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Determinants of Post-Harvest Losses at Different Stages along the Tomato Marketing Channels

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Abstract: *Postharvest losses have been identified as one of the key causes of food shortage problems in most developing countries and in Nigeria specifically. The study examined the determinants of postharvest losses at different stages along the tomato marketing channels in the study area. A standardized structured questionnaire was used to collect data from the respondents through a combination of purposive and simple random sampling techniques. Descriptive statistics were used to summarize the characteristics of the respondents. Furthermore, Post-Harvest Loss Estimation (PHLE) Model was also used to examine the determinants of post-harvest losses at different stages along the tomato marketing channels in the study area. The result of factors affecting tomato postharvest losses revealed that poor storage system was the major factor affecting tomato postharvest losses and was ranked first. Studies also revealed that the factors that limit the use of modern techniques for tackling postharvest tomato losses revealed that the majority of the respondents were unaware of techniques like modified atmosphere packaging (MAP), 1-methyleclypropene (I-MCP), calcium chloride, and postharvest heat treatment used to prolong the shelf life of tomatoes. Consequently, inadequate information on postharvest management practices is a major challenge that limits proper postharvest tomato handling practices. Therefore, information should be made available through adequate extension services by the government on the improvement in the traditional tomato postharvest handling practice coupled with improved management practices.*

Keywords*: Postharvest, Losses; Tomato; Storage, Marketing and Handling*

Introduction

Post-harvest operations are considered as the stage of crop production immediately following harvest up to the moment of human consumption. Postharvest loss is a major challenge hampering food availability in most developing countries. Postharvest loss is a large and

serious problem that needs to be addressed urgently and is particularly acute in developing countries where food loss reduces income by at least 15% for over 470 million smallholder downstream value chain actors, exposing them to inadequate expenditure on food leading to food insecurity (Adeoye, *et al.* 2009).

The better the postharvest handling and marketing systems, the longer the shelf life. Postharvest losses occur throughout the marketing chain from the time when tomato is harvested to the stage of sorting, grading, washing, and drying. Further, losses occur during transportation, storage, and processing (Idah, *et al.,* 2007). In developing countries like Nigeria, post-harvest losses have been highlighted as one of the determinants of food shortage (Adeoye, *et al.* 2009). Proper post-harvest storage, packaging, transportation, and handling technologies are practically insufficient for perishable crops like vegetables, thereby allowing considerable loss of the product. In the case of tomatoes about 45 percent of tomatoes harvested in the country are lost between harvest and final consumer (Adeoye, *et al.* 2009). This is despite the fact that the country has not been able to meet the domestic demand for tomatoes. The supply shortfall of tomatoes is revealed by the fact that in 2019, the Federal Government of Nigeria imported tomato paste worth sixteen billion Naira to bridge the gap between tomato demand and supply in Nigeria (SureChain, 2021). Such supply shortfalls have implications for food security seeing that not much is done to prolong shelf the life of fresh tomatoes along the marketing chain has remained limited among tomato marketers in Nigeria (Babarinsa and Dwidara, 2011).

Methodology

The study was conducted in Borno state. Borno State lies between latitudes 10^0 30^0N and 13^0 50^0N and longitudes 11^0 0^oE and 13^0 45^0E. It is located in the North Eastern corner of Nigeria (Figure 1.1) and comprises 27 Local Government Areas with a land mass of 69,450 square kilometers (Borno State Ministry of Land and Survey, 2008).

Post-Harvest Loss Estimation (PHLE) Model was used to examine the determinants of post-harvest losses at different stages along the tomato marketing channels in the study area. Therefore, samples for the study were drawn using a two-stage sampling procedure. In the first stage, based on the concentration of production and marketing of fresh tomatoes in the study area, five local government areas were purposively selected. These are Jere and Konduga Local Government areas from the Sudan Savannah, Monguno from the Sahel, and Biu and Hawul local government areas from the Guinea savannah. In the second stage, eighty (80) wholesalers and two hundred and twenty (220) retailers were selected randomly from the highly concentrated tomato markets in the five local government areas and this served as the sample size (see Table 1.1). Samples of wholesalers and retailers were taken along the marketing chain of the produce to the final consumer. The list of marketers in the tomato marketers' association in the study area was used as the sampling frame. Postharvest losses were estimated for every respondent at various stages from the farm gate marketers to the wholesalers and retailers along the tomato supply chain to the final consumer.

