

# Tomato Post-Harvest Handling Practices and Farmers' Welfare in Tarka Local Government Area of Benue State, Nigeria

Mnena Franca Tughgba

Centre for Food Technology and Research (CEFTER),  
Rev. Fr Moses Orshio Adasu University (formerly, Benue State University), Makurdi

## Abstract

*This study examined the relationship between tomato post-harvest handling practices and farmers' welfare in Tarka Local Government Area of Benue State, Nigeria. A descriptive survey design was adopted, and data were collected from 384 tomato farmers selected through a multistage sampling technique involving purposive and random sampling. A structured questionnaire was used for data collection. Data were analyzed using Structural Equation Modeling (SEM) to assess both the measurement and structural components of the model. The results revealed that education had a significant positive effect on the welfare of farmers, while household size exhibited a significant negative effect. In contrast, age and farm size were statistically insignificant, indicating that these factors do not meaningfully influence welfare outcomes. However, distance to market had a significant negative effect, suggesting that farmers located farther from markets experience lower welfare due to higher transaction costs and reduced access to buyers. Among the postharvest variables, storage practices ( $\beta = 0.995$ ,  $p < 0.001$ ) showed the strongest and most significant positive influence on farmers' welfare, followed by sorting practices ( $\beta = 0.050$ ,  $p < 0.001$ ). These findings demonstrate that improvements in storage efficiency, product sorting, and proximity to markets significantly enhance farmers' income, reduce losses, and improve living standards. Accordingly, the study recommends that policies should prioritize farmer education, targeted training in sorting and storage practices, and the strengthening of agricultural extension services to promote postharvest quality preservation, minimize losses, and enhance the overall welfare and resilience of tomato farmers in Benue State.*

**Keywords:** Farmers' welfare, post-harvest handling practices, storage practices, sorting practices, tomato,

## Introduction

The post-harvest phase of agricultural production represents a critical segment in the global food value chain, serving as a key determinant of food security and the welfare of farming households (Tiwari et al., 2020). For perishable crops such as tomatoes (*Solanum lycopersicum*), poor handling, inadequate sorting and packaging, insufficient storage, and inefficient transportation systems frequently result in substantial quantitative and qualitative losses from field to consumer. Studies in smallholder systems reveal that mechanical damage, bruising, decay, and inappropriate storage significantly reduce marketable produce, thereby diminishing farmers' income and overall welfare (Gokul & Korsten, 2025; Deribe, et al., 2019). Consequently, efficient post-harvest handling practices such as sorting, grading, and proper storage have been increasingly recognized as pivotal in strengthening food systems, improving farmer income, and promoting rural welfare.

Across Africa, post-harvest inefficiencies are aggravated by infrastructural deficits, high transaction costs, and limited access to affordable post-harvest technologies (Ambika & Dawadi, 2022). Smallholder farmers reportedly lose between 30% and 50% of fruits and vegetables annually, reflecting not only wasted food but also lost income and deteriorating household welfare. Socio-economic barriers including education, household size, farm size, and limited financial capacity further constrain the adoption of improved handling techniques. Empirical evidence from Uganda shows that insufficient technical knowledge and weak institutional support significantly impede farmers' ability to reduce losses and sustain livelihoods (Babirye Magala et al., 2024). These findings emphasize that post-harvest management is a vital nexus between production efficiency and farmer welfare across developing economies.

In Nigeria, tomato production forms a crucial component of the horticultural sub-sector, contributing significantly to domestic consumption, employment, and agro-processing. However, the tomato value chain is typified by high post-harvest losses, poor sorting and grading, limited storage infrastructure, and weak market linkages (Tughgba, 2024; Korie et al., 2024). Despite its potential, inadequate adoption of modern post-harvest technologies such as plastic crates and cooling systems continues to constrain farmer profitability and welfare due to high costs, poor accessibility, and limited extension services (Korie et al., 2024). In Benue State, these challenges are particularly pronounced. The Tarka Local Government Area (LGA), a major tomato-producing zone, presents a unique context to examine how farmers' socio-economic characteristics, sorting and storage practices collectively influence welfare outcomes (Tughgba, 2024; Beeior et al., 2025).

Despite growing recognition of post-harvest losses, most existing studies focus on loss percentages or monetary estimates, often neglecting the intricate relationship between specific handling practices and farmers' welfare (Adhikari & Aarati, 2021; Ambika & Dawadi, 2022). Empirical research linking sorting, grading, and storage to measurable welfare outcomes particularly at the local government level is sparse. This gap limits the ability of policymakers and extension services to design context-specific interventions that effectively improve farmer welfare. Understanding how socio-economic attributes such as education, household size, and farm experience mediate the welfare effects of post-harvest handling is critical to designing targeted and inclusive policy responses.

Tomato production, as a major livelihood activity in rural Nigeria, should ideally benefit from efficient post-harvest handling that minimizes losses, sustains quality, and maximizes market returns. In advanced agricultural systems, post-harvest management is supported by cold-chain infrastructure and institutional frameworks that ensure high product quality and farmer profitability (Gokul & Korsten, 2025). Conversely, smallholder farmers in developing countries often suffer from inadequate sorting, grading, and storage facilities, resulting in over 40% losses in perishable produce annually (Ambika & Dawadi, 2022). Empirical evidence from South Africa, Uganda, and Tanzania explains that farmers' knowledge and handling proficiency directly affect food safety, product value, and income levels (Beharielal, et al., 2022; Babirye Magala et al., 2024). Nevertheless, limited studies have integrated socio-economic determinants and specific post-harvest practices into welfare-focused analyses.

In Nigeria, while tomato production contributes substantially to rural livelihoods, post-harvest inefficiencies remain a major threat to income and food security (Ohagwu, et al.,

2022; Korie, et al., 2023). Research in Benue State has largely emphasized production and marketing, with minimal focus on post-harvest handling and its welfare implications. Furthermore, existing works rely heavily on descriptive statistics, rarely applying advanced econometric techniques capable of linking socio-economic and technical factors to welfare outcomes (Ocholi, et al., 2020; Adekunle & Adebayo, 2019; Tijani, 2022).

The present study addresses these gaps by integrating multiple analytical approaches to examine the complex interrelationships among socio-economic characteristics, sorting and storage practices, and welfare outcomes among tomato farmers in Tarka LGA, Benue State. The research employs descriptive analysis, multiple regression, and binary probit models to assess how these factors jointly influence welfare indicators such as income, output, and living standards. This multidimensional approach advances the understanding of post-harvest handling within a local Nigerian context and contributes novel empirical evidence to the discourse on agricultural productivity and rural welfare. Accordingly, the study aims to:

- i- Assess the influence of socio-economic characteristics of tomato farmers on their welfare in Tarka LGA, Benue State.
- ii- Examine the effect of sorting practices on farmers' welfare.
- iii- Determine how storage practices influence farmers' welfare.

