and engage more effectively with buyers operating in larger regional markets such as Abuja or Lagos.

Post-harvest handling practices also present an area where relatively modest investments could generate meaningful improvements in value capture. As noted during the validation workshop, avocados are often harvested from tall trees and allowed to fall to the ground, leading to bruising and quality deterioration. Improvements in harvesting techniques, packaging materials and transport conditions could reduce physical damage and increase the proportion of fruit reaching market in saleable condition.

Another potential investment area relates to the supply of improved planting material. The study identified varietal characteristics as an important factor influencing productivity and harvest management. Investments in nursery development and seedling distribution systems could help address current limitations in access to reliable grafted varieties. However, such investments would need to be accompanied by farmer training and extension support to ensure successful adoption and long-term orchard management.

Importantly, the relatively low environmental impact profile identified in the analysis suggests that the existing smallholder production system operates with limited external inputs. Future investment strategies should therefore aim to strengthen productivity and income outcomes while maintaining these low-input characteristics. Approaches that build upon existing agroforestry-style production systems may offer a more sustainable pathway than attempts to introduce highly intensive plantation models.

An additional characteristic of the production system with potential strategic relevance is that avocado cultivation within the study area is almost entirely rainfed.

In contrast to many commercial avocado production systems globally, which rely heavily on irrigation, rainfed production may represent a comparative advantage in terms of environmental performance. In recent years, such characteristics have gained attention in international markets, where concerns regarding water use in avocado production have become increasingly prominent.

While the current study does not assess market premiums associated with rainfed production, this feature may present future opportunities for differentiated market positioning, particularly if combined with improvements in quality consistency, aggregation and supply reliability.

Realising this potential would require further analysis of market demand, certification requirements and value chain coordination mechanisms.

Finally, the results indicate that improving farmer income outcomes will likely require a combination of production improvements and stronger value chain integration. Investments that address only one of these dimensions are unlikely to fully resolve the income gap identified in the analysis. A more effective strategy may involve coordinated interventions that strengthen productivity, improve post-harvest management and enhance market access simultaneously.

7. CONCLUSION

This study applied the true pricing framework to avocado production within a cluster of smallholder farmers in Southern Kaduna, Nigeria. Drawing on primary survey data collected from 150 farmers and applying the analytical methodology developed by True Price, the analysis quantified the social and environmental externalities associated with current production practices.

The results indicate that the dominant component of the true price gap arises from the income gap relative to the living income benchmark. This finding reflects the structural characteristics of the production system rather than unusually high environmental pressures. Avocado cultivation in the surveyed communities is typically integrated within mixed farming systems managed by smallholder producers using relatively low levels of external inputs. As a consequence, environmental impacts per unit of output remain comparatively modest, while income constraints emerge as the principal factor shaping the overall true price estimate.

The analysis also highlights the importance of value chain structure when interpreting true pricing results. Farm-gate prices remain substantially lower than retail prices observed in urban markets, yet this price spread does not imply that social or environmental costs are internalised within the value chain. Instead, it reflects the dynamics of aggregation, transport, perishability and retail margins that characterise the marketing of fresh produce.

Insights from the validation workshop further confirmed several of the structural conditions identified in the survey data. Participants noted that avocado is generally treated as a secondary crop within mixed farming systems, that access to improved planting material remains limited and that marketing channels are largely informal. These factors contribute to variability in productivity and constrain the income potential of avocado production among smallholder farmers.

Taken together, the findings suggest that strengthening the economic sustainability of the avocado value chain in Southern Kaduna will likely depend on improvements in both production efficiency and market participation. Enhancements in seedling quality, orchard management practices, post-harvest handling and farmer coordination could contribute to improved productivity and greater value capture at the farm level.

More broadly, the study demonstrates the value of applying true pricing methodologies within emerging agricultural sectors. By quantifying the social and environmental costs that remain unpriced within current market transactions, the approach provides a structured basis for understanding the economic sustainability of production systems and identifying areas where targeted improvements may generate meaningful impact.

8. KEY RECOMMENDATIONS

The recommendations presented below are directly informed by the identified true price gap in smallholder avocado production, which is primarily driven by under-earning among farmers. Each recommendation is therefore designed to address specific drivers of this gap, with a focus on improving farmer incomes, strengthening value chain efficiency, and reducing associated external costs.

The findings of the True Cost Accounting assessment highlight several structural priorities for strengthening the economic and environmental sustainability of avocado production within the surveyed communities.

While the analysis indicates that the current production system generates relatively limited environmental externalities, the results reveal a significant economic constraint within the value chain. The primary challenge identified is the significant true price gap driven predominantly by farmer under-earning, rather than environmental externalities linked to the persistence of low farmer incomes associated with low productivity levels, fragmented marketing structures and limited access to improved planting material.

These findings suggest that improving the sustainability of the avocado value chain will require interventions that address both production performance and market integration. Productivity improvements alone are unlikely to close the income gap identified in the analysis if farmers continue to participate in highly fragmented marketing systems. At the same time, improved market access will have limited impact if production volumes and orchard performance remain constrained by the current characteristics of the production system.

Taken together, the analysis indicates that strengthening the economic sustainability of avocado production will require coordinated improvements across four key areas.

8.1. Strengthening Orchard Management Practices

Linked true price driver: Low productivity and yield variability contributing to farmer under-earning

The study indicates that avocado trees within the surveyed communities are typically integrated into mixed farming systems and often receive limited agronomic attention. Basic orchard management practices such as pruning, spacing optimisation, pest monitoring and improved harvesting methods are applied inconsistently across farms.

Strengthening farmer knowledge of these practices represents one of the most immediate opportunities for improving productivity. Relatively simple improvements in orchard management could increase yields and improve fruit quality while maintaining the low-input characteristics that currently limit environmental impacts within the production system.

These findings are particularly relevant for extension services, development programmes, and farmer support organisations seeking to improve productivity through low-cost, practice-based interventions.

8.2. Expanding Access to Improved Planting Material

Linked true price driver: Structural productivity constraints limiting long-term income potential

The predominance of traditional tall avocado varieties represents an important structural constraint within the production system. These trees typically require longer maturation periods before fruiting and create practical challenges during harvesting due to their height.

Improving access to reliable grafted seedlings adapted to local agroecological conditions could significantly improve productivity outcomes over time. However, such improvements will depend on the development of reliable nursery systems, seedling quality assurance mechanisms and farmer access to information regarding varietal selection and orchard establishment.

