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EVALUATION OF POSTHARVEST LOSSES IN PHYSICAL AND ECONOMIC PERSPECTIVES ALONG TOMATO VALUE CHAIN IN KANO STATE, NIGERIA

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ABSTRACT

The study evaluate postharvest losses in physical and economic perspectives along tomato value chain in Kano State, Nigeria. Random sampling technique was applied to select a total of 517 respondents across the different segments of the value chain. Data were collected from the field using a structured questionnaire and qualitative data were collected through Focus Group Discussions (FGD), Key Informant Interviews (KII) with institutions and other value chain supporters. Descriptive statistics, gross margin analysis and an Informal Food Loss Assessment Method (IFLAM) were used in data analysis. Result of the study reveals that tomato wastage occurs mainly at the harvesting, packaging, loading and offloading, at storage and during transportation and delivery to different markets. All actors along the value chain experience losses at different stages. An average physical loss of 1,154Kg, 698Kg, 942Kg, 323Kg, and 229Kg were estimated at different points of activities along the value chain for Farmers, Rural assemblers, wholesalers, retailers and processors respectively, while the estimated economic losses of tomato for various actors in the value chain for Farmers, Rural Assemblers, Wholesalers, Retailers and Processors was found to be №336,312.9, №382,771.5, №534,086.0, №269,769.1 and №116,014.7 respectively. It can be concluded that postharvest loss is a major threat to tomato value chain actors in the study area. It was also discovered that attack by insect, pest and diseases, lack of storage facilities like cold room, lack of processing industries, inadequate investment capital, poor flow of market information along the value chain, poor packaging materials, lack of government support among others were among the major reasons for tomato postharvest losses across the value chain. It is therefore recommended that stakeholders like government, NGOs, research centers, development partners and cooperatives organization should provide cold store facilities along the value chain in the study area.

Keywords: Actors, Analysis, Marketing and Postharvest

INTRODUCTION

Agricultural value chain provides a reference point for improvements in supporting agricultural services and the agribusiness environment (Ilu, 2015). It contributes to pro-poor initiatives and better linking of small businesses with the market (Webber and Labaste, 2009). Value chain approach provides an analytical framework for identifying agricultural production and marketing constraints and assessing the economic viability of solutions to overcome the identified constraints (Aminu and Shehu, 2007). As products move successively through the various stages of production, marketing, processing and to final consumption, transactions take place between the multiple chain stakeholders, money changes hands, information is exchanged value is progressively added, profits and losses were experienced (Yumkella, 2011; Lee *et al.*, 2012 and Gebre *et al.*, 2020).



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Tomato (*Lycopersicon esculentum*) is one of the most important and widely grown vegetables in Nigeria (FAOSTAT, 2018). Small-scale farming families produce the bulk of fresh market tomatoes. It is an important cash-generating crop to farmers and provides employment in Nigerian agricultural sector. Global production of tomato is estimated to be above 171 million metric tons over an area of five million hectares of cultivated land, with major producers being China, United States, Turkey, Egypt and India (FAOSTAT, 2018 and Dube *et al.*, 2020). China is the leading country in world with a total production of about 50 million tones followed by India with over 17.5 million tones (FAOSTAT, 2018; Animashaun *et al.*, 2010). In Africa, total tomato production for 2012 was 17.938 million tons with Egypt leading with total production of over 8.625 million tones, followed by Nigeria with over 1.56 million tones (FAO, 2014 and Dube *et al.*, 2020). Nigeria is ranked 13th on the global tomato production scale, accounts for 10.79 per cent of Africa's and 1.2 per cent of total world tomato production (FAO, 2014).

FAO (2014), reported that postharvest loss threatens food, income, and nutrition security for smallholders. Losses at farm, collection, wholesale, and retail levels are defined as "food loss", while losses at consumer level are termed "food waste. This study focuses only on postharvest losses of tomato value chain as the sum of losses at farm, collection, wholesale, and retail levels. Physical losses were estimated as the proportion that is deteriorated to the point that it is unfit for human consumption.

MATERIALS AND METHODS

The Study Area

The study was conducted in Kano State Nigeria. The State is located in northwestern Nig eria and lies between latitude 13°N and 11°S and longitude 8°W and 10°E with a total land area of 20,760sqkilometers. TheState has a total of 44 Local Government Areas with a projected populati on of 15,462,177 million people at 3.38% increase (NPC/NBS, 2022).

