Effect of Tomato Post-Harvest Losses on Households' Food Security

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Abstract: *One of the main factors contributing to food shortage in Nigeria and majority of developing nations is postharvest losses. Therefore, the study examined the effect of tomato post-harvest losses on the food security status of households. The study covered losses that occurred in the course of marketing tomatoes from the farm to the final consumers of tomatoes. Samples for the study were drawn using a multi-stage sampling technique. Five local government areas that were prominent in tomato production and accessible with regard to security were purposely selected for the study. Both primary data and secondary information were used for the study. Descriptive statistics, food security index, postharvest loss estimation model, binary logistic regression, and t-test were used to analyse the data generated by the study. The findings of the study revealed that the majority of the tomato marketers in the study area were young people with strength and stability. Majority of tomato marketers were also male with small-size enterprise holdings. Small-size enterprises result in small income and small income reduces the marketers' purchasing power to reduce tomato postharvest losses. The consequence of this is food insecurity resulting from an inability to access sufficient food among marketing households. The findings of the study further revealed that the majority of the sampled marketers' households were food insecure. This was found to be attributed to the large volume of tomato postharvest loss encountered by the tomato marketers in the study area which tends to reduce household income and therefore, household food budget.*

Keywords: *Households, Income, Losses, Marketing, and Size*

1.0 Introduction

Food security is a situation that exists when all people, at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Four dimensions of food security have been identified. These are food availability, accessibility, utilization, and stability. All four of these dimensions must be achieved to have full food security (Babatunde *et al.,* 2007). More recent development

in food security studies emphasize the importance of food sustainability which may be considered as the long-term (fifth) dimension of food security.

Peng and Benny (2019) are of the opinion that food security is best considered as a causal, the linked pathway from production to consumption, through distribution to processing recognised in a number of domains, rather than as four "pillars" or dimensions. Food security and food insecurity are dynamic, reciprocal, and time-dependent and the resultant status depends on the interaction between the stresses of food insecurity and the coping strategies to deal with them. Measuring food security at the household level involves five categories of indicators including dietary diversity and food frequency, spending on food, consumption behaviours, experiential indicators, and self-assessment measurements (Peng and Berry, 2019). This study adopts the food accessibility pillar as its concept of food security. It looks at the ability of households to purchase available food in sufficient quantities to meet households' food needs. This is related to the food spending of food, category by Peng and Berry (2019).

Furthermore, postharvest loss on the other hand is degradation in both quantity and quality of food produced from immediately after harvest to consumption. Quality losses include those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product. These losses are generally considered in developed countries (Kader, 2002). Quantity losses refer to those that result in the loss of a portion of the amount of a given food product. Loss of quantity is more common in developing countries (Kitinoja, 2010).

Postharvest food loss (PHL) is the measurable qualitative and quantitative food loss along the supply chain, starting at the time of harvest till its consumption or other uses (Hodges, 2014). Postharvest loss can occur either due to food waste or due to inadvertent losses along the way. Thus, food waste is the loss of edible food due to human action or inaction such as throwing away wilted produce, not consuming available food before its expiry date, or taking serving sizes beyond one's ability to consume. Food loss on the other hand is the inadvertent loss in food quantity because of infrastructure and management limitations of a given food value chain. Food losses can either be the result of a direct quantitative loss or arise indirectly due to qualitative loss. Food loss and food waste contributed to postharvest food losses. Food loss can be quantitative as measured by decreased weight or volume or can be qualitative, such as reduction in nutrient value and unwanted changes in taste, colour, cosmetic features and texture of food (Buzby and Hyman, 2012). Quantitative food loss refers to the reduction in weight of food available for human consumption. The qualitative food loss can occur due to incidence of insect pest, mites, rodents and birds or from handling, physical changes or chemical changes in fat, carbohydrate and protein and by contamination of mycotoxins, pesticide residues, insects, fragments of excreta of rodents and birds and their dead bodies. When this qualitative deterioration makes food unfit for human consumption and is rejected, it contributes to food loss (Bada, 2016).

Ahmed (2014) analysed food security level among rural farming households in Osun state, and revealed that food insecurity line was at N69.14 per adult equivalent per day. Over 60% of the households were food insecure. The shortfall index revealed that these households fell short of recommended calorie intake by 36%. Total elasticity change revealed that 10% increase in household size led to about 24% increase in the level of food insecurity while a 10% increase in total expenditure and food allocation led to about 32% and 49% increase in the level of food insecurity respectively. Food insecurity was influenced by income earning opportunities,

agricultural production inputs, access to remittance, improved asset base and production capacities of the households. Furthermore, Mohiuddin *et al*. (2016) in their study on poverty, food security status of farm households in some selected areas of Bangladesh reported that out of 150 households, about 24% of the households were below the lower poverty line and about 37% were below the upper poverty line. About 19% lay below the hardcore poverty line and about 35% lay below the absolute poverty line. The study observed that on the average, the rural households were more or less secure in relation to availability of food round the year.