This area is of particular importance to nurseries, research institutions, and development partners focused on strengthening long-term productivity and varietal performance within the avocado sector.

8.3. Strengthening Farmer Coordination and Aggregation Mechanisms

Linked true price driver: Fragmented market access and weak bargaining power reducing farm-gate prices

The analysis highlights the fragmented nature of avocado marketing within the surveyed communities. Most farmers currently sell fruit individually through informal channels, typically to itinerant traders or within local markets. This structure limits bargaining power, increases transport costs and reduces farmers' ability to access larger regional markets.

Supporting forms of coordinated marketing among producers may therefore represent an important pathway for strengthening income outcomes. Even relatively small farmer clusters or producer groups could enable the consolidation of production volumes, coordination of harvesting schedules and improved engagement with buyers operating in larger urban markets.

These insights are especially relevant for value chain actors, cooperatives, and market facilitators seeking to improve aggregation, coordination, and farmer participation in higher-value markets.

8.4. Improving Post-Harvest Handling and Market Integration

Linked true price driver: Post-harvest losses and quality deterioration reducing effective income

Post-harvest handling practices represent another area where targeted interventions could improve value capture within the value chain. Because avocado fruit is highly sensitive to physical damage during harvesting and transport, improvements in harvesting techniques,

packaging materials and transport coordination could significantly reduce spoilage and quality deterioration.

Investments in simple collection points, coordinated transport arrangements or improved packaging systems may therefore generate meaningful improvements in the proportion of fruit reaching market in saleable condition.

Taken together, these priorities suggest that strengthening the avocado value chain in Southern Kaduna will require a combination of production improvements, stronger farmer coordination mechanisms and targeted investments in post-harvest management and market access. The following section translates these strategic priorities into a practical roadmap outlining short-, medium- and long-term actions that may support the development of a more productive and economically resilient avocado sector within the region.

This represents a key area of interest for traders, logistics providers, and development partners working to reduce losses and improve value capture across the supply chain.

9. NEXT STEPS

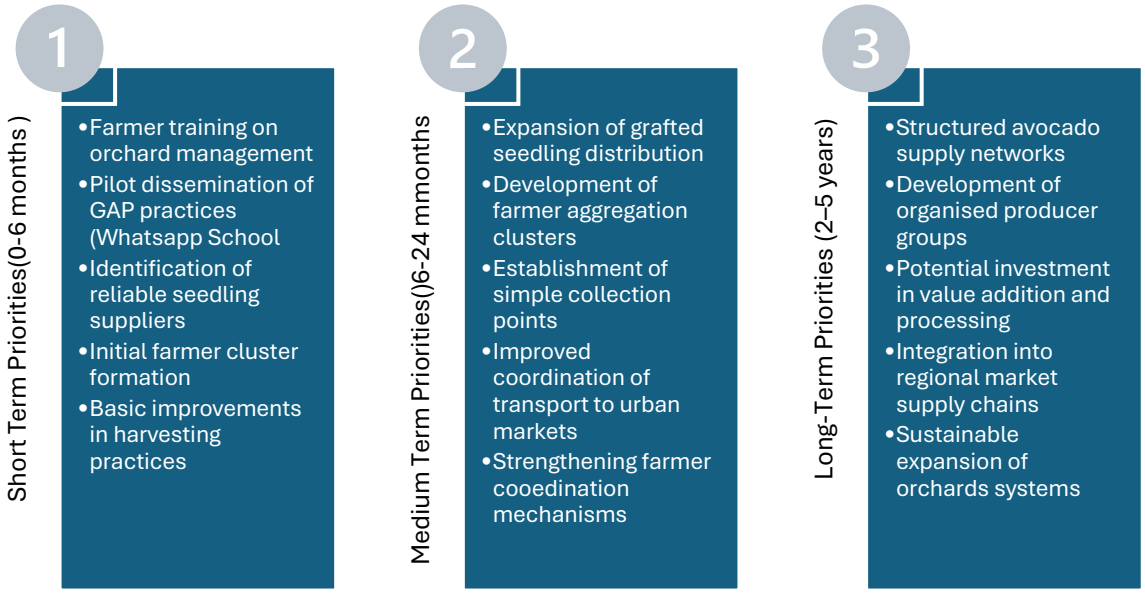


Figure 5 - Roadmap for strengthening the Avocado value chain in Southern Kaduna.

9.1 Next Steps: Roadmap for Future Action

This study represents an initial application of True Cost Accounting (TCA) to the avocado value chain in Southern Kaduna[4]. The analysis provides a baseline understanding of the economic, environmental, and social dimensions of smallholder avocado production, as well as the gap between realised farm income and the living income benchmark used in the model. This gap, which represents a multiple of the current farm-gate price, serves as the central reference point for the prioritisation of actions outlined in this roadmap.

The findings indicate that the primary opportunity lies in improving how existing production translates into income, rather than expanding production alone. Future actions should therefore prioritise interventions that increase value capture at the farmer level.

As a seed-funded initiative, the objective of this phase was to generate a credible baseline assessment, validate findings with stakeholders, and identify priority intervention areas for closing the true price gap. The study was therefore not designed to implement interventions directly, but rather to establish a credible analytical foundation to inform future action.

The findings highlight several structural constraints affecting avocado production and farmer income, including fragmented marketing systems, limited orchard management practices, variability in yields across farms, and the predominantly rain-fed nature of production

[4] To support practical engagement with the concepts presented in this study, a simplified checklist outlining key considerations when applying True Cost Accounting in agricultural value chains is provided in Annex A.

systems. Addressing these issues requires coordinated efforts across production practices, market organisation, farmer support systems, and institutional engagement.

While the current production system is not yet optimised for export markets, the growing global demand for avocados presents a medium- to long-term opportunity. However, participation in export markets will require significant improvements in quality consistency, post-harvest handling, traceability, and compliance with international standards.

In this context, immediate focus should remain on strengthening performance within domestic markets, while gradually building the conditions required for future participation in higher-value market segments.

In its current state, strategic investments in aggregation systems, extension services, and quality control mechanisms could serve as foundational steps towards future export readiness, while also contributing to incremental improvements in farmer income within domestic markets.

The following roadmap outlines a phased set of potential actions arising from the study findings and stakeholder validation discussions. These actions are organised across short-, medium-, and longer-term horizons and are intended to guide future collaboration between farmers, sector actors, development partners, and policymakers interested in strengthening the avocado value chain in Nigeria.