## Literature Review

### Conceptual Clarifications

**Tomato post-harvest:** Post-harvest handling denotes the interval from harvest to ultimate consumption or processing. This phase is critical for tomatoes due to their extreme perishability, resulting in losses both quantitatively (in weight or volume) and qualitatively (in marketability and nutritional content). As reported by the FAO (2023) and Akpan et al. (2024), significant quantities of tomato production in low- and middle-income nations are lost or deteriorated during post-harvest phases. These losses stem from a confluence of physical, biological, and institutional variables that impede efficient post-harvest management.

**Tomato handling practices:** Post-harvest handling procedures for tomatoes are essential for preserving fruit quality and reducing losses, especially in the Tarka Local Government Area (LGA) in Benue State, Nigeria. The processes encompass the harvesting, sorting, packing, storage, and transportation of tomatoes, utilizing either conventional or modern methods. Harvesting tomatoes at the ideal maturity stage is crucial for preserving quality and prolonging shelf life (Arah et al., 2016). Hand picking, a fundamental process, is described as the manual extraction of mature, marketable tomatoes from the plant. This approach may mitigate bruising and degradation, but its efficacy in Nigeria is contingent upon factors such as timing, labor, and training (FAO, 2011). Color and size grading guarantees that tomatoes conform to market standards, enhancing their longevity and economic worth. Nonetheless, smallholder farmers in Nigeria encounter difficulties in adopting uniform grading processes, leading to irregular methods and post-harvest losses (Olayide, 2024). Culling, the elimination of damaged or diseased fruits, is a crucial activity that inhibits the proliferation of rot and enhances the quality of the remaining produce (USDA, 2013). In Nigeria, cultural standards may result in the preservation of marginal fruits, hence aggravating losses (Ohagwu et al., 2024; Olayide, 2024). In this study, tomato handling encompasses all operations related to post-harvest crop management, including sorting, grading, packaging, storage, and

transportation, with the objectives of preserving quality, minimizing losses, and enhancing the income and living standards of farmers.

**Farmers' Welfare:** The welfare of farmers is a multifaceted notion that includes economic, social, and environmental aspects. It is typically represented by indicators like as income, output, and quality of life. Globally, researchers such as Waarts et al. (2021) explain the significance of attaining a living income, which allows farmers to secure a respectable level of life, encompassing sustainable production and ethical procurement. Research conducted by Aremu et al. (2025) and Watema (2025) in Nigeria examines the effects of agricultural extension services and non-farm income on household welfare, respectively. These studies indicate that access to extension services and diversification into non-agricultural industries can improve farmers' income and overall well-being. The convergence of these approaches acknowledges that farmers' welfare is influenced not only by income but also by access to services, market opportunities, and the capacity to attain a satisfactory level of living. Divergence exists in the emphasis on various areas; for example, international studies frequently explain the notion of a livable income, whereas Nigerian research concentrate more on income diversification and access to services. This study defines farmers' welfare as the capacity of farmers to attain a respectable quality of living through sustainable agricultural techniques, facilitated by sufficient revenue, access to services, and chances for economic diversification. This definition incorporates the three indicators of income, output, and standard of living, consistent with the study's aims.

### **Theoretical Framework**

The theory of Welfare Economics, or Traditional Welfare Theory, was formulated by Arthur C. Pigou in the early 20th century. This theory analyzes the welfare of people and communities in relation to economic resources, consumption, and distribution. It pertains to the wellbeing of farmers by emphasizing factors such as income, living standards, and social security. The idea is important in evaluating the impact of alterations in agricultural practices or policy on farmers' economic welfare. Its efficacy is rooted on its quantitative methodology for assessing welfare alterations and disparities, rendering it valuable for appraising the effects of post-harvest techniques on farmers' welfare. Nonetheless, the theory's limitation lies in its singular emphasis on economic indicators, potentially neglecting psychological, social, and environmental dimensions of welfare. The Welfare Economics Theory is pertinent to this study as it facilitates the examination of how socio-economic factors such as education, age, and farm size influence farmers' income and welfare. Consequently, by examining sorting techniques (such as handpicking and grading) and storage methods (e.g., basket storage), the theory elucidates how these practices affect economic outcomes, including farmers' revenue and living standards. Additionally, it offers a framework to evaluate how modifications in farmers' practices result in enhancements in welfare, enabling the study to quantify the economic effects of post-harvest handling procedures on farmers in Tarka LGA, Benue State.

### **Empirical Review**

A growing body of research has examined the influence of handling practices on tomato quality and post-harvest losses, emphasizing how improper handling contributes to significant economic and nutritional waste. Atsor and Manguts (2024) investigated the handling practices

of fresh tomatoes in Benue State, revealing that poor harvesting, challenging transportation, inadequate storage facilities, and exposure to harsh environmental conditions significantly escalate post-harvest losses. Their descriptive survey showed that farmers often harvested tomatoes either prematurely or overripe, lacking proper storage and transport mechanisms factors that hastened deterioration. The authors concluded that improved handling infrastructure and value addition could mitigate losses and enhance farmer income. Similarly, Ambika and Ebha (2022) conducted a global review of tomato post-harvest handling practices, identifying harvesting, precooling, sorting, grading, packaging, storage, and transportation as major determinants of tomato quality and shelf life. Their findings confirmed that inefficient handling contributes to 20–50% losses in developing countries, stressing the role of efficient post-harvest management in improving both food security and farmer revenue. While insightful, their review depended primarily on secondary data, lacking empirical evidence directly linking improved practices to welfare outcomes.

Complementary experimental studies further emphasize the technical aspects of post-harvest management. Makonnen Tolasa (2021) found that appropriate harvesting stages and pre-storage treatments such as calcium chloride and cactus mucilage significantly extend tomato shelf life and maintain market quality. Likewise, Moneruzzaman et al. (2009) demonstrated that optimal harvesting and storage conditions substantially preserve the physical and chemical integrity of tomato fruits, while Hurst (2010) explained the necessity of proper sanitation and handling during post-harvest operations to minimize spoilage. Although these studies highlight the importance of post-harvest techniques for maintaining product quality, they generally overlook the broader socio-economic implications for farmers' livelihoods. Thus, a critical gap persists in connecting the technical dimensions of post-harvest management to welfare outcomes among smallholder farmers.

The intersection between socio-economic attributes and post-harvest performance has been widely acknowledged in empirical literature. Ashinya, et al. (2021) examined post-harvest losses of tomatoes and pumpkins among women farmers in Benue State and found that education, income, marital status, and farming experience significantly influenced the level of losses, while age and savings had no notable effect. The study explained the importance of socio-economic characteristics in determining farmers' post-harvest efficiency, recommending targeted education and infrastructural support to alleviate losses. However, the study's cross-sectional design restricted causal inference. In a related study, Ifabiyi (2014) analyzed tomato farmers' adoption of post-harvest value addition technologies in Oyo State, Nigeria, revealing that educational attainment, cooperative participation, and access to extension services were critical factors influencing technology adoption. Similarly, Adepoju (2014) found that post-harvest losses in Ogbomosho had a direct negative effect on farmers' income and well-being, emphasizing the potential welfare gains from improved handling practices. Comparable insights were offered by Anang, et al. (2013) in Ghana, who reported that limited market access and substandard agricultural practices hindered competitiveness in tomato production. These findings collectively suggest that post-harvest outcomes are not merely a function of technical practices but are deeply embedded in farmers' socio-economic realities such as education, access to finance, and institutional support. However, most of these studies used descriptive or regression-based analyses without employing integrative frameworks that jointly assess how these factors influence multidimensional welfare outcomes.