Sampling Procedure

A multistage sampling technique was use in drawing the sample size from the sample frame. In consultation with Extension Agents (EAs) in KNARDA, 4 LGAs were purposively selected from 2 agricultural zones (Rano and Danbatta zone) based on tomato production activities. In the second stage, two (2) tomato producing communities were purposively selected from each of the 4 selected local government areas. Kura and Garun Malam were purposively selected from Zone 1 (Rano zone) while Dambatta and Bagwai were selected from Zone 2 (Danbatta zone). These areas were selected for the study due to their high potential in tomato and other vegetables production in the state. To have full representation of all actors along the value chain, all existing links in the tomato value chain were identified during reconnaissance survey conducted in the study area. The survey showed that there were more than 15 vegetable farmer's groups called Water Users Association (WUA), under Kano River Irrigation Project (KRIP) area within Kura and Garin Malam LGAs and more than 11 within Danbatta and Bagwai (under Dambatta (Tomas) irrigation project area and Watari Irrigation Project (WIP) area respectively. The sample size was drawn from the sample frame using Slovin's formula as a random sampling technique formula as used by Yang et al. (2020) and Ilu et al. (2021). A combination of purposive and simple random sampling technique was used in selecting 517 respondents for the study.

Data collection

Data were collected from the field through the use of structured questionnaire within the months of December to late January 2024 during dry season farming. In addition, Key Informant





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Interviews (KII), Focus Group Discussion (FGD), assessment of the services and service providers was conducted to get clear understanding, observations, and perceptions about the entire tomato value chain in the study area.

Analytical technique

Data collected were analyzed using descriptive statistics, farm budgeting model, and Informal Food Loss Assessment Methods (IFLAM) as used by Kruijssen *et al.* (2020); Torell *et al.* (2020) and Yvette *et al.* (2011).

Descriptive statistics and graphical mapping:

Descriptive statistics and graphical mapping are two methods of summarizing and presenting data in a meaningful way (Salkind, 2017 and Purdue OWL, 2020). Descriptive statistics include measures of central tendency, variability, and distribution, such as mean, median, mode, standard deviation, and frequency. Graphical mapping includes various types of charts, graphs, and plots, such as bar charts, pie charts, histograms, scatter plots, and box plots.

Gross Margin Analysis (GMA):

These include detailed analysis of cost and returns of tomato production and marketing at different (ith) level of the value chain such as Total cost of production and marketing (Fixed cost + Variable cost), Gross Revenue generated (Total quantity x Unit price), Net Income and actors share in consumer's price.

Postharvest Loss Assessment Method (Informal Food Loss Assessment Method (IFLAM))

Reducing postharvest loss throughout vegetable value chains will be an important pathway to sustaining food security and nutrition security in Nigeria. However, lack of understanding of the nature of losses, location and percentage share of the losses in total revenue of actors across the value chain and associated factors remains a major challenge to development and implementation of postharvest loss mitigation strategies. This study estimates the physical and economic loss experienced by tomato value chain actors at different stages of tomato handling from harvesting to table of final consumer. Kikulwe et al. (2018) refers economic loss as the proportion that are partially spoiled or damaged and whose market price is discounted as a result. In this study, both the indicative average prices of good quality tomato and the discounted prices for tomato that have incurred quality deterioration at the different value chain level was measured. An Informal Fish Loss Assessment Method (IFLAM) and the Questionnaire Loss Assessment Method (QLAM) was adopted and use in assessing postharvest losses in this study as used by Kruijssen et al. (2020), Torell et al. (2020) and Yvette et al. (2011); Gustafsson et al, (2013). Informal Food Loss Assessment Method (IFLAM), also known as the Exploratory Loss Assessment Method (EFLAM) is an informal method based on participatory rural appraisal (PRA) principles (Yvette et al. 2011; Gustafsson et al., 2013 and FAO, 2014). It is used to generate a qualitative and indicative quantitative data that can be used to make decision or to plan the use of Load Tracking and the Questionnaire Loss Assessment Method both of which are quantitative assessment methods. Load Tracking (LT) is used to quantify losses at stages along the distribution chain or losses related to specific value chain activities such as harvesting, loading, transportation, uploading, processing, storage and other marketing activities (Diei-Ouadi and Mgawe, 2011 and Kikulwe et al., 2018). It relies on both measurable quantity and quality losses at each stage of the value chain by evaluating quality and weight of a load of food product (Diei-Ouadi and Mgawe, 2011). Questionnaire Loss Assessment Method (QLAM) relies on interviewing a population sample in a community or geographical area using a questionnaire to validate the postharvest loss data. According to Diei-Ouadi and Mgawe (2011), the IFLAM framework helps to develop a



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qualitative understanding of losses and provides indicative quantitative data on losses. Kruijssen *et al.* (2020) and Torell *et al.* (2020), also used IFLAM, in generating data which describes the types, causes, timing, impacts, and trends of post-harvest losses, as well as the stakeholders affected by these losses and their perceptions of the impacts.