Investment Reflection

The findings raise an important question regarding the viability of increased investment in avocado production. While the current income outcomes are constrained, the analysis suggests that targeted improvements in productivity and market coordination could significantly enhance value capture. Further evidence from pilot interventions will be required to determine the extent to which avocado production represents a scalable and economically viable pathway for smallholder farmers.

9.2 Short-Term Priorities (0–6 months)

The immediate priority following completion of this study is to consolidate the findings, share the results with relevant stakeholders, and identify practical entry points for follow-up action. As this project was designed as a seed-funded analytical phase, the short-term focus is on translating the evidence generated through the TCA assessment into actionable insights and strengthening engagement with actors in the avocado value chain.

9.2.1 Dissemination of Findings

The findings of this study should be shared with key stakeholders within the avocado value chain, including farmer representatives, agricultural extension services, research institutions, and development organisations. Dissemination activities may include stakeholder briefings, targeted presentations, and circulation of the report through relevant networks. This process will help ensure that the evidence generated through the TCA analysis informs ongoing discussions on horticulture value chain development in Nigeria.

9.2.2. Consolidation and Further Analysis of Field Data

The dataset collected during this study provides an opportunity for additional analysis beyond the initial modelling exercise. Short-term analytical work could include examining variations in production outcomes across farms, differences in orchard structure (such as number of avocado trees), and patterns in farmer marketing behaviour. These insights could help identify potential entry points for future interventions.

9.2.3. Identification of Potential Farmer Clusters

Based on the survey data and field observations, areas with relatively higher concentrations of avocado production could be mapped and assessed as potential locations for follow-up engagement. Identifying such clusters would support the design of future pilot initiatives related to farmer coordination, training, or value chain support.

9.2.4. Development of Knowledge-Sharing Materials

Given the limited familiarity with True Cost Accounting among many sector actors, simplified communication materials explaining the findings of this study and the relevance of TCA could be developed. These materials could support future engagement with farmers, development partners, and policymakers interested in understanding the broader economic, environmental, and social dimensions of agricultural production systems.

9.2.5 Pilot Knowledge-Sharing Initiative for Good Agriculutrual Practices

As part of the follow-up to this study, an exploratory knowledge-sharing initiative is being considered to support the dissemination of Good Agricultural Practices (GAP) among avocado farmers. One approach under consideration is the use of simple digital communication channels, such as WhatsApp-based learning groups, to share practical guidance on orchard management, harvesting practices, and post-harvest handling.

Such an initiative could provide a low-cost mechanism for strengthening farmer knowledge and facilitating peer learning, particularly in contexts where formal extension services may be limited. The approach would be tested on a pilot basis with interested farmer groups to assess its effectiveness as a tool for knowledge exchange within the avocado value chain.

In the short term, priority should be placed on strengthening the evidence base, identifying high-potential farmer clusters, and testing low-cost mechanisms for improving farmer knowledge. These actions provide a foundation for more targeted and resource-intensive interventions in subsequent phases.

9.3 Medium-Term Priorities (6–24 months)

The medium-term phase focuses on translating the insights generated by the study into pilot initiatives and capacity-building activities that could strengthen farmer productivity, market participation, and value chain coordination. These initiatives would allow sector actors to test practical approaches to improving outcomes for avocado farmers while generating further learning for future scale-up.

9.3.1 Strengthening Orchard Management Practices

The study findings suggest that avocado production in the study area is characterised by limited orchard management, with trees often integrated within mixed farming systems and receiving minimal inputs. Medium-term initiatives could therefore explore approaches to improve basic orchard management practices, including pruning, tree maintenance, and harvesting techniques that may contribute to improved productivity and fruit quality.

9.3.2 Expansion of Knowledge-Sharing Platforms

Building on short-term knowledge-sharing initiatives such as the pilot WhatsApp-based learning groups, the medium-term phase could expand farmer engagement around Good Agricultural Practices (GAP). This may include structured training sessions, peer-learning exchanges among farmers, and collaboration with extension services to promote improved management practices across avocado-producing communities.

9.3.3 Improving Post-Harvest Handling and Fruit Quality

Field discussions and validation workshop insights indicate that harvesting and post-harvest handling practices vary significantly among farmers. Medium-term initiatives could therefore explore practical measures to reduce damage to fruit during harvesting, handling, and transport. Improving post-harvest practices could help increase the proportion of fruit that reaches markets in good condition and improve price outcomes for farmers.

9.3.4 Farmer Coordination and Aggregation

The study suggests that avocado marketing is largely fragmented, with farmers often selling individually in small quantities. Strengthening farmer coordination mechanisms—such as informal producer groups or cluster-based aggregation—could help improve bargaining power, facilitate more efficient market access, and reduce transaction costs within the value chain.

9.3.5 Continued Application of True Cost Accounting Insights

The medium-term phase could also explore how insights from the TCA analysis might be incorporated into agricultural development programmes or advisory initiatives. This may include adapting simplified elements of the TCA approach to support discussions around sustainability, farmer income, and value chain development in the avocado sector.

The medium-term phase should prioritise testing integrated interventions that simultaneously address productivity and market access constraints. This stage is critical for generating practical evidence on which combinations of interventions most effectively improve farmer income outcomes.

9.4 Long-Term Priorities (2–5 years)

The longer-term phase focuses on scaling successful pilot initiatives and strengthening the institutional and market conditions required for a more resilient and productive avocado value

chain. Insights generated through the TCA assessment and subsequent pilot activities could inform broader efforts to improve farmer income outcomes, production practices, and coordination within the avocado sector.

9.4.1 Scaling of Successful Pilot Initiatives

Lessons from medium-term pilot activities—such as improved orchard management practices, farmer coordination mechanisms, and enhanced post-harvest handling—could be expanded to additional avocado-producing communities. Scaling these approaches would require collaboration among farmer groups, development partners, and sector actors interested in supporting horticultural value chain development.

9.4.2 Strengthening Value Chain Coordination

Long-term improvements in the avocado sector may depend on stronger coordination among producers, traders, processors, and market actors. Encouraging more structured market linkages and improving the flow of information within the value chain could contribute to more stable market participation for farmers.

9.4.3 Institutional and Policy Engagement

Over time, the findings of the study and the results of follow-up pilot initiatives could inform broader discussions on horticultural development in Nigeria. Engagement with relevant institutions—including research organisations, agricultural development programmes, and sector stakeholders—may help integrate insights from the study into future agricultural initiatives and value chain strategies.