Table 1.1: Sampling Technique used to select tomato marketers at various marketing stages

Agro-ecological zone	Local Government Area	Community	Wholesalers sample frame/sizes	Retailers sample frame/sized	Total sample size
Sudan Savanna	Jere	Zabamari	10/20	40/80	50
		Gonglon	0/20	40/80	50
	Konduga	Alau	10/20	40/80	50
		Konduga	5/10	20/40	25
Sahel Savana	Monguno	Mune	5/10	15/30	20
		Irrigation	10/20	15/30	25
Guinea Savannah	Biu	Tum	5/10	10/20	15
		Bera	10/20	15/30	25
	Hawul	Sabon Kasuwa	5/10	10/20	15
		Kukurpu	10/20	15/30	25
					300

Source: Field Survey, 2020

The major post-harvest activities on the supply chain were harvesting, packaging, storage and transportation. The principles of computing and index estimation were used to adopt models for estimation of post-harvest losses at different post-harvest stages. The total postharvest losses at any postharvest stage for a given agricultural product are the sum of food losses occurring at each stage of the process (Aulakh and Regimi, 2013 and Bada, 2016). The Postharvest Loss Estimation (PHLE) Model is expressed as:

$$TPHL = \Sigma [\Sigma H_i + \Sigma S_i + \Sigma P_i + \Sigma R_i + \Sigma T_i] \quad (2)$$

Where,

TPHL = Total Post-Harvest Losses (kg)
Σ = Summation
H_i = postharvest losses during harvest (kg)
S_i = postharvest losses during sorting (kg)
P_i = postharvest losses during packaging (kg)
R_i = postharvest losses during storage (kg)
T_i = postharvest losses during transportation (kg)

Total postharvest losses were being determined by summing all the losses due to storage, processing, packaging etc.

Total Post-Harvest Loss Index is given by:

$$TPHLI = \frac{TPHL}{TH} \quad (3)$$

Where,

TPHLI = Total Post-harvest loss index,

TPHL = Total post-harvest loss (kg)

TH = Total Harvest (kg)

The respective ratios of H_i, S_i, P_i,R_i, and T_i, to TH were estimated to obtain indices that revealed the individual contributions of post-harvest losses at each stage of the harvest and postharvest activities. Thus,

Loss Index = (*LES/TH*) (4)

Where,

TH = Total Harvest (kg)
LES = Loss at each stage (kg) i.e:
H_i = Total post-harvest loss during harvesting (kg),
S_i = Total post-harvest loss during sorting (kg),
P_i = Total post-harvest loss during packaging (kg),
R_i = Total post-harvest loss during storage (kg), and
T_i = Total post-harvest loss during transportation (kg),

Results and Discussion

Table 2.2 revealed that the total value of tomato postharvest loss encountered by wholesales at the stage of the harvest was estimated to be ₦26,605.80 (53.21 USD) with a mean value of 2,732.4 and a standard deviation of 1,759.5. The total value of tomato postharvest losses at various stages was estimated to be ₦78,530.60 (157.06 USD). These values represent the value of deteriorated tomatoes in the wholesale market. When converted to the value of fresh tomato, this quantity of tomato would be valued at ₦2,181,400 (4,362.80 USD). The difference between the total value of deteriorated tomato and the same tomato valued as the fresh tomato was estimated to be ₦2,102,869.40 (4,205.74 USD). This huge amount of money can be part of the marketers' income which can immensely contribute to the marketers' household needs. Minimising postharvest food losses in the supply chain is a resource-efficient way that can help in strengthening food security. This great loss could cause economic losses including wrecking significant harm to the household food security status.

2.1 Quantity and Value of Tomato Postharvest Losses at Different Stages

Table 2.1 shows the quantity of tomato postharvest losses.

Table 2.1: Quantity of Losses

Stages	Quantity of Tomato Loss (basket)			
	Total Loss/basket	Mean (basket)	SD	Loss Index
Wholesalers (N = 70)				
Harvest	295.62	30.4	19.6	0.062
Sorting	79.37	21.9	15.0	0.017
Packaging	95.36	16.8	12.7	0.020
Storage	257.47	49.0	28.8	0.053
Transportation	144.76	11.5	5.8	0.030
TPHL	872.56			
TH	5111.60			
TPHLI	0.170701			
Retailers (N = 230)				
Harvest	159.18	13.2	8.5	0.054
Sorting	42.74	9.5	6.5	0.015
Packaging	51.35	7.3	5.5	0.018
Storage	138.64	21.3	12.5	0.047
Transportation	77.95	5.0	2.5	0.026
TPHL	469.84			
TH	2752.40			
TPHLI	0.170701			

Field Survey, 2020

2.2. Quantity of Tomato Postharvest Losses at Different Stages

2.2.1 Tomato Losses Among Wholesaler

Table 2.1 had a mean average loss at harvest estimated to be 30.4kg/basket and a standard deviation of 19.6. The total tomato postharvest loss at harvest was estimated to be 295.62 basket with a tomato postharvest loss index of 0.170701. The high standard deviation or mean loss indicates that tomato losses takes place at harvest level in different quantities for different marketers. Losses at the harvest stage are highest compared to other stages. This may be due to the method of handling of tomato at this stage by the farmers/marketers. Furthermore, the time taken to move the commodity from the farm could also result in spoilage. This is more pronounced for farmers that are located in remote places. A similar trend is observed both among wholesale losses and retail losses. The result in Table 2.1 indicates that apart from the harvest stage, the next point of high loss was during storage, when storage conditions are not convenient, the rate of losses is inevitable.