FAO (2008) disclosed that there are no clear statistics to ascertain that the food insecurity condition is the same at household level especially in rural areas of South Africa. The result of the study also revealed that about 14 million people or 35% of the population of the country were estimated to be vulnerable to food insecurity. One and half million or one quarter of children under the age of six had stunted growth due to malnutrition. Food insecurity is more prominent in rural areas (Toit et al. 2011).

2.0 Methodology

2.1 The Study Area

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 and comprises 27 Local Government Areas with a land mass of 69,450 square kilometers (Borno State Ministry of Land and Survey, 2008). It shares international borders with the Republic of Niger to the north, Chad to the north-east and Cameroun to the east. Within Nigeria, its Neighboring states are Adamawa to the south, Gombe to the south-west and Yobe to the west. It has a projected 2019 population of 5,175,244 people from 2006 census at an annual growth rate of 3.2 percent (NPC, 2006). It has hot climate with temperatures ranging between 35^{0C} and 40^{0C} for a greater part of the year. It has a short period of rainfall from July to September with an average of about 647mm per annum (Lake Chad Research Institute, 2007). This climate presents short raining season suitable for tomato production and high temperature that contributes to hasten tomato deterioration after harvest. Agriculture is the main stay of the Borno state economy. Major crops grown include: Maize, Cowpea, Millet, Sorghum, Rice, Groundnut, Soybean and Wheat. Vegetables cultivated in the state include Onion, Tomatoes, Pepper, Garden eggs and other leafy vegetables. Major livestock kept include: Cattle, Sheep, Goat and Poultry. Major occupations of the people include Civil service, trading as well as farming. The major ethnic group is Kanuri. Others include Babur/Bura, Shuwa Arabs, Margi, Fulani, Hausa and many immigrants from within and outside Nigeria (Borno State Agricultural Development Programme, (BOSADP, 2007)

2.2 Sampling Procedure

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). 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: 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

2.3 Data Analysis
Household Food Security Index (Income and Expenditure Method) was used to examine the effect of tomato post-harvest losses on the food security status of households. The index was developed by Ononoma *et al.* (2007). The food security index is given by:

$$F_i = \frac{\text{per capita food expenditure of the } i^{th} \text{ household}}{\frac{2}{3} \text{ mean per capita food expenditure of all households}} \quad \text{...........................(1)}$$

Where:

F_i = food security index
when $F_i \geq 1$, i^{th} household is food secure
when $F_i < 1$, i^{th} household is food insecure

$$PCFE = \frac{HFE}{HHS} \quad \text{.. (2)}$$

Where:
PCFE = Per capita food expenditure
HFE = Household food expenditure
HHS = Household size
Also
$$MPCFE = \frac{\Sigma PCFE}{TNR} \quad \text{.. (3)}$$
Where:

MPCFE   =   mean per capita food expenditure   ………………………………… … *(4)*

Σ =   Summation

PCFE   =   per capita food expenditure

TNR   =   total number of respondents

Furthermore, determinants of food insecurity of households were modeled as shown in the below equations. The model is Logit regression:

$$Y_i = g(I_i) \qquad \text{……………………………………………………………………} (5)$$

$$I_i = b_0 + \sum_{j=1}^{n} b_j X_{ji} \text{ ………………………………………………………...} (6)$$

Where,

Yi is the observed response for the ith observation (i.e. the binary variable, $Y_i = 1$ for food secure household and $Y_i = 0$ for a food insecure household). It is an underlying and unobserved stimulus index for the ith observation (conceptually, there is a critical threshold (I_i^*) for each household; if $I_i \geq I_i^*$ the household is observed to be food secured). If $I_i < I_i^*$ the household is observed to be food insecure, g is the functional relationship between the field observation (Y_i) and the stimulus index (I_i) which determines the probability of being food secure.

The logit model assumes that the underlying stimulus index (I_i^*) is a random variable, which predicts the probability of being food secure. Therefore, for the ith observation (a household):

$$Yi = \text{In} \frac{P}{1-P_i} = bo + \sum_{j=1}^{n} b_j X_{ji} \text{ ……………………………………………………….} (7)$$

Where Yi = food security status of ith household (where 1 = food, 0 = food insecure)

The relative effect of each explanatory variable (X_{ji}) on the probability of being food secure is measured by differentiating with respect to X_{ji} using the quotient rule:

$$\frac{dP_i}{dX_{ji}} = \left[\frac{e^{1i}}{(1+e^{1i})^2}\right]\left[\frac{I_i}{X_{ji}}\right] \text{ ………………………………………………………………} (8)$$

Where:

P_i =   the probability of an ith household being food secure

X_i =   vector of explanatory variables which are defined below

X_1 =   total postharvest loss (₦)

X_2 =   income from sales of tomato (₦)

X_3 =   marketing experience (years)

X_4 =   enterprise size (basket)

X_5 =   age of household head (years)