9.4.4 Continued Application of True Cost Accounting

The experience gained through this project may support the wider use of True Cost Accounting as a diagnostic tool for understanding sustainability outcomes in agricultural value chains. Future applications could explore the use of TCA to analyse other crops or regions, contributing to a broader evidence base on the economic, environmental, and social dimensions of agricultural production systems.

9.4.5 Capacity Building & Stakeholder Empowerment

Capacity building remains a central pillar of value chain development. Strengthening farmer knowledge in areas such as orchard management, pest control, harvesting practices, and post-harvest handling can contribute directly to improved yields and quality outcomes.

In addition, stakeholder empowerment—including the formation of farmer groups, improved access to extension services, and stronger linkages with buyers—can enhance bargaining power and facilitate more efficient market participation.

9.4.6 Future Research Priorities

Future research should focus on addressing key data and knowledge gaps identified through this study, including:

a. Longitudinal tracking of farmer incomes relative to living income benchmarks, to assess changes over time and the effectiveness of interventions
b. The impact of agronomic improvements on yield variability and productivity outcomes
c. Market access dynamics, including price transmission along the value chain and factors influencing farm-gate pricing
d. Post-harvest losses and quality-related price differentials, particularly in relation to handling, storage, and aggregation practices
e. Further analysis of the relationship between input use, yield variability, and income outcomes across different production systems. This would require larger sample sizes and more consistent farm-level record keeping to support robust comparative assessment.

9.4.7 Monitoring and Evaluation Framework

In parallel, monitoring frameworks should be established to systematically track both productivity and income outcomes over time.

Key indicators should include:

a. Productivity metrics such as yield per tree, tree density, and input utilisation
b. Income-related indicators, including total household income and progress toward living income benchmarks

Such frameworks will enable ongoing assessment of whether implemented interventions contribute meaningfully to reducing the true price gap and improving farmer livelihoods.

Taken together, these phased actions provide a structured pathway for addressing the key drivers of the true price gap identified in this study. By linking improvements in productivity, market access, and value chain coordination to measurable income outcomes, the roadmap offers a practical framework for translating True Cost Accounting insights into targeted interventions and investment opportunities within the avocado sector.

Over the longer term, the focus should shift toward scaling proven interventions and strengthening institutional structures that support sustained improvements in farmer income. At this stage, investment decisions should be guided by evidence generated through earlier pilot activities and their demonstrated impact on closing the true price gap.

10. INTERVENTION PRIORITISATION FRAMEWORK

10.1 Purpose and Context

The True Cost Accounting assessment identified a substantial true price gap within the avocado value chain, driven primarily by farmer under-earning. While Sections 9 and 10 outline strategic priorities and a phased roadmap for addressing these constraints, there remains a need to translate these insights into a more structured basis for decision-making.

This section presents a prioritisation framework designed to support stakeholders in identifying and sequencing potential interventions based on their expected contribution to improving farmer income, feasibility of implementation, and overall alignment with the drivers of the true price gap.

10.2 Approach to Prioritisation

Interventions are assessed against a set of practical criteria derived from the study findings and validation discussions. Given that under-earning is the dominant component of the true price gap, particular emphasis is placed on the extent to which proposed actions can improve income outcomes at farm level.

10.3 Prioritisation Criteria

- **Impact on income**

The extent to which the intervention directly improves farmer earnings through higher productivity, improved price realisation, or reduced losses.

- **Feasibility**

The practicality of implementation within the current institutional, technical, and market context.

- **Cost intensity**

The relative level of financial or organisational resources required to implement the intervention.

- **Time to impact**

The expected timeframe within which measurable results are likely to be observed.

- **Strategic relevance**

The degree to which the intervention addresses the core structural constraints identified in the value chain.

10.4 Intervention Matrix

Intervention	Constraints Addressed	Income Impact	Feasibility	Cost Intensity	Priority
Improved harvesting tools	Fruit loss and damage during harvesting	High	High	Low	High Priority
Farmer aggregation / clustering	Fragmented market access and weak bargaining power	High	Medium	Low	High Priority
Post-harvest handling improvements	Quality deterioration and spoilage	Medium–High	High	Low	High Priority
Basic sorting and grading	Price inefficiencies in local markets	Medium	High	Low	High Priority
Local aggregation points	Market coordination constraints	High	Medium	Medium	Moderate Priority
Small-scale value addition (e.g. oil extraction, processed products)	Limited value capture and price ceilings in raw fruit markets	High	Low-Medium	Medium - High	Moderate Priority
Export market development	Limited access to higher-value markets	High	Low	High	Long Term Priority

Table 6: Prioritised interventions based on income impact, feasibility and cost considerations

10.5 Interpretation of Results

The prioritisation indicates that the most immediate opportunities lie in low-cost, high-feasibility interventions that directly improve harvesting practices, reduce post-harvest losses, and strengthen farmer coordination. These interventions are likely to generate relatively quick improvements in income outcomes while requiring limited capital investment.

In contrast, more capital-intensive interventions—such as the development of aggregation infrastructure or export market linkages—remain important but are better positioned as medium- to long-term priorities. Their effectiveness is likely to depend on prior improvements in production consistency, quality, and coordination among producers.

10.6 Implications for Investment and Implementation

The framework suggests that early-stage interventions should focus on improving the efficiency of existing production and marketing systems rather than expanding production alone. Sequencing interventions in this manner may allow stakeholders to generate measurable improvements in farmer income while building the conditions necessary for more complex investments at later stages.

This approach also provides a structured basis for aligning future pilot initiatives, development programmes, and potential investment strategies with the key drivers of the true price gap identified in this study.

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APPENDIX A – STRUCTURE OF THE TCA CHECKLIST

1. Production System Characterisation

Objective: Establish the structural and agronomic baseline of the value chain.

- What crops are produced and in what combinations (mono vs mixed systems)?
- What production systems are used (rainfed, irrigated, agroforestry, wild harvest)?
- What is the average farm size, tree density, and age profile (for perennial crops)?
- What are the dominant agronomic practices (planting, pruning, pest control, harvesting)?
- What inputs are used (fertiliser, pesticides, labour, tools), and at what intensity?
- What are the key constraints affecting productivity (soil fertility, access to inputs, knowledge)?
- What is the yield potential vs actual yield gap?
- What proportion of farmers apply improved practices vs traditional methods?