Table 2.1 revealed that the total quantity of tomato postharvest loss at the stage of storage was 257.47 baskets with a mean of 11.5 and a standard deviation of 28.8 while the tomato postharvest loss index was estimated to be 0.053. This shows that the quantity of tomato loss at storage was very high. This is because tomato has very high moisture content and therefore is very difficult to store at ambient temperature for a long time. Also, the required climatic conditions are also difficult to obtain in most tropical countries and therefore losses of appreciable quantities of the harvested tomatoes occurs which in turn reduces income of the marketer and consequently result in household food insecurity.

It was observed from Table 2.1 that the overall quantity of tomato postharvest losses was estimated to be 872.56 basket from a total harvest of 5111.60 basket of tomato received by wholesalers, while the total postharvest loss index (TPLI) was 0.170701. The high postharvest tomato losses could become an obstacle in achieving sustainable food security status since high postharvest losses could result in loss of income for marketers and high prices of the commodity resulting in inadequate food access. Such an occurrence could contribute to food insecurity among marketing households.

2.2.2 Tomato Losses among Retailers

It was revealed from table 2.1 that the quantity of tomato postharvest loss by retailers during the stage of harvest was 159.18 baskets with a mean of 13.2 and a standard deviation of 3.5. The standard deviation indicates that there is not much variation from the mean of losses among the respondents. The loss index during the stage of harvest was 0.054 and 0.047 during the stage of storage. The indices were high during the stage of harvest and storage in both wholesaler and retailers. The high losses at these two stages may be attributed to the fact that most tomato producers in developing countries harvest tomatoes when they are fully ripened (Aidoo *et al.* 2014). Fully ripened tomatoes are more susceptible to mechanical injuries during harvesting which result in shorter shelf life because of faster deterioration. The inability of marketers to harvest tomatoes at the correct time or to follow the vital tomatoes harvesting procedure coupled with some inefficiencies like lack of ready market and poor storage facilities explain the reasons why there are lots of losses in tomatoes during harvest and storage. This agrees with Walkins (2006). Invariably, the losses result in lower income to marketers', higher prices of tomatoes and increased food insecurity

2.2.3 Values of Tomato Postharvest Losses at Different Stages

It was revealed from Table 2.2 that the total value of tomato postharvest loss encountered by wholesales at the stage of harvest was estimated to be ₦26,605.80 with the mean value of 2,732.4 and a standard deviation of 1,759.5. The total value of tomato postharvest losses at various stages was estimated to be ₦78,530.60. These values represent the value of deteriorated tomatoes in the wholesale market. When converted to the value of fresh tomato, this quantity of tomato would be valued at ₦2,181,400. The difference between the total value of deteriorated tomato and the same tomato valued as fresh tomato was estimated to be ₦2,102,869.40. This huge amount of money can be part of the marketers'

income which can immensely contribute to the marketers' household needs. Minimising postharvest food losses in the supply chain is a resource-efficient way that can help in strengthening food security. This great loss could cause economic losses including wrecking significant harm on the household food security status.

Table 2.2: Value of Tomato Loss

Stages	Value of Tomato Loss (Naira)		
	Mean	**SD**	**Total Value of Loss**
Wholesalers (N =70)			
Harvest	2,732.4	1,759.5	739,050
Sorting	1,966.5	1,345.5	198,425
Packaging	1,511.1	1,138.5	238,400
Storage	4,409.1	2,587.5	643,675
Transportation	1,035.0	517.5	361,900
TPHL			
TH			
TPHLI			
TVFTL			2,181,400
TVPHL			78,530.60
Difference			2,102,869.40
Retailers (N = 230)			
Harvest	1,188.0	765.0	397,950
Sorting	855.0	585.0	106,850
Packaging	657.0	495.0	128,375
Storage	1,917.0	1,125.0	346,600
Transportation	450.0	225.0	194,875
TVFTL			1,174,600
TVPHL			42,285.80
Difference			1,132,314.20

Source: Field Survey, 2020

2.3 Factors Affecting Postharvest Tomato Losses

Table 2.3: Factors Affecting Postharvest Tomato Losses

Factors Affecting Tomato Postharvest Loss	Frequency	Percentage	
Bad storage system	254	84.7%	1st
poor packaging material	230	76.7%	2nd
Climate change/high temperature	427	70%	3rd
Low demand	212	70.7%	4th
Bad roads	207	69.0%	5th
Poor handling and sorting at harvest	203	67.7%	6th
Lack of adequate means of transportation	196	65.3%	7th
Poor pest control	190	63.3%	8th
High rate of rainfall	165	55.0%	9th