Beyond handling and socio-economic determinants, the adoption of modern technology and market integration also substantially shape welfare outcomes. Ni Putu Lisa Ernawatiningsih et al. (2023) found that information technology adoption enhances agricultural productivity and farmer welfare by improving decision-making, although the study lacked sample clarity and contextual detail. Similarly, Vishal et al. (2014) reviewed post-harvest technologies for fruits and vegetables, showing that modern storage and transportation methods significantly reduce losses and boost food security. However, their work, did not empirically evaluate how these interventions translate into welfare improvements.

Studies outside Africa have also linked technological access and market dynamics to farmer well-being. Allo et al. (2018) analyzed rising food prices in Indonesia and observed that income, regional disparities, and production reliance strongly influenced welfare responses. Sugiana et al. (2018) evaluated farmers' welfare in Denpasar using the Farmers' Terms of Trade Index (FTTI) and found that welfare was largely determined by land ownership, business scale, and family labor contributions. While these studies contribute to understanding the structural factors shaping welfare, they focus predominantly on macroeconomic determinants rather than the micro-level dynamics of post-harvest handling in perishable crops like tomatoes. Studies focusing on the quality and preservation of tomatoes also provide indirect insights into welfare outcomes. Arah et al. (2015) synthesized pre- and post-harvest factors affecting tomato quality and found that appropriate harvesting, sorting, packaging, and cold storage significantly improve shelf life and quality. Similarly, experimental studies such as those by Makonnen Tolasa (2021) and Moneruzzaman et al. (2009) demonstrate that improved pre-storage treatments and handling conditions extend product life. However, these works largely address quality outcomes rather than farmers' welfare. The focus on biophysical quality parameters, without integrating socio-economic welfare measures such as income, living standards, or output, represents a critical limitation.

At the farm level, Herrera Sabillón et al. (2021) examined European farmers' well-being and found that financial status, work hours, and social involvement affected subjective happiness but explained only a small share of overall welfare variance. Similarly, Babatunde (2008) reported substantial income inequality among Nigerian rural households, shaped by socio-economic factors. Although both studies contribute to the broader discourse on welfare, they do not contextualize these insights within the post-harvest management framework leaving an empirical vacuum in understanding how post-harvest practices, particularly in perishable crops, directly affect welfare outcomes in developing contexts.

A synthesis of existing empirical evidence reveals several critical gaps that justify the present study. While prior studies (Atsor & Manguts, 2024; Ambika & Ebha, 2022; Ashinya et al., 2021) have identified key determinants of post-harvest losses and socio-economic factors affecting tomato handling, most of these studies conceptualize welfare narrowly focusing primarily on income or market access as sole indicators of well-being. Few studies have examined welfare as a multidimensional construct encompassing income, productivity, and living standards simultaneously. Moreover, much of the existing literature relies on descriptive or cross-sectional methods, which, though informative, lack the analytical depth to capture complex relationships among handling practices, socio-economic characteristics, and welfare outcomes. Furthermore, research has largely focused on either the technical aspects of post-harvest management (Hurst, 2010; Moneruzzaman et al., 2009) or socio-economic

determinants (Adepoju, 2014; Ifabiyi, 2014), with limited integration of both dimensions in a single analytical model. Empirical evidence from Nigeria, particularly at the subnational level such as Tarka LGA in Benue State, remains scarce. This absence of localized, mixed-method evidence restricts the formulation of context-specific policy and extension strategies.

The present study therefore fills this gap by adopting an integrated analytical framework that combines quantitative and qualitative approaches to examine how socio-economic characteristics, sorting and storage practices jointly influence farmers' welfare. By operationalizing welfare through income, output, and living standard indices, this research provides an understanding of how post-harvest handling practices affect farmer well-being within the localized context of Tarka LGA, Benue State.

### Methodology

**Research Design:** The research employed a descriptive survey design. This design is appropriate as it facilitates the gathering of data from tomato farmers to elucidate their post-harvest handling techniques, identify problems, and evaluate the impact of these practices on their welfare. The survey method provides both quantitative and qualitative insights, allowing the researcher to examine patterns, linkages, and limitations within the studied area.

**Study Area:** The research was performed in the Tarka Local Government Area (LGA) in Benue State, Nigeria. Tarka LGA is situated in the North-Central geopolitical zone and is recognized for its significant agricultural output, especially in tomato production. The region is situated in the guinea savannah zone, distinguished by conducive climatic conditions for tomato cultivation, encompassing fertile soils and moderate precipitation. The local population predominantly participates in agriculture, with tomatoes constituting a significant cash and food crop.

**Sample and Sampling Techniques:** The sample size was established using Cochran's formula because the total number of farmers was unknown, ensuring the study sample's representativeness and statistical reliability.

$$n_0 = \frac{z^2 p(1-p)}{e^2}$$

Z = z-value at your confidence level (1.96 for 95% confidence), p = expected proportion (0.5 if unknown; it gives the maximum, most conservative  $n_0$ ), and e = desired margin of error (0.05 for  $\pm 5\%$ ). Substituting the values, we have; Z=1.96, p = 0.5, e=0.05

$$n_0 = \frac{1.96^2 0.5(1-0.5)}{0.05^2}$$

$$\frac{0.9604}{0.0025}$$

$$= 384.16$$

$$= 384$$

A multistage sampling method was utilized. In the initial phase, five prominent tomato-producing villages were deliberately chosen based on production intensity. In the second stage, basic random sampling was employed to select 78 respondents from each community in equal proportions.

**Method of Data Collection:** Primary data was obtained through a standardized questionnaire distributed to tomato cultivators. The questionnaire had closed-ended questions structured in alignment with the study's unique aims. Trained enumerators proficient in English and Tiv facilitated the administration of the devices to guarantee clarity and precision of responses.

**Validity and Reliability of Instrument:** The questionnaire's content validity was confirmed by expert evaluation by agricultural economists and postharvest professionals. Their recommendations facilitated essential adjustments to guarantee the instrument precisely assesses the relevant constructs. A pilot test was conducted on 10% of the sample size to assess the instrument's dependability. The questionnaire's reliability was assessed using Cronbach's Alpha coefficient, yielding a value of 0.84, deemed adequate for internal consistency.

**Structural Equation Modelling (SEM) Specification:** The proposed Structural Equation Model (SEM) for this study was designed to examine the interrelationships between tomato post-harvest handling practices and the welfare of tomato farmers in Tarka Local Government Area of Benue State. The SEM framework integrates both the measurement model and the structural model, linking latent constructs through their observed indicators and estimating causal relationships among latent variables. The model comprises four latent variables (constructs). This include, Storage Practices (ST), Sorting Practices (SP), and Farmers' Welfare (WF). The first three latent variables (ST, SP, and PK) serve as exogenous constructs (independent variables), while Farmers' Welfare (WF) is treated as the endogenous construct (dependent variable). Additionally, the welfare construct is influenced by a set of observed socio-economic characteristics (SC1-SC5), which act as control variables in the model.