Physical and Economic Loss

Postharvest loss assessment method as used by Kikulwe *et al.* (2018) was used in estimating the physical and economics losses at different segments of the value chain in objective v. Kikulwe *et al.* (2018) who refers postharvest losses as the measurable quantitative and qualitative food losses in the postharvest system.

Physical loss

Physical losses along the value chain were measured in kilogram weight of tomatoes lost (physically and completely damaged) at each activity as the produce move from one actor to another actor along the value chain (Sharma, *et al.* (2009) and Parayil, (2021). Physical loss (Kg)_{ith} = Total Quantity produced or purchased (kg) – Total Quantity Spoiled (kg) Percentage physical losses by each actor were computed as follows:

$$Physical loss (\%) = \frac{Total Quantity Spoiled (kg)}{Total Quantity Produced or Purchased (kg)} X 100 ...(1)$$

Economic loss

This reveals the monetary value of the total tomato loss by each actor along the value chain. It is part of the total revenue lost due to physical damage and quality losses. The loss of whole tomato fruit (rotten) and depreciation in quality was measured by the deviation from the actual market price obtained for the best quality fresh tomato fruits (Kikulwe *et al.*, 2018). Economic losses were computed as follows: Economic Loss (\mathbb{N}) = Actual market price for fresh fruits (\mathbb{N}/Kg) - Physical Loss value (\mathbb{N}/Kg)

Percentage Economic Loss (%) = $\frac{\text{Economic Loss Value (N/Kg)}}{\text{Actual market value of good tomato fruits (N/Kg)}} X 100 ...(2)$ The extent of postharvest loss at ith value chain node were estimated as the sum of the average physical and average economic losses at the ith stage, as;

Postharvest Loss_i Value = Physical Losses_i Value + Economic Losses_i Value \dots (3)

Partially spoiled tomatoes can move directly from the farm to retailers, and to final consumers. The total amount of economic losses in the value chain can be estimated as a sum of economic losses at each level (ith) of the value chain. However, since produce that are physically lost at one point of the chain disappear from the value chain and cannot be lost again, the total amount of physical losses along the whole value chain were calculated by summing up the losses at each level (ith) of the value chain (Enoch *et al.*, 2018).

RESULTS AND DISCUSSION

Tomato Value Chain Actors

The study identified the respective value chain actors and the role played by each actor along the chain in Kano state. The actors identified include the Input dealers, Producers (farmers), Marketers (rural assemblers, wholesalers, and retailers), the Processors (hotel, restaurants, industries), Transporters, Consumers and other service providers like research centers, extension and financial institutions respectively. Activities started from the input dealers which were linked to the producers either directly or through the extension agents. The farmers procured the production inputs from the input dealers and produce tomatoes from which it flows into the market

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through various channels until it finally reaches the ultimate consumers. This was in line with the findings of Ugonna *et al.* (2015), Suleiman *et al.* (2019), Tafida and Ayuba (2020).

Structure and Strength and Flow (%) of Tomato Produce Along the Value Chain

According to McCormick and Schmitz (2007) as cited by Paresh (2018) in his study on Value Chain Analysis of Tomato in Jessore District of Bangladesh stated that value chain mapping enables to visualize the flow of the product from production to end consumer through various actors. It also helps to identify the different actors involved in the tomato value chain and to understand their roles and linkages. Tomato value chain structure in the study area comprises of different forms of channels through which tomatoes flows from initial point of production (farmers) to the end users (consumers). This support the findings of Umar (2017). Figure 1 reveals the strength and percentage distribution of tomatoes from one actor to another actor along the value chain.



Figure 1: Tomato Value Chain Map indicating the strength (%) and Flow of Tomato Among the
ActorsSource: Field survey, 2023

Aggregate Physical Loss of Tomato

Physical losses are measured in weight lost from one value chain stage to the next (Strecker *et al.*, 2022). Table 1 present physical losses experienced by each actor along the chain. The losses are calculated by subtracting the weight of crops discarded from the initial total weight of the crops



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produced or purchased by each value chain actor (Strecker *et al.*, 2022). This was achieved by weighing the quantity of tomato produced or purchase in kilogram (Kg) and the quantity sold out (Kg) at the beginning and end of each point along the value chain (Table 1).