Source: Field Survey, 2020

Table 2.3 revealed that the majority (85%) of the tomato marketers identified bad storage systems as a major factor enhancing tomato postharvest losses in the study area and was ranked first (1st). This indicates that unfavourable hot conditions in a storage place played a significant role in food loss. Aido *et al.* (2014) and Mofa (2011) also reported in their postharvest study that the lack of adequate and effective storage facility was ranked as the most important and critical constraint of tomato postharvest handling. Table 2.4 also reported that poor packaging material is another factor enhancing postharvest tomato losses and was ranked 2nd and constituted about 77% of the responses. This is similar to Mbuk *et al.* (2011) and FAO (2014) who reported that poorly packaged food crops often get squeezed and this result in considerable food loss. The result further disclosed that high environmental temperature (3rd) which constitutes 76% of responses, lack of adequate demand for the produce at harvest (4th) as well as poor road network which constitutes 69% of respondents' opinion contributed to tomato quality being lost. This corroborates Abimbola (2014), Basappa (2007) and Seid *et al.* (2011). In addition, the result also indicated that climate change is another factor enhancing postharvest tomato losses. This factor constitutes 69% of responses while poor handling and sorting after harvest was ranked sixth (6th). Inadequate transportation constitutes about 65% and was ranked eighth (8th), pest and disease constitute about 63% and was ranked ninth (9th) while the high rate of rainfall is 55% and ranked tenth (10th). Given the study area, high temperature is a climatic factor that tomato marketing must overcome.

2.4 Effects of Postharvest Loss on Food Security Status of Respondents

Table 2.4: Effects of Postharvest Loss on Food Security Status of Households

Variables	Coefficient	Std. Err.	z
Total postharvest tomato loss	-0.1531	0.0389	-3.94***
_cons	3.2280	1.1195	2.88***
Log likelihood	-153.21292		

Source: Field Survey, 2020

Note: **,*** are significant at 5% and 1% respectively

Conclusion

The study analysed the factors affecting postharvest losses at different stages along the tomato marketing channels and concluded as follows:

1. tomato marketers were small size enterprise holders with different years of tomato marketing experience.
2. postharvest losses occurred in the course of marketing tomato from the farm to the final consumers of tomato.
3. tomato losses at harvest and storage stages were the highest due to the method of handling of tomatoes at these stages by the farmers and the marketers
4. time taken to move the commodity from the farm could also result in spoilage
5. the required climatic conditions to store harvested tomatoes are also difficult to obtain in most tropical countries and therefore losses of appreciative quantities of the harvested tomatoes occur which in turn reduces income of the marketers and consequently result in household food insecurity.
6. factors that limits the use of modern techniques for tackling postharvest tomato losses revealed that majority of the respondents were unaware of techniques like modified atmosphere packaging (MAP), 1-methyleclypropene (I-MCP), calcium chloride and postharvest heat treatment used to prolong shelf life of tomatoes.

References

Adeoye, I.B., O.M.O., Babalola, S. O. and Afolayan, S.O. (2009): Economic Analysis of Tomato Losses in Ibadan Metropolis, Oyo State, Nigeria. *African Journal of Basic and Applied Sciences* 1 (5 – 6): 87 – 92.

Aidoo, R., Danfoku, R.A. and Mensah, J.O. (2014): Determinants of Post-harvest Losses in Tomato Proluction in Northern District of Ghana. *Journal of Development and Agricultural Economics* 6 (8), 338 – 344.

Aulakh, J. and Regimi, A. (2013): Post-harvest Food Losses Estimation Development of Consistent Methodology. Economic paper No. 150363, 2013 Annual meeting (4-6), Washington, D.C.

Babarinsa, F.A. and Omodara, M.A. (2011). Improving the shelf-life of tomatoes. Role of

Bada, M. (2016): Post-harvest Losses in Marketing of Fresh Tomato in Kano State, Nigeria, unpublished M.Sc. Thesis in the Department of Agricultural Economics, Bayero University Kano, Nigeria.

Borno State Ministry of Land and Survey (2008): Annual Report.

Idah, P. A., Ajisegiri, E. S. A., and Yisa, M. O. (2007): Fruits and Vegetables Handling and transportation in Nigeria. *Australian Journal of Technology* 10(13) 175-183.

Mofa, (2011): Annual Report for Offinso North District, Ministry of Food and Agriculture, Ghana. Nigerian Stored Product Institute (NSPRI). Paper presented at the Capacity Building Programme for Tomato Production, Processing and Export in Benue State, 13-14, December, Gboko.

Surechain, (2021). Food loss in Nigeria: value chain analysis of tomato commissioned by the Centre for the Promotion of Imports from developing country. Federal Ministry of Foreign Affairs.