2. Economic Performance & Viability

Objective: Assess whether production is economically viable and scalable.

- What are typical yields (per tree, per hectare)?
- What prices do farmers receive (seasonal variation, price dispersion)?
- What are the main cost components (labour, inputs, transport, losses)?
- What is the gross margin per farmer?
- What is the **net income per farmer from the crop**?
- How does this compare to **living income benchmarks**?
- What is the **true price gap (€/kg or ₦/kg vs farm-gate price)**?
- What are the key drivers of the gap:

    a. Low yields?
    b. Low prices?
    c. High costs?
    d. Post-harvest losses?

3. Environmental Impact Profile

Objective: Identify key environmental externalities and their drivers.

- What type of land is used (natural vegetation, cultivated land, mixed systems)?
- What are the land occupation characteristics (extent, intensity)?
- What water sources are used (rainfed vs irrigation)?
- What soil management practices are applied (mulching, fallowing, erosion control)?
- What agrochemicals are used and how frequently?

- What are the main quantified environmental cost drivers (e.g. climate change, land use)?

- Are impacts low due to low intensity, or efficient due to good practices?
- What happens to environmental impact under scale-up scenarios?
- Is there risk of:

    a. Land expansion?
    b. Soil degradation?
    c. Increased emissions?

4. Social & Livelihood Outcomes

Objective: Evaluate contribution to farmer welfare and socio-economic stability.

- What proportion of household income comes from the crop?
- What are the labour requirements (family vs hired labour)?
- Are there seasonal income fluctuations?
- Does income from the crop enable farmers to reach living income thresholds?
- What are secondary income sources, and how do they affect reliance on the crop?
- Does the crop:

    a. Stabilise income?
    b. Or remain supplementary?

- Are there:

    a. Gender dynamics in production and income control?
    b. Youth participation constraints?

5. Market Structure & Value Distribution

Objective: Understand how value is created, captured, and distributed.

- How do farmers sell their produce (farm-gate, traders, aggregators)?
- What market channels exist (local markets, urban markets, export)?
- Are there aggregation or cooperative structures?
- What is the price transmission structure along the value chain?
- Where is value concentrated (farm vs trader vs processor)?
- What are the key inefficiencies:

    a. Information asymmetry?
    b. Fragmented supply?
    c. Weak bargaining power?

- What proportion of produce meets:

    a. Market quality standards?
    b. Export requirements?

6. Post-Harvest Systems & Losses

Objective: Identify inefficiencies after production.

- What are the harvesting practices?
- How is produce handled, stored, and transported?
- Are there grading or sorting systems?
- What are post-harvest loss rates (%)?
- What causes losses:

    a. Poor handling?
    b. Transport delays?
    c. Lack of storage?

- What is the price penalty for poor quality?

7. Intervention Levers & Upgrade Pathways

Objective: Identify actionable areas for improving outcomes.

- What production improvements are feasible?
- What training or extension services are required?
- What market coordination mechanisms can be introduced?

Categorise interventions into:

A. Productivity Levers

- Improved planting material
- Orchard management
- Irrigation

B. Market Levers

- Aggregation systems
- Direct market linkages
- Pricing transparency

C. Value Addition

- Processing (e.g. oil, dried products)
- Quality grading systems

D. Institutional Support

- Cooperatives
- Extension services
- Financing mechanisms

8. Investment Readiness & Decision Questions

Objective: Translate TCA findings into investment logic.

- Is the value chain currently:
  - Viable?
  - Marginal?
  - Structurally constrained?
- Under what conditions does it become investable?
- What is the minimum intervention package required to close the true price gap?
- What is the expected return pathway:
  - Yield increase?
  - Price improvement?
  - Cost reduction?
- What risks must be managed:
  - Climate?
  - Market volatility?
  - Adoption risk?

9. Monitoring & Learning Framework

Objective: Enable longitudinal tracking and adaptive management.

Key Indicators:

Productivity

- Yield per tree / hectare
- Tree density
- Adoption of improved practices

Economic

- Farm-gate price
- Net income per farmer
- Income vs living income benchmark

Environmental

- Emissions per kg
- Land use per kg

Market

- Share of produce sold through structured channels
- Price variability

APPENDIX B – SURVEY INSTRUMENT

A.1 Overview

This appendix presents the structured data collection instrument used for the baseline assessment of avocado production in Southern Kaduna. The tool was administered by trained enumerators to capture farm-level production, income, cost, labour and environmental data required for the true pricing analysis.

The instrument was implemented digitally using a structured spreadsheet format. Questions were grouped into thematic modules to ensure consistency, minimise respondent burden and improve data reliability.

A.2 Instrument Structure

The survey instrument comprised the following modules:

Module 1 — Farmer Identification and Farm Profile

- Respondent ID
- Location (LGA, community)
- Farm size
- Number of avocado trees
- Age of trees
- Farming system type (mixed cropping, orchard, agroforestry)

Module 2 — Production and Yield

- Number of harvest cycles
- Quantity harvested per cycle
- Local measurement units used
- Conversion to kilogram equivalents
- Post-harvest loss estimates

Module 3 — Revenue and Sales

- Volume sold
- Farm-gate selling price
- Total avocado revenue
- Sales channels (trader, local market, direct buyer)

Module 4 — Cost Structure

- Fertiliser expenditure
- Agrochemical use
- Hired labour costs
- Equipment costs

- Transport costs

Module 5 — Labour Allocation

- Family labour inputs
- Hired labour inputs
- Seasonal labour variations
- Gender distribution of labour tasks

Module 6 — Environmental Practices

- Irrigation use
- Water sources
- Land preparation methods
- Soil management practices
- Agrochemical handling and disposal

Module 7 — Unit Conversions

- Standard weight equivalents for:

    a. Baskets
    b. Sacks
    c. Local containers

- Enumerator-supported conversion factors

A.3 Data Quality Controls

To ensure consistency and reliability:

- Enumerators received training on unit conversions and questionnaire administration.
- Local trade units were standardised using fixed weight equivalents.
- Built-in spreadsheet checks reduced entry errors.
- Field supervision ensured completeness of responses.

Primary data were collected using a structured survey instrument specifically designed to support farm-level True Cost Accounting analysis. The instrument was developed to capture quantitative production, income, and resource-use data required for modelling both social and environmental externalities.

The survey instrument was organised into interconnected modules to ensure internal consistency across production, income, and cost variables.