 Table 1: Aggregate physical loss (Kg) of tomato for various actors along the value chain

Farmers	Assembler	Wholesaler	Retailer	Processor	Total Loss by all Actors (Kg)
272	-	-	-	-	272
210	340	387	140	90	1167
243	85	240	70	85	723
53	53	36	15	17	174
65	120	49	46	22	302
311	100	230	52	15	708
1,154	698	942	323	229	3,345
34.5%	20.9%	28.1%	9.7%	6.8%	100.0%
	Farmers 272 210 243 53 65 311 1,154 34.5%	FarmersAssembler272-210340243855353651203111001,15469834.5%20.9%	FarmersAssemblerWholesaler2722103403872438524053533665120493111002301,15469894234.5%20.9%28.1%	FarmersAssemblerWholesalerRetailer272210340387140243852407053533615651204946311100230521,15469894232334.5%20.9%28.1%9.7%	FarmersAssemblerWholesalerRetailerProcessor2722103403871409024385240708553533615176512049462231110023052151,15469894232322934.5%20.9%28.1%9.7%6.8%

Source: Field survey 2023

Estimated Physical Losses (Kg)

Tomato wastage occurs mainly at the harvesting, packaging, loading and uploading, storage and during transportation to market. Table 1 and figure 2. Provide information on the estimated physical losses experienced by all actors that handles tomato and tomato produce along the value chain. An average physical loss of 1,154Kg, 698Kg, 942Kg, 323Kg, and 229Kg were estimated at different points of activities along the value chain for Farmers, Rural assemblers, wholesalers, retailers and processors respectively. The findings of this study are in line with the report of Aulakh *et al.* (2013) who stated that as food travels along the value chain from harvest to consumption, losses occurred at each stage along the chain and contribute to the total postharvest loss experienced in the value chain.



Figure 2: Estimated Physical Losses (Kg)

Source: Field survey, 2023

Percentage Share in Total Physical Loss (%)

Figure 3 reveals the percentage share of each value chain actor in total physical loss. The loss is much higher for the farmers with a percentage loss share of 34.5% than for other actors



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along the value chain. This finding is in line with the findings of Adegbola and Oyekale (2019) and Isaac *et al.* (2016) who reported that between 30-45% of food crop produced in Nigeria particularly vegetable crops is wasted due to improper handling procedures and lack of methods to prevent decay.



Figure 3: Percentage Share in Total Physical Loss (%)

Source: Field survey, 2023

Estimated Economic losses Along the Value Chain

The total economic loss is the percentage of total revenue lost due to physical and quality losses (Strecker *et al.*, 2022). Both loss of whole tomato fruits and the depreciated value due to quality loss were measured by the deviation from the actual market price of best quality tomato fruits at same time in the market (Strecker *et al.*, 2022). Result in Table 2 reveals the total economic loss value of \aleph 336,312.9, \aleph 382,771.5, \aleph 534,086.0, \aleph 269,769.1 and \aleph 116,014.7 for Farmers, Rural Assemblers, Wholesalers, Retailers and Processors respectively. Which is equivalent to 24.9%, 17.1%, 24.6%, 19.2% and 10.3%, of the total revenue generated.

ECONOMIC LOSSES	Farmers	Rural Ass.	Wholesalers	Retailers	Processor
Average Quantity Loss (Kg)	1,616.7	1,051.6	970.3	464.6	222.2
Rate (₦/Kg)	63.6	15.6	16.5	13.5	2.2
Economic waste Value (N)	102,822.6	16,410.3	16,043.2	6,254.3	481.3
Actual Market Price (₦/Kg)	271.6	379.6	566.9	594.2	524.4
Actual Market Value (₦)	439,135.6	399,181.8	550,129.2	276,023.4	116,496.1
Economic Loss (₦)	336,312.9	382,771.5	534,086.0	269,769.1	116,014.7
Percentage in Total Revenue Source: Field Survey, 2023	24.9	17.1%	24.6%	19.2%	10.3%

,		,	,		,		0				
Table 2	2: I	Estimated	Economic	losses	(₦) of	tomato f	or various	actors in	the	value	chain







Figure 4: *Percentage Share of Actors in Total Value Chain Economic Loss* **Source:** Field survey, 2023



Figure 5: Percentage economic loss in total value chain loss Source: Field survey, 2023

Reasons for the Losses

Result presented in Table 3 reveals the major reasons for tomato postharvest losses in the study area base on the response of various actors along the value chain. Attack by insect pest and diseases, Lack of storage facilities like cold room, lack of processing Industries, Inadequate investment capital, poor flow of market information along the value chain, poor packaging materials, lack of government support among others were among the major reasons for tomato postharvest losses across the value chain. This finding is also in line with the report of Adegbola and Oyekale (2019) who reported that the main reasons of tomato postharvest losses in Nigeria are poor infrastructure like storage facilities, cold rooms, road networks, poor market structure for vegetables, low-value addition, and problems of pest and diseases respectively. Aulakh *et al.* (2013) also reported in his study on estimation of post-harvest food losses that; premature harvesting, poor storage facilities, lack of of infrastructure, lack of processing facilities and inadequate market facilities as the causes of food losses in developing countries like Nigeria.