**Measurement Model Specification:** For the latent variable 1 [Storage Practices (ST)], the construct captures the extent and quality of tomato storage behavior among farmers. It is measured using five (5) observed indicators: ST1: Average duration of tomato storage before sale, ST2: Quantity of tomatoes stored per season, ST3: Average expenditure on storage materials or facilities, ST4: Storage capacity available, and ST5: Size of the farm. The CFA results indicate strong factor loadings for the indicators, ranging from 0.705 to 0.998, demonstrating high internal consistency and convergent validity. The highest loading was recorded for ST4 (0.998), suggesting that storage capacity available is the most dominant indicator of farmers' storage practices. ST2 (0.705) showed the least loading, implying moderate contribution, possibly due to variability in seasonal production and resource constraints.

For the latent variable 2 [Sorting Practices (SP)], sorting practices reflect the farmers' engagement in sorting and grading tomatoes to enhance market quality. It is represented by three (3) observed indicators: SP1: Removing damaged or rotten fruits before harvesting, SP2: Grading tomatoes by size or quality before selling, and SP3: Removing diseased fruits before packing for sale. The standardized factor loadings for sorting practices were very high, ranging between 0.986 and 0.988. These near-unity coefficients indicate exceptional internal reliability and construct validity. This suggests that all indicators strongly reflect the underlying latent construct, with SP1 (0.988) marginally leading in its contribution.

For the latent variable 3 [Farmers' Welfare (WF)], farmers' welfare is the dependent construct and is conceptualized as a multidimensional measure of economic well-being and

quality of life resulting from tomato production. It is measured through three (3) observed indicators: WF1: Average monthly income from tomato farming (in Naira), WF2: Total number of tomatoes produced per farming season (in baskets), and WF3: Perceived improvement in standard of living due to tomato farming. The factor loadings for WF range between 0.750 and 0.964, signifying strong convergent validity. The indicator WF2 (0.964) contributes most strongly, showing that production output is the best single predictor of welfare among farmers. WF3 (0.750), though significant, contributes moderately, which may reflect subjective variation in farmers' perceptions of improved living standards.

**Structural Model Specification:** The structural model hypothesizes causal relationships among the latent variables as follows:

$$WF = \beta_1 ST + \beta_2 SP + \beta_3 SC1 + \beta_4 SC2 + \beta_5 SC3 + \beta_6 SC4 + \beta_7 SC5 + \mu$$

Where:

$WF$  = Farmers' Welfare (endogenous latent variable);  $ST$ , and  $S$

$P$  = Exogenous latent variables (Storage and Sorting respectively);

$SC1$ – $SC5$  = Socio-economic indicators (household size, education, age, farm size, and distance to market);

$\beta_1$ – $\beta_2$  = Standardized regression weights representing the direct effects of each post-harvest handling construct on welfare;

$\beta_3$ – $\beta_7$  = Coefficients capturing the influence of socio-economic controls; and

$\mu$  = Error term representing unexplained variance in welfare. The model therefore assumes that improvements in storage practices and sorting practices of post-harvest handling will each have a positive and statistically significant impact on farmers' welfare, even after accounting for socio-economic characteristics.

**Confirmatory Factor Analysis (CFA):** The CFA results provide empirical support for the measurement validity of the constructs. All factor loadings exceed the minimum threshold of 0.70, demonstrating that each indicator contributes significantly to its corresponding latent construct. The high standardized loadings across all constructs suggest excellent convergent validity, while the clear distinction between latent variables ensures discriminant validity. Moreover, the reliability coefficients (Cronbach's = 0.84) exceed 0.80, confirming the internal consistency of the measurement model. The Average Variance Extracted (AVE) values exceed 0.50, further supporting construct validity.

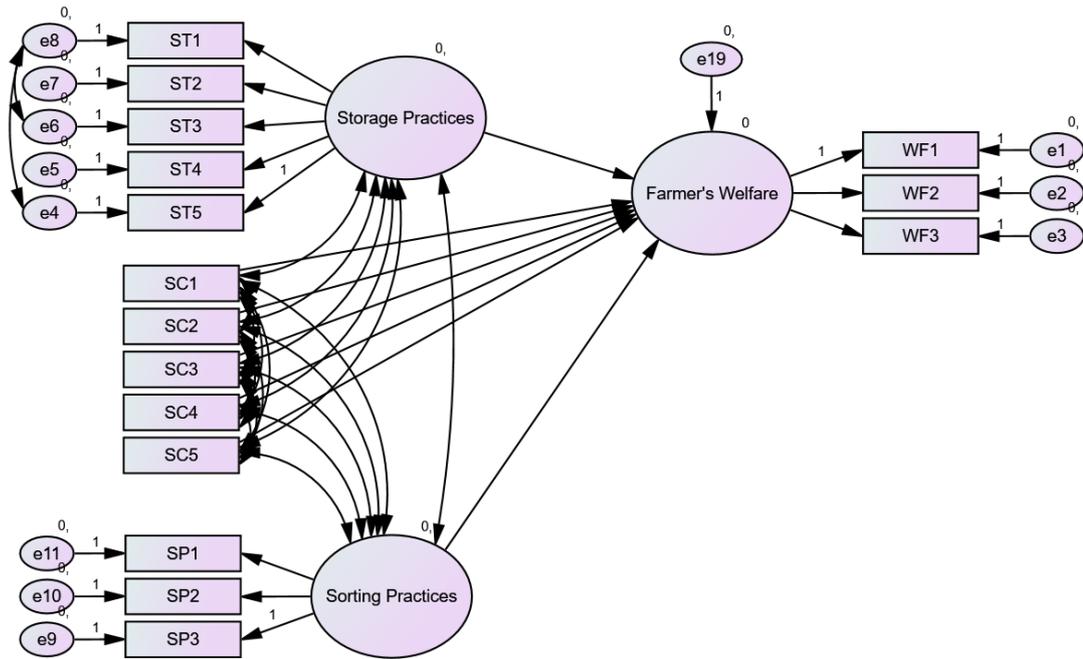


Figure 1: Structural Equation Model of Tomato Postharvest Handling Practices and Farmers' Welfare

The path diagram (Figure 1) illustrates the relationships among the latent and observed variables: Three exogenous latent variables (Storage Practices – ST, Sorting Practices – SP) are positioned on the left, each linked to their respective observed indicators (ST1–ST5, SP1–SP3). The endogenous latent variable (Farmers' Welfare – WF) appears on the right, connected to its observed indicators (WF1–WF3). Direct causal paths are drawn from ST and SP to WF, representing the hypothesized influences of postharvest handling on welfare. Five observed socio-economic variables (SC1–SC5) are depicted as additional predictors of WF, each with a unidirectional arrow toward the welfare construct. Measurement errors ( $e_1$ – $e_{15}$ ) are shown on each observed indicator, and a disturbance term ( $e_{19}$ ) is attached to the welfare construct, indicating unexplained variance.