Income Module

The income module captured:

- Total household income across all livelihood activities

- Income attributable to avocado production
- Income from other crops and non-farm activities
- Seasonal income variation where applicable

This module was designed to enable comparison of total household income against a living income benchmark and to calculate the proportional contribution of avocado production to household earnings.

Yield and Production Module

Production-related variables included:

- Number of avocado trees under cultivation
- Estimated output per harvest cycle
- Number of harvest cycles per year
- Total annual production volume

In addition to yield data, the survey captured information on the land area dedicated to avocado production. Because avocado is frequently grown within mixed-cropping systems in Southern Kaduna, farmers were asked to estimate the portion of their cultivated land containing avocado trees. Where multiple crops were grown within the same plot, the area attributed to avocado production was estimated based on tree density and the approximate spatial share of avocado trees within the field. This estimation enabled the calculation of land occupation impacts within the True Price framework.

Farmers frequently reported output in fruit counts rather than weight. Enumerators applied a standardised field conversion protocol, estimating three large avocados as equivalent to one kilogram. This conversion was applied consistently across the dataset to enable per-kilogram modelling.

Revenue Module

The revenue module captured:

- Farm-gate sale price per unit
- Quantity sold
- Quantity retained for household consumption
- Sales channel (farm-gate, trader collection, local market)

This information enabled calculation of weighted average farm-gate prices and total avocado revenue per household.

Cost Module

Production costs captured included:

- Hired labour payments
- Basic input purchases (where applicable)
- Farm-level transportation expenses
- Other direct production costs reported by farmers

Household labour contributions were captured separately and not treated as a direct cash expense unless explicitly monetised by farmers.

Labour Module

The labour module documented:

- Household labour days allocated to avocado production
- Hired labour days
- Gender-disaggregated labour contributions where reported

This information provided contextual understanding of labour allocation within production systems.

Water Use Module

The water module recorded:

- Irrigation use (if applicable)
- Source of water
- Rain-fed reliance

Given that most surveyed farms were rain-fed, irrigation was limited in the sample; however, water use practices were documented for completeness.

Data Validation and Consistency Checks

Enumerators received pre-deployment training on:

- Unit standardisation
- Cross-checking production and revenue consistency
- Identifying internal reporting inconsistencies

During data processing, basic consistency checks were applied to:

- Ensure that reported revenues aligned with reported quantities and prices
- Identify outliers in yield or income reporting
- Confirm plausible production ranges

The final deployed survey instrument is included in Annex A.

2.5 Income Gap Calculation

The income-related social externality in this assessment is quantified as **"underearning"**, defined as the shortfall between a household's actual annual income and a living income benchmark, adjusted for household size. The underearning impact is expressed in monetary terms per kilogram of avocado produced (€/kg).

2.5.1 Living Income Benchmark Application

For each surveyed household, total annual household income was compared to a living income benchmark applicable to rural production conditions.

The benchmark was adjusted to reflect reported household size. This adjustment ensures that income sufficiency is assessed relative to household needs rather than applying a uniform income threshold across households of different sizes.

The household income gap was calculated as:

Household Income Gap

= Living Income Benchmark (adjusted) − Actual Household Income

Where actual household income exceeded the benchmark, the income gap was truncated at zero. In such cases, no income gap externality was recorded.

2.5.2 Revenue-Based Allocation to Avocado Production

Because surveyed households typically derive income from multiple activities, the full household income gap was not automatically attributed to avocado production.

Instead, the income gap was allocated proportionally based on avocado's contribution to total household income. The allocation factor was calculated as:

Avocado Revenue Share

= Avocado Revenue ÷ Total Household Revenue

The portion of the income gap attributable to avocado production was then calculated as:

Allocated Income Gap

= Household Income Gap × Avocado Revenue Share

This revenue-based allocation ensures that avocado production is assigned only the proportional share of the household income shortfall corresponding to its contribution to overall household income. Allocation was based on revenue rather than profit.

2.5.3 Conversion to Per-Kilogram Income Gap Impact

To express the income gap in comparable units, the allocated income gap amount was divided by total annual avocado output (in kilograms) per household:

Income Gap (€/kg)

= Allocated Income Gap ÷ Annual Avocado Output (kg)

At sample level, the income gap footprint indicator was calculated by aggregating allocated income gap amounts across households and dividing by total avocado output across the sample.

The resulting value represents the average income gap externality per kilogram of avocado produced within the surveyed cluster.

2.5.4 Modelling Boundaries and Assumptions

The income gap modelling assumes:

- Household income figures are annualised and reflect total revenue across livelihood activities.
- Avocado revenue share accurately represents the proportional economic contribution of avocado production.
- Production volumes reported by farmers are consistent with annual output.

The calculation does not imply that avocado production is solely responsible for household under-earning. Rather, it allocates the observed income gap proportionally within diversified livelihood systems.

2.6 Environmental Impact Modelling

Environmental externalities were estimated at farm level and expressed in monetary terms per kilogram of avocado produced (€/kg). The modelling approach links reported production data to environmental impact factors and applies monetisation coefficients to convert physical impacts into economic values.

The environmental impact categories included in this assessment are:

- Land occupation
- Greenhouse gas emissions
- Water use

The modelling is production-stage only and does not include downstream transport, storage, retail, or consumption impacts.

2.6.1 Yield and Production Basis

All environmental impacts were calculated relative to annual avocado output per household, expressed in kilograms.

Production volumes were derived from:

- Reported number of trees
- Reported output per harvest cycle
- Number of harvest cycles per year
- Standardised fruit-to-kilogram conversion protocol

Environmental intensities were calculated on a per-kilogram basis to allow comparability across households with different production scales.

2.6.2 Land Occupation

Land occupation impact was calculated based on:

- Reported area under avocado cultivation (hectares)
- Total annual avocado output (kg)

Land use intensity per kilogram was derived by dividing cultivated area by total production volume.

Land occupation (ha/kg)

= Area under avocado cultivation (ha) ÷ Annual avocado output (kg)

The resulting land intensity per kilogram was then monetised using established valuation coefficients within the applied modelling framework.

This approach assumes that land under avocado cultivation is fully attributable to avocado production during the reporting period.

2.6.3 Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions were estimated using proxy emission factors associated with:

- Transport to local markets
- Reported input use (where applicable)

Given the predominantly low-input, smallholder production systems observed in the sample, emissions were primarily driven the impact of fuel use as well as pesticide and fertilizer use.