Table 3. Major reasons for losses across the value chain								
Postharvest Losses	Farmers (%)	Rural Assembler (%)	Wholesaler (%)	Retailer (%)	Processor (%)	Consumers (%)		
Lack of storage facilities	34.2	74.8	84.3	35.6	54.9	73.7		
Lack of functional processing industries	42.8	72.9	64.3	15.5	-	-		
Inadequate investment capital	69.4	53.1	45.3	68.4	93.2	-		
Poor flow of information	53.2	48.7	43.2	24.4	33.8	-		
Lack of processing skills	83.2	53.4	62.5	55.7	0	83.7		
Pest and Diseases	94.6	68.7	81.7	71.8	45.3	45.9		
Poor packaging materials	68.1	45.5	73.8	32.6	72.2	-		
Lack of government support	54.1	82.3	69.6	13.2	87.2	-		
Perishability	38.6	15	47.2	4.7	-	-		
Lack of Improved variety	26.2	-	-	-	98.4	-		
High Temperature and Pressure	22.4	32.5	23.8	53.8	-	-		
Nature of the crop	15.1	-	15.3	37.6	23.5	23.2		
Poor market price	23.6	36.4	15.6	23.8	-	67.3		
Market Glut	75.2	62.7	83.4	59.1	-	-		
poor handling by other actors	-	16.8	42.6	35.7	43.2	18.7		
Insecurity	-	41.7	72.4	9.3	12.7	-		

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Source: Field survey, 2023

Measures Taken to Reduce Losses

The demand for tomato and other vegetables is increasing in parallel with population growth in Kano state and Nigeria at large. Hence, reducing the postharvest losses will play a significant role in increasing tomato production and marketing efficiency along the value chain in the state. Therefore, appropriate measures have to be taken by the chain stakeholders so as to effectively reduce the losses. Table 4 reveals information on the measures taken by the value chain actors in reducing losses among which include but not limited to Sun drying, seeking market information, harvesting fruits at 75% maturity, sorting and grading the fruits while some of the value chain actors just pray and do nothing. This finding is in line with the report of Elik et al. (2019) that in many developing countries like Nigeria, major causes of fresh fruits and vegetables losses are the lack of infrastructures, poor harvesting, poor transportation, poor storage and processing technologies among others. Therefore, reducing postharvest losses in tomato along the value chain will be a very effective way of increasing income and reducing poverty among the respective value chain actors as well as ensuring food security by maintaining the quality of the produce. Result on Table 4 implies that the value chain actors are using their own local and traditional methodologies in reducing the impact of postharvest losses. Hence, there is need for stakeholders (government, NGOs, and other value chain development partners to intervene



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through conducting trainings, workshops and provision of required infrastructures for reducing postharvest losses along the value chain.

Postharvest Losses	Farmers (%)	Rural Assembler (%)	Wholesaler (%)	Retailer (%)	Processor (%)	Consumers (%)
Sun drying	75.4	64.3	52.7	32.4	78.4	-
Selling at lower price	83.6	74.6	83.5	60.8	-	-
Seeking market information	56.3	45.7	71.2	27.2	-	-
Harvesting fruits at 75% maturity level	63.8	-	-	-	-	-
Sorting and grading	64.2	75.2	68.9	41.6	-	23.6
Pray and do nothing	25.5	30.4	43.1	15.2	-	-

Table 4: Measures taken to reduce losses

Source: Field survey, 2023

CONCLUSION AND RECOMMENDATIONS

The study concluded that postharvest loss is a major threat to tomato value chain actors in the study area as the sector creates jobs and serves as a source of income for various segments of actors operating along the value chain. The interdependence and linkages between actors along the value chain is very clear. Although, there were some challenges and constraints from one point of the value chain to another that needs to be rectified among which include but not limited to high postharvest loss. Hence, for tomato value chain to be very efficient in the study area, all the identified problems that leads to high postharvest losses have to address by collective action of stakeholders like government, NGOs, research centers, development partners and cooperatives of the different value chain actors in the study area.

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