**Results and Discussion**

This section delineates the outcomes and analyzes the findings pertaining to the study on post-harvest handling techniques of tomatoes and the welfare of farmers in Tarka Local Government Area, Benue State. It examines the impact of socio-economic attributes, sorting techniques, storage procedures, and farmers' expertise in post-harvest management on their overall well-being.

Category	Frequency	Percentage (%)
<b>Age</b>		
18-25	50	13.02
26-35	100	26.04
36-45	80	20.83
46-55	90	23.44
56+	64	16.67
<b>Total</b>	<b>384</b>	<b>100%</b>
<b>Sex</b>		
Male	200	52.08
Female	184	47.92
<b>Total</b>	<b>384</b>	<b>100%</b>
<b>Marital Status</b>		
Single	150	39.06
Married	180	46.88
Divorced	30	7.81
Widowed	24	6.25
<b>Total</b>	<b>384</b>	<b>100%</b>
<b>Educational Status</b>		
No Formal Education	40	10.42
Primary	60	15.62
Secondary	120	31.25
Tertiary	164	42.71
<b>Total</b>	<b>384</b>	<b>100%</b>

*Source:* Authors Computation, 2025

The demographic attributes of the participants in this study indicate a heterogeneous cohort of tomato cultivators in the Tarka Local Government Area, Benue State. The predominant age group of farmers is 26-35 years (26.04%), succeeded by those aged 46-55 years (23.44%). This indicates a comparatively youthful agricultural demographic, with a substantial segment remaining in their prime employment years. The gender breakdown reveals a nearly equal division, with 52.08% male and 47.92% female participants. This signifies that both men and women are actively engaged in tomato cultivation in the region. Data on marital status indicates that a significant majority of farmers are married (46.88%), with a lesser proportion being single (39.06%), implying that numerous farmers bear familial obligations that may affect their agricultural choices and well-being.

A substantial percentage of respondents (42.71%) possess tertiary education, whilst 31.25% have finished secondary school, reflecting a considerably elevated level of formal education among the farmers. Nonetheless, 10.42% of farmers lack formal education, and 15.62% have attained only primary schooling, thereby constraining their access to contemporary agricultural practices and expertise. The ramifications of these findings are significant for the study, as the socio-economic attributes of farmers, such as age, education, and marital status, can profoundly affect their agricultural practices and well-being. Educated and younger farmers are more inclined to use superior post-harvest handling procedures, whereas individuals with bigger family sizes or limited formal education may have difficulties

in enhancing their wellbeing. The study explains the necessity for tailored interventions that address the socio-economic variety of farmers to improve their welfare and post-harvest practices in Tarka Local Government Area.

**Impact of Tomato Post-Harvest Handling Practices and Farmers' Welfare**

The results on the impact of impact of tomato post-harvest handling practices on farmers' welfare in Tarkaa local government area of Benue state are presented on Figure 1

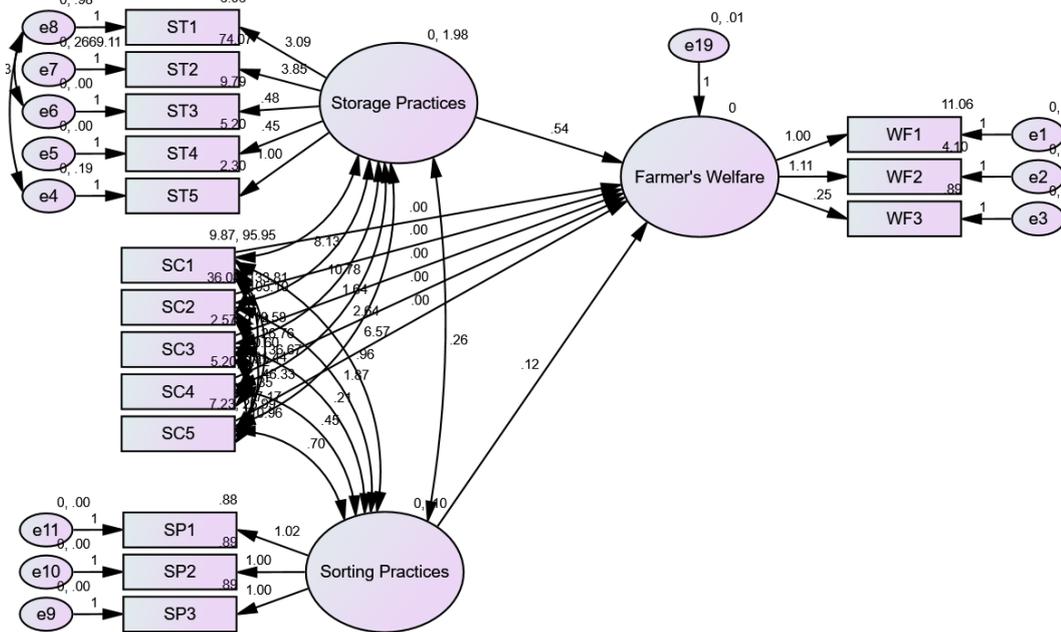


Figure 1: Impact of Tomato Post-Harvest Handling Practices on Farmers' Welfare

**Table 2: Impact of Tomato Post-Harvest Handling Practices on Farmers' Welfare**

Variable	Unstandardized Estimates	Standardized Estimates	S.E.	C.R.	P
WF<---ST	0.543	0.995	0.01	54.138	***
WF<---SP	0.124	0.05	0.016	7.631	***
WF<---SC5	-0.004	-0.03	0.002	-2.856	0.004
WF<---SC4	0.003	0.011	0.003	0.889	0.374
WF<---SC3	-0.002	-0.005	0.007	-0.32	0.749
WF<---SC1	-0.005	-0.06	0.001	-3.471	***
WF<---SC2	0.003	0.038	0.001	3.166	0.002

Source: Extracts from SPSS Amos

results presented in Table 2 reveal that storage practices (ST) exert a statistically significant and positive influence on farmers' welfare, with an unstandardized estimate of 0.543, a standardized estimate of 0.995, and a critical ratio (C.R.) of 54.138 (p < 0.001). This implies that improvements in storage practices are almost perfectly associated with better welfare outcomes among tomato farmers. The unstandardized coefficient (0.543) suggests that a one-

unit enhancement in storage practices leads to a 0.543-unit increase in welfare, holding other factors constant. The standardized coefficient (0.995), which is close to one, indicates a very strong and nearly proportional effect, suggesting that proper storage is a critical determinant of welfare. Theoretically, this finding is consistent with post-harvest management and welfare theory, which posits that effective storage reduces spoilage, ensures stable household food supplies, and secures income against seasonal price fluctuations. In practical terms, this explains the importance of investing in improved storage facilities and training programs that can significantly enhance farmers' economic stability and livelihood resilience.

The estimated effect of sorting practices (SP) on farmers' welfare also shows a positive and statistically significant relationship, with unstandardized and standardized estimates of 0.124 and 0.050, respectively (C.R. = 7.631,  $p < 0.001$ ). Although the magnitude of the coefficient is modest compared to storage, it indicates that better sorting practices contribute meaningfully to welfare improvements. This suggests that enhancing sorting methods such as separating damaged tomatoes from fresh ones and ensuring uniform quality can improve market value, reduce post-harvest losses, and increase farmers' income. The relatively smaller standardized coefficient implies that while sorting contributes to welfare, its effect is supplementary compared to storage improvements. Nonetheless, the statistical significance confirms that sorting remains a crucial component of welfare enhancement through quality control and price optimization.