Emission intensity per kilogram was derived from production data and converted into monetary values using standard social cost factors embedded within the modelling framework.

No direct field measurement of emissions was conducted.

2.6.4 Water Use

Water use modelling distinguished between:

- Rain-fed production
- Irrigated production (where applicable)

Most surveyed farms relied primarily on rainfall. Where irrigation was reported, water use was captured through the survey instrument.

Water use per kilogram was calculated relative to production volumes and monetised using established water valuation factors within the modelling framework.

2.6.5 Monetisation and Aggregation

For each impact category:

a) Physical intensity per kilogram was calculated at household level.
b) Monetisation factors were applied to convert physical impacts into €/kg values.
c) Household-level results were aggregated to derive a sample-level average environmental externality per kilogram.

All monetisation factors applied are embedded within the modelling framework provided for this assessment and were not independently derived within this study.

Global monetisation were applied using the True Price Foundation Monetisation Factors for True Pricing adjusted for inflation based on the local currency (naira). The only country-specific monetisation factor was applied for the impact of scarce water use - linked to scarcity factors derived from WWF[5].

2.6.6 Modelling Boundaries and Assumptions

The environmental modelling assumes:

- Reported land area and production volumes are accurate.
- Fruit-to-kilogram conversion is applied consistently.
- Production conditions during the reporting period are representative of annualised output.
- Emission and valuation factors are appropriate proxies for smallholder production systems.

The analysis does not include:

- Soil nutrient depletion beyond land occupation proxy
- Downstream transport emissions
- Post-harvest losses

Environmental results should therefore be interpreted as production-stage externality estimates within defined modelling boundaries.

[5] For more information see the True Price module here: https://www.truepricefoundation.org/publications/scarce-water

2.7 Limitations and Assumptions

This assessment applies a structured modelling framework to estimate selected social and environmental externalities at farm level. As with all model-based analyses, the results are subject to defined limitations and underlying assumptions.

2.7.1 Self-Reported Data

Production volumes, income, land area, and cost information were self-reported by farmers. While enumerator training and internal consistency checks were applied, no independent verification of reported figures (e.g., field measurement, financial records) was conducted.

As such:

- Yield estimates may be subject to recall bias.
- Income reporting may be affected by seasonality or aggregation of multiple income streams.
- Land area estimates may be approximate rather than survey-measured.

2.7.2 Unit Conversion Assumptions

Farmers frequently reported production in fruit counts rather than weight. A standardised field conversion (three large avocados per kilogram) was applied consistently across the dataset.

Variability in fruit size introduces sensitivity in per-kilogram calculations. Under- or over-estimation of average fruit weight will proportionally affect:

- Yield per hectare
- Income per kilogram
- Land occupation intensity
- Income gap per kilogram

This conversion assumption is a key modelling parameter.

2.7.3 Living Income Benchmark Application

The income gap calculation relies on comparison between reported household income and an adjusted living income benchmark.

Results are sensitive to:

- Accuracy of household income reporting
- Household size reporting
- Benchmark calibration for rural conditions

The model allocates income gap proportionally based on revenue share. It does not assume that avocado production alone causes household income insufficiency.

2.7.4 Yield Sensitivity

Environmental intensities (particularly land occupation per kilogram) are highly sensitive to reported production volumes.

Lower reported yields mechanically increase per-kilogram land occupation intensity and associated monetised environmental costs. Conversely, higher yields reduce per-kilogram intensities.

No independent yield measurement was conducted; the model assumes reported production volumes reflect typical annual output.

2.7.5 Sampling Limitations

The study uses a purposive, cluster-based sample of 150 farmers within Southern Kaduna. The findings provide structured insight into the surveyed cluster but are not statistically representative of Kaduna State or Nigeria as a whole.

Variations in agro-ecological conditions, orchard maturity, and market access across regions may result in different true price outcomes.

2.7.6 Monetisation Assumptions

The assessment applies the global Monetisation Factors for True Pricing by the True Price Foundation (2025). These factors estimate the remediation costs associated with environmental and social impacts, encompassing restoration, compensation, prevention, and retribution.

To estimate monetisation factors. The Principles for True Pricing document defines the principle of remediation that monetization can be based on. The monetisation factors require normative assumptions and interpretation, and significant uncertainties exist in the estimates of restoration, compensation, prevention and retribution costs[6].

The full machine-readable instrument is available as a supplementary Excel file upon request.

[6]https://www.truepricefoundation.org/wp-content/uploads/2025-Monetisation-Factors-for-True-Pricing_v4.pdf

APPENDIX C – KEY ASSUMPTIONS

This appendix summarises the principal assumptions applied in the true pricing analysis. These parameters influence income allocation, environmental impact estimation and monetary conversion processes. Documenting these assumptions enhances transparency and enables reproducibility of results.

C.1 Income Modelling Assumptions

Parameter	Value Used	Rationale	Source
Living income benchmark		Benchmark used to estimate income gap	Anker Research Institute
Income allocation method	Revenue-based allocation	Allocates household income gap proportionally to avocado revenue share	True Price framework
Household income recall period	12 months	Captures full agricultural cycle	Survey design
Currency base year	2025[7] €	Standardises comparisons	Study protocol

C.2 Production & Yield Assumptions

C.2.1 Trade Unit Weight Estimation Assumptions

Avocado transactions within the study area commonly occur using local trade units rather than standardised weight measures. These include baskets, painter buckets, retail heaps and repurposed grain sacks. Because weighing facilities were not available at the point of transaction, kilogram equivalents were estimated using visual enumeration methods.

Average fruit weight was approximated using field consensus indicating that three large avocados are equivalent to approximately one kilogram, implying an average fruit weight of approximately 0.33 kg.

Trade unit weights were then estimated through visible fruit counts derived from field photographs taken during data collection. Estimated fruit counts were multiplied by the assumed average fruit weight to obtain indicative kilogram equivalents.

These estimated weights were used solely for analytical standardisation and price comparability within the modelling framework. They do not represent laboratory measurements and may vary depending on fruit size and packing density.