In examining socio-economic controls, household size (SC1) shows a negative and statistically significant impact on welfare, with an unstandardized estimate of  $-0.005$  and a standardized estimate of  $-0.060$  (C.R. =  $-3.471$ ,  $p < 0.001$ ). This indicates that larger household sizes tend to lower welfare levels among farmers, likely due to the strain larger families place on limited household resources such as income, food, and inputs. The finding supports the economic theory that dependency ratios affect per-capita welfare negatively, emphasizing the need for balanced household planning and efficient resource management to sustain living standards.

Education (SC2) demonstrates a positive and statistically significant effect on farmers' welfare, reflected by an unstandardized estimate of 0.003 and a standardized coefficient of 0.038 (C.R. = 3.166,  $p = 0.002$ ). This suggests that increases in educational attainment or training enhance welfare outcomes, even if the effect size is relatively small. The result highlights the importance of education in enabling farmers to adopt innovative post-harvest techniques, interpret market information, and improve productivity. Therefore, strengthening agricultural extension services and capacity-building programs could magnify these benefits and translate knowledge into tangible welfare gains.

In contrast, distance to market (SC5) has a negative and statistically significant relationship with welfare, as indicated by an unstandardized estimate of  $-0.004$  and a standardized estimate of  $-0.030$  (C.R. =  $-2.856$ ,  $p = 0.004$ ). This finding aligns with theoretical expectations that greater market distance raises transaction and transportation costs, reduces profitability, and limits farmers' access to timely market opportunities. Economically, the result shows the need for improved rural infrastructure and market linkages to minimize logistical barriers and support equitable market participation for smallholder farmers.

Meanwhile, farm size (SC4) and age (SC3) show statistically insignificant effects on welfare, with unstandardized coefficients of 0.003 and  $-0.002$ , standardized estimates of 0.011 and  $-0.005$ , and  $p$ -values of 0.374 and 0.749, respectively. These results suggest that neither

farm size nor age independently contributes significantly to welfare variations among tomato farmers. Theoretically, this indicates that welfare improvements depend more on efficiency and technology adoption than on demographic factors or scale of operation. Larger farms do not necessarily guarantee higher welfare without corresponding investments in post-harvest management, while farmers' age may not be a determining factor in welfare outcomes once experience and resource access are accounted for.

**Model Fit Evaluation:** The overall model fit indices provide empirical validation for the adequacy of the specified Structural Equation Model (SEM). The Chi-Square statistic is statistically significant, which is not uncommon in large-sample SEM applications, as the test is highly sensitive to sample size. Consequently, more emphasis is placed on alternative fit indices. The Normed Fit Index (NFI), Incremental Fit Index (IFI), and Comparative Fit Index (CFI) all exceed the conventional threshold of 0.90, suggesting that the hypothesized model fits the data well relative to a null model. The Root Mean Square Error of Approximation (RMSEA) falls within the acceptable range ( $\leq 0.08$ ), further supporting an adequate level of approximation between the observed and estimated covariance matrices. The Standardized Root Mean Square Residual (SRMR) is particularly favorable, being well below the recommended cutoff of 0.05, signifying a strong level of residual fit. Although the Tucker-Lewis Index (TLI) and Relative Fit Index (RFI) fall slightly short of the ideal 0.90 threshold, their proximity to this benchmark indicates that the model remains reasonably specified. Collectively, these indices confirm that the structural model demonstrates good overall fit, theoretical coherence, and statistical adequacy, indicating that the hypothesized relationships among latent variables are consistent with the observed data.

### **Hypothesis Testing for Study Objectives**

Based on the standardized and unstandardized estimates from the Structural Equation Modeling (SEM) output presented in Table 2, the hypotheses corresponding to the study objectives were tested at the 5% level of significance ( $\alpha = 0.05$ ). Each hypothesis was evaluated according to the magnitude, direction, and statistical significance of the estimated coefficients.

### **Objective 1: To assess the influence of socio-economic characteristics of tomato farmers on their welfare in Tarka Local Government Area of Benue State.**

Among the socio-economic characteristics, household size (SC1) exhibited a significant negative effect on welfare ( $\beta = -0.060$ ,  $p < 0.001$ ), indicating that larger household sizes are associated with a decline in welfare levels. This suggests that as household size increases, available income and resources per capita decrease, exerting downward pressure on welfare. Education (SC2) showed a positive and statistically significant effect on welfare ( $\beta = 0.038$ ,  $p = 0.002$ ), implying that higher educational attainment enhances welfare outcomes through improved knowledge, decision-making, and adoption of productive practices.

Conversely, age (SC3) ( $\beta = -0.005$ ,  $p = 0.749$ ) and farm size (SC4) ( $\beta = 0.011$ ,  $p = 0.374$ ) recorded insignificant effects, suggesting that these variables do not significantly influence welfare within the model. However, distance to market (SC5) exhibited a negative and statistically significant effect ( $\beta = -0.030$ ,  $p = 0.004$ ), meaning that farmers located farther from markets tend to experience lower welfare due to higher transportation costs and limited access to buyers. Since at least three socio-economic factors (household size, education, and

distance to market) show significant relationships with welfare, the null hypothesis ( $H_{01}$ ) is rejected. Therefore, we conclude that socio-economic characteristics collectively exert a statistically significant influence on the welfare of tomato farmers in the study area.

**Objective 2: To examine the effect of sorting practices on the welfare of tomato farmers in Tarka Local Government Area of Benue State.**

The results show that sorting practices (SP) have unstandardized and standardized coefficients of 0.124 and 0.050, respectively, with  $p < 0.001$ . Since the probability value is less than 0.05, the null hypothesis is rejected. This indicates that sorting practices significantly and positively influence farmers' welfare. Although the standardized coefficient is relatively small, the positive sign implies that improvements in sorting such as removing damaged tomatoes and grading by size and quality enhance product value, reduce post-harvest losses, and improve market returns. Thus, we reject  $H_{02}$  and conclude that sorting practices significantly enhance farmers' welfare in the study area.

**Objective 3: To assess how storage practices influence the welfare of tomato farmers in Tarka Local Government Area of Benue State.**

The estimated coefficients for storage practices (ST) are 0.543 (unstandardized) and 0.995 (standardized), with  $p < 0.001$ , indicating a strong and statistically significant positive relationship. The standardized coefficient, being almost equal to one, demonstrates that storage practices have the most substantial effect among all variables in the model. This result confirms that improved storage practices, such as proper ventilation, use of appropriate containers, and reduction of physical damage, lead to higher welfare by minimizing post-harvest losses and ensuring income stability. Consequently, the null hypothesis ( $H_{03}$ ) is rejected, confirming that better storage practices significantly and positively influence tomato farmers' welfare.

**Table 3: Summary of Hypothesis Testing Results**

Hypothesis	Relationship Tested	Std. Estimate	p-value	Decision	Interpretation
$H_{01}$	Socio-economic characteristics → Welfare	-0.060 to 0.038	0.000–0.749	Reject $H_{01}$	Household size, education, and distance to market significantly affect welfare
$H_{02}$	Sorting Practices → Welfare	0.050	*** (<0.001)	Reject $H_{02}$	Sorting practices significantly improve welfare
$H_{03}$	Storage Practices → Welfare	0.995	*** (<0.001)	Reject $H_{03}$	Storage practices have the strongest positive influence on welfare

**Discussion of Findings**

The study examined the effects of socio-economic characteristics, sorting, and storage practices on the welfare of tomato farmers in Tarka Local Government Area of Benue State using Structural Equation Modeling (SEM).

Among the socio-economic characteristics analyzed, education, household size, and distance to market exhibited statistically significant effects on farmers' welfare, while age and farm size were not significant determinants. Education (SC2) had a positive and significant effect on welfare ( $\beta = 0.038$ ,  $p = 0.002$ ), indicating that farmers with higher levels of formal education tend to achieve better welfare outcomes. This suggests that education enhances farmers' capacity to access information, adopt improved post-harvest technologies, and make informed production and marketing decisions. These findings are consistent with those of Ashinya, et al. (2021) and Adepoju (2014), who emphasized that education fosters efficiency and innovation in agricultural management, thereby improving income and living standards.

Household size (SC1) exhibited a negative and significant relationship with welfare ( $\beta = -0.060$ ,  $p < 0.001$ ), implying that larger families may dilute household resources, reducing per capita welfare. This finding aligns with welfare theory, which posits that higher dependency ratios constrain household consumption capacity and limit investments in productivity-enhancing activities. Similarly, distance to market (SC5) was found to have a negative and significant effect on welfare ( $\beta = -0.030$ ,  $p = 0.004$ ), suggesting that farmers farther from markets experience lower welfare levels due to higher transportation costs, post-harvest losses during transit, and limited access to buyers. This result supports the argument of Ogunniyi and Ajao (2011) that infrastructural barriers significantly restrict rural farmers' welfare potential.

In contrast, age (SC3) ( $\beta = -0.005$ ,  $p = 0.749$ ) and farm size (SC4) ( $\beta = 0.011$ ,  $p = 0.374$ ) were statistically insignificant, indicating that neither demographic characteristics nor farm size alone determine welfare in this context. This diverges slightly from Sugiana et al. (2018), who observed a positive relationship between farm size and welfare in more capital-intensive agricultural systems. In Tarka, smallholder production and limited mechanization appear to neutralize the scale advantage typically associated with larger farms.

The study found that sorting practices (SP) had a positive and statistically significant impact on farmers' welfare ( $\beta = 0.050$ ,  $p < 0.001$ ). Although the standardized effect is modest, it implies that improvements in sorting such as grading tomatoes by ripeness, size, and quality, and removing damaged fruits contribute meaningfully to welfare enhancement. This finding aligns with the works of Arah et al. (2015) and Karki and Dawadi (2022), who reported that proper sorting and grading reduce post-harvest losses and improve profitability by ensuring uniform product quality and higher market prices. Similarly, Atsor and Manguts (2024) identified improper sorting during transport as a major cause of tomato spoilage in Benue State. The present study contributes by empirically quantifying the welfare gains attributable to efficient sorting rather than infrastructure-heavy investments. This highlights that behavioral improvements in post-harvest handling can generate significant welfare outcomes for smallholders, even where physical storage or processing capacity is limited.

Among all variables tested, storage practices (ST) exerted the strongest positive and statistically significant influence on welfare ( $\beta = 0.995$ ,  $p < 0.001$ ). The nearly perfect standardized coefficient explains the centrality of storage efficiency in safeguarding farmers' livelihoods. Improved storage practices help reduce spoilage, extend the shelf life of tomatoes, and allow farmers to sell when prices are more favorable, thereby stabilizing income and improving food security. These results are consistent with Moneruzzaman et al. (2009) and Hurst (2010), who emphasized that effective storage enhances both product quality and economic returns. However, the present study goes further by showing that technical

knowledge and handling efficiency, rather than mere expansion of storage capacity, drive welfare gains. This observation contrasts slightly with Makonnen Tolasa (2021), who focused on physical infrastructure development. In Tarka, where farmers often lack access to controlled storage environments, training in cost-effective, knowledge-based storage methods such as ventilated crates or shaded storage yields more immediate and sustainable welfare benefits. Thus, the findings confirm that efficient and informed storage management is the single most powerful determinant of welfare among tomato farmers in the study area.

The good overall fit of the SEM model validates these relationships, confirming that the hypothesized framework effectively integrates socio-economic, behavioral, and technical dimensions of welfare. This evidence contributes to the broader literature on post-harvest management by establishing that human capital and behavioral efficiency, rather than physical expansion or demographic traits, underpin welfare improvement among smallholder farmers in Nigeria.

### **Conclusion and Policy Recommendations**

This study concludes that the welfare of tomato farmers in Tarka Local Government Area is significantly influenced by their education level, household size, distance to market, and post-harvest handling practices, particularly sorting and storage. Among these, storage practices exert the strongest positive effect, followed by sorting efficiency and education, while household size and distance to market negatively affect welfare. These findings affirm that human capital development and behavioral efficiency are more powerful drivers of welfare than demographic or structural factors such as farm size or age. The results emphasize that welfare improvement among smallholders depends not on the expansion of production scale, but on the quality, efficiency, and knowledge intensity of post-harvest activities.

### **Policy Recommendations**

- i- Given the significant positive impact of education on farmers' welfare, government agencies particularly the Benue State Agricultural and Rural Development Authority (BNARDA) should prioritize continuous farmer education and capacity development. This should include adult literacy programs, technical training, and management workshops that enhance decision-making and innovation in postharvest handling. Expanding community-based farmer field schools to include modules on sorting, storage, and market management will build long-term human capital. Demonstration plots, peer-to-peer learning, and mentorship programs should be used to ensure sustained participation and practical skill transfer.
- ii- Since sorting practices significantly improve welfare, policy interventions should focus on the institutionalization of standardized sorting and grading systems. Training programs led by agricultural extension officers, cooperatives, and private sector partners should emphasize quality differentiation based on color, ripeness, size, and integrity. Local cooperatives should be supported with affordable sorting equipment—including trays, sorting tables, and protective gloves—to improve product presentation and reduce contamination. Market policies should introduce price incentives for quality-based produce, encouraging farmers to adopt systematic sorting as part of their value chain process.
- iii- Given that storage practices exert the strongest influence on welfare, interventions should prioritize low-cost, scalable, and climate-resilient storage technologies over large, centralized facilities. The Federal Ministry of Agriculture and Rural Development, in

collaboration with partners such as FAO and IFAD, should promote the use of ventilated crates, evaporative coolers, and solar-powered storage units suited to local conditions. Demonstration projects should focus on practical training in storage hygiene, temperature regulation, and moisture management, which are proven to minimize postharvest losses and stabilize income throughout production cycles.