[7] Monetisation factors and all results are expressed in 2025 euros (using conversion factor Conversion rate naira to euro (0.0005841) source: https://www.exchange-rates.org/exchange rate-history/ngn-eur-2025

Parameter	Value Used	Rationale	Source
Avocado weight conversion	3 large fruits = 1 kg	Derived from field validation	Field survey
Basket weight equivalent	[5kg]	Standardised for enumerator consistency	Field piloting
Sack weight equivalent	[30 kg]	Standardised for enumerator consistency	Field piloting
Production stage boundary	Farm-gate only	Excludes downstream logistics impacts	Study scope

Estimated Trade Unit Weight Equivalents

Trade Unit	Estimated Fruit Count	Implied Weight (kg)	Estimation Basis
Basket	~30 fruits	~10 kg	Visual count × average fruit weight
Painter bucket	~15 fruits	~5 kg	Visual count × average fruit weight
Retail heap	~8 fruits	~2.6 kg	Visual count × average fruit weight
Sack	~90 fruits	~30 kg	Layered visual estimation × fruit weight

C.3 Financial & Conversion Assumptions

Parameter	Value Used	Rationale	Source
Exchange rate	₦1,652 per €	Average during analysis period	Central Bank data
Price baseline	Farm-gate price	Aligns with production boundary	Study design
Retail prices	Contextual only	Not used in modelling baseline	Market survey

C.4 Environmental Modelling Assumptions

Parameter	Value Used	Rationale	Source
Emission factors	Standard True Price dataset	Ensures comparability across studies	True Price database
Land occupation factor	Standard dataset	Monetises land-use impact	True Price database
Water use modelling	Rain-fed baseline	Reflects farmer practices	Survey findings
Agrochemical intensity	Low-input profile	Based on survey responses	Field data

ANNEX D- CONTEXTUAL FINDINGS FROM FIELD DATA

This section presents descriptive findings derived from the survey of 150 avocado-producing households in Southern Kaduna. The purpose is to characterise the production systems, income structures, and operational realities observed in the field before introducing any monetised modelling results. The analysis in this section is descriptive only.

D.0 Key Input and descriptive statistics

	Value	Notes
Number of surveyed farmers	150	Full survey sample
Average number of avocado trees per farm	7.8	Range: 2–70 trees
Average total annual avocado harvest per farm	439.5 kg	Range: 0–4,300 kg
Average yield per tree	67.1 kg/tree	Range: 0–210 kg/tree
Average total farm size	0.79 ha	Range: 0.07–3.00 ha
Average area under avocado	0.21 ha	Range: 0.07–2.00 ha
Average household size	7.6 persons	Includes farmer
Average share of household farm income from avocado	14.3%	Range: 0–80%

D1 Farmer Typology

The surveyed farmers operate within smallholder, mixed-livelihood systems in which avocado cultivation is integrated into broader agricultural activity. Avocado is rarely cultivated as a monoculture enterprise. Instead, it forms part of diversified farming structures that commonly include staple crops and other seasonal produce.

Production is largely household-managed. Labour inputs are drawn primarily from family members, with hired labour used selectively during harvest or peak activity periods. Mechanisation is limited, and management practices reflect low-input systems typical of smallholder contexts.

Avocado production functions differently across households. For some farmers, it represents a supplementary income stream that complements other crop activities. For others, particularly those with more mature orchards, avocado contributes a substantial share of annual agricultural revenue. This variation in production intensity and economic dependence is a defining structural feature of the sample.

D2. Farm Size Distribution

Land under avocado cultivation varies across households, though the majority of producers operate on relatively modest land areas. Avocado plots are often embedded within mixed-use farmland rather than clearly demarcated commercial orchards.

Smaller-scale producers typically cultivate avocados on fractions of a hectare or in dispersed tree clusters within multi-crop systems. A smaller subset of farmers maintain more concentrated orchard areas, reflecting either earlier adoption, stronger market orientation, or better land access.

The distribution of cultivated area indicates that avocado production in the surveyed cluster remains predominantly small-scale, with production volumes closely tied to landholding size and orchard maturity rather than intensive input application.

D3 Yield Distribution

Annual avocado output exhibits significant variability across the sample. Differences in production volumes are associated with orchard age, tree density, maintenance practices, and environmental conditions.

Some households report relatively low annual output, reflecting younger trees or dispersed cultivation. Others demonstrate substantially higher output levels, consistent with more mature orchards or higher tree counts.

Because production is primarily rain-fed and minimally mechanised, yield variability is influenced by seasonal conditions and natural growth cycles. The distribution of yields within the sample is therefore uneven, with a concentration of lower-output producers and a smaller group contributing disproportionately higher volumes.

This heterogeneity in production levels has implications for both income distribution and environmental intensity calculations, though those implications are not explored in this section.

D4 Revenue Composition

Household income in the surveyed cluster is diversified. Avocado revenue represents one component of total annual household income rather than the sole source.

The contribution of avocado income to total household revenue varies across households. For some producers, avocado constitutes a minor proportion of total earnings, functioning as a complementary income source. For others, particularly those with higher production volumes, avocado represents a significant share of agricultural income.

Non-avocado income streams commonly include other crop cultivation and, in some cases, non-farm activities. This diversified income structure is central to understanding the proportional allocation logic applied later in the modelling section.

The observed variation in revenue composition reinforces that avocado production plays different economic roles across households within the same geographic cluster.

D5 Labour Patterns

Avocado cultivation relies primarily on household labour. Family members contribute to land preparation, maintenance, and harvesting activities. Hired labour is used selectively, typically during harvest periods or where orchard size exceeds household labour capacity.

Labour demand is seasonal rather than continuous. Peak labour intensity corresponds with harvest cycles, while maintenance activities are less labour-intensive.

Gender-disaggregated labour contributions, where reported, indicate that household labour allocation is shared across members, though the degree of participation varies by household structure.

The limited reliance on mechanisation and the predominance of family labour are defining characteristics of the production system.

D6 Input Usage Patterns

Input intensity across the sample is generally low. Production systems are predominantly rain-fed, with limited reported use of irrigation infrastructure. Fertiliser application and other purchased inputs are not uniformly adopted across households.

This low-input structure suggests that production expansion is more closely linked to land area and tree maturity than to chemical or technological intensification.

Transport costs at farm level are incurred primarily where produce is moved to collection points or local markets. Mechanised operations are minimal.

D7 Post-Harvest Losses

Farm-level post-harvest losses are reported through farmer recall. Losses occur due to spoilage, pest damage, delayed sale, and unsold produce. The magnitude of reported losses varies across households.

Given the absence of structured cold-chain systems and limited storage infrastructure, post-harvest losses represent an operational constraint within the production cluster. These losses are recorded descriptively in this section and are not monetised here.