- iv- Agricultural extension agencies should intensify outreach coverage to ensure that all tomato farmers have access to regular training and advisory services on postharvest handling, packaging, and storage. Knowledge transfer should be made more accessible through radio programs in local dialects, mobile advisory messages, and on-farm demonstrations. Stronger partnerships between universities, research institutes, and local councils can enhance the scientific accuracy and local relevance of training content, ensuring that recommendations are both practical and culturally appropriate.
- v- To enhance collective efficiency, farmers should be mobilized into cooperative groups that facilitate knowledge sharing, joint marketing, and collective investment in postharvest technologies. Government policy should introduce microcredit schemes and financial incentives for cooperatives adopting improved sorting and storage practices. Strengthened cooperatives can negotiate better market prices, reduce transportation costs, and access shared equipment and training opportunities. Such coordinated structures will reinforce farmers' market power, reduce postharvest losses, and ensure that welfare gains are inclusive and sustainable across the tomato value chain.
- vi- Since distance to market negatively affects welfare, policies should aim to upgrade rural roads, transportation systems, and market facilities to reduce logistical barriers. Government investment in feeder road rehabilitation and the establishment of local produce aggregation centers will help farmers reduce transport costs, minimize spoilage during transit, and increase their access to profitable urban markets. Improved infrastructure will not only raise welfare but also stimulate local economic growth in the Tarka region and beyond.

## References

- Adekunle, A. A., & Adebayo, O. S. (2019). Postharvest losses in tomato production in Nigeria. *Journal of Agricultural Science and Practice*, 4(1), 1-8
- Adhikari, B., & Aarati G.C. 2021. Post-harvest practices of horticultural crops in Nepal: Issues and management. *Archives of Agriculture and Environmental Science*, 6 (2), 227–233. <https://doi.org/10.26832/24566632.2021.0602015>
- Akpan, M., Okechukwu, O., & Eze, T. (2024). Post-harvest losses and management practices in sub-Saharan Africa: A case study of tomato farmers. *Journal of Agricultural Development*, 30(1), 44-59.
- Ambika K., & Dawadi, E. (2022). A Review on Post-Harvest Handling Practices of Tomato (*Lycopersicum Esculentum*). *Food and Agri Economics Review*, 2(2): 100-103.
- Babirye Magala, D., Egessa, J., Atim, J., Sseruwu, G., & Namirimu, T. (2024). Measures for reducing tomato post-harvest losses at farmer level in the Lake Victoria Crescent agro-ecological zone. *Uganda Journal of Agricultural Sciences*, 22(1), 55–73.
- Babirye Magala, D., Egessa, J., Atim, J., Sseruwu, G., & Namirimu, T. (2024). Measures for reducing tomato postharvest losses at farmer level in the Lake Victoria Crescent agro-ecological zone. *Uganda Journal of Agricultural Sciences*, 22(1), 55–73.
- Beeior, C.T., Akpehe, G.A., Wegh, S.F., Odiaka, E.C., & Igbanyam, C. (2025). Adoption of tomato post – harvest value addition technologies (TPVTS) and well-being of Tiv rural farmers

- in Benue State, Nigeria. *Nigerian Journal of Agriculture and Agricultural Technology*, 5(2A), 32–39.
- Beharielal, T., Thamaga-Chitja, J., & Schmidt, S. (2022). Socioeconomic characteristics associated with farming practices, food safety and security in the production of fresh produce; a case study including small-scale farmers in KwaZulu-Natal (South Africa). *Sustainability*, 14(17), 10590. <https://doi.org/10.3390/su141710590>
- Deribe, H., Beyene, B., & Beyene, B., (2019). Review on Pre- and PostHarvest Management on Quality Tomato (*Lycopersicon esculentum* Mill.) Production. *Food Science and Quality Management*, Pp. 54.
- FAO. (2011). Postharvest management of tomato for quality and safety assurance. Food and Agriculture Organization of the United Nations.
- FAO. (2023). The State of Food and Agriculture 2023: The role of post-harvest management in reducing food losses and waste. Food and Agriculture Organization of the United Nations.
- Gokul, J. K., & Korsten, L. (2025). Quality and quantity losses of tomatoes grown by small-scale farmers under different production systems. *Horticulturae*, 11(8), 884.
- Jimmy, U.J., Osogi, M.A., Asuquo, J.B., Emmanuel, A.O., Akpan, J.W., & Udoh. I.J. (2025). Hunger in the "Oil Field": A Review of Food Crisis and Hunger Alleviation Programmes in Nigeria. *Saudi J. Humanities Soc Sci*, 10(3): 75-91.
- Korie, N., Njeru, L. K., & Mburu, J. (2023). Assessment of factors influencing adoption of tomato post-harvest loss-reduction technologies in Kaduna State, Nigeria. *East African Journal of Science, Technology & Innovation*, 4(2). <https://doi.org/10.37425/eajsti.v4i2.599>
- Kuranen-Joko, D. N. & Dzahan, H. L. (2018). Determinants of post-harvest losses among tomato farmers in Gboko Local Government Area of Benue State, *International Journal of Agricultural Research and Food Production*, 3(4):27-33.
- Ocholi, A., Nyiatagher, Z. T. & Ayila, V. N. (2020). Effect of marketing intermediaries on pricing of agricultural perishable products: A case study of onions and tomatoes in Benue State, *Journal of Agricultural and Crop Research Nigeria*. 8(7): 132-139.
- Ohagwu, V. A., Iwuchukwu, J. C., & Nwobodo, C. E. (2024). Knowledge of farmers on post-harvest handling of tomato in Enugu State, Nigeria. *Journal of Agricultural Extension*, 29(3), 1–14.
- Olayide, O. (2024). Assessing post-harvest loss of tomato and its implications for household welfare in Akinyele LGA, Oyo State. *Journal of Horticulture and Forestry*, 16(2), 45–59.
- Tijani, S. A. (2022). Determination of utilization of tomato value addition technologies among beneficiaries in Oyo State, Nigeria. *Agricultural Tropical Et. Subtractica*, 55(8):169-184.
- Tiwari, I., Shah, K.K., Tripathi, S., Modi, B., Shrestha, J., Pandey, H.P., Bhattarai, B.P., & Rajbhandari, B.P., 2020. Post-harvest practices and loss assessment in tomato (*Solanum lycopersicum* L.) in Kathmandu, Nepal. *Journal of Agriculture and Natural Resources*, 3 (2), 335–352. <https://doi.org/10.3126/janr.v3i2.32545>
- Tobe, O. K., Atala, T. K., Saddiq, N. M., & Damisa, M. (2023). Factors influencing the adoption of improved tomato post-harvest loss management practices among farmers in north-west zone of Nigeria. *Farm Management*, 8, 36–43.
- Tughbga, M. F. (2024). The Effect of post-harvest losses of tomato on farmers income in Tarka Local government. An Unpublished M.Sc. Manuscript in the Department of Economics, Benue State University Makurdi Nigeria.
- USDA Agricultural Marketing Service. (2013). United States Standards for Grades of Fresh Tomatoes. U.S. Department of Agriculture.