X_6 =   educational qualification of household head (years)

X_7 =   household size (number)

X_8 =   sex (where 1 = male, 0 = otherwise)

X_9 =   marital status (where 1 = married, 0 = otherwise)

X_{11} =   household consumption (₦)

X_{12} =   secondary occupation

In addition, t-test was used to show the difference in household food security with food loss and without food loss.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{SE\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (9)$$

where:

t = student t-test

x_1 = mean of food security index of tomato marketing households assuming there were no tomato losses in marketing

x_2 = mean of food security of tomato marketing households who suffered tomato losses in marketing

S^2 = standard error

n_1 & n_2 = number of observations in each group (with losses and without losses respectively)

3.0 Results and Discussion
3.1 Socio-economic Characteristics of Tomato Marketers
The descriptive statistics of the sampled tomato marketers as presented in Table 2 shows the descriptive features of the tomato marketers in the study area. These features include age, sex, marital status, years of formal education, household size, average weekly income, marketing experience, access to credit, enterprise size, sources of credit, and secondary income.

Table 2: Socioeconomic Characteristics of Respondents

Age (Years)	Frequency	Percentage	Mean	S.D
<20	3	1.0		
20-30	74	24.7		
31-40	98	32.7	40	12.32
41-50	77	25.7		
51-60	40	13.3		
>60	8	2.7		
Sex				
Female	53	17.7		
Male	247	82.3		
Marital Status				
Married	279	93.0		
Single	15	5.0		
Divorced	4	1.3		
Widowed	2	0.7		
Year of formal schooling (years)				
No schooling	8	2.7		
1-6	127	42.3		
7-12	118	39.3	8	1.23
13-18	39	13.0		
>18	8	2.7		
Household size				
<3	36	12.0	8	

3-6	91	30.3	
7-10	160	53.3	1.03
11-13	7	2.3	
>13	6	2.0	
Weekly total household income(₦)			
<10000	24	8.0	
10001-20000	146	48.7	
20001-30000	79	26.3	
30001-40,000	24	8.0	18,000 2003.1
40,001-50000	15	5.0	
>50000	12	4.0	

Source: Field Survey, 2020

3.2 Food Security Status of Respondent Household

Table 3 shows the food security status of tomato marketing households in the study area.

Table 3: Food Security Status of Respondent Households

Status	Frequency	Percentage	Food Security Index
Food insecure	245	81.7%	
Food secure	55	18.3%	
Total	300	100.0%	₦4,454.45 (8.91 *USD*)

Source: Field Survey, 2020

Table 3 revealed that about 82% of the respondent households were food insecure while 18% of the tomato marketers' households were food secure. The result of the study revealed that the mean per capita food expenditure per month was estimated to be ₦4,454.45 (8.91 *USD*) (and this value was used as the food security index. This means that any respondent whose per capita weekly food expenditure is less than ₦4,454.45 (8.91 *USD*) (food security index) was considered to be food insecure. The large proportion of households with per capita income of less than ₦4,454.45 (8.91 *USD*) indicated large proportion of tomato marketers had low income. The result of this study indicated that majority (82%) of the sampled marketers' households were food insecure. This could be as a result of inadequate income to access sufficient food per capita. This corroborates Babatunde *et al.* (2007), Amaza *et al.* (2008) and Ahmed (2014) who observed that majority of sampled households were food insecure. This could in part be attributed to the large volume of tomato postharvest loss encountered by the tomato marketers in the study area which could reduce household income.

3.3 Effects of Postharvest Loss on Food Security Status of Respondents

Table 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.

The result from Table 5 shows that the coefficient of total tomato loss (x_1) is negative and significant at 1% level. This implies that as the marketer's tomato loss increases the likelihood of being food insecure increases. This implies that there is an inverse relationship between tomato loss and the food security of tomato marketing households.

3.4 Effects of Socioeconomic Characteristics on Food Security Status of Respondents' Households

Table 5: Effects of Socioeconomic Characteristics on Food Security Status of Respondents

Variables	Coefficient	Std. Err.	z
Income	0.3570	0.0143	25.0***
Market experience	0.1873	0.0775	2.4**
Enterprise size	0.1208	0.0358	3.4***
Age	-0.2392	0.0903	-2.7***
Years formal education	0.2296	0.0175	13.1***
Household size	0.1215	0.0139	8.7***
Sex	-0.0063	0.0256	-0.2NS
Marital status	0.3714	1.4715	0.3NS
Expenditure	0.3612	0.0571	6.3***
Hh consumption	-0.5134	0.1654	-3.1***
Secondary occupation	-0.5263	0.1497	-3.5***
_cons	-1.5752	0.3730	-4.2***

Source: Field Survey, 2020

Note: **,***< NS are significant at 5% ,1% not significant respectively

Average income (x_2) had positive coefficient and was statistically significant at 1%. Marketers income has positive effect on food security status, implying that the less the marketers earn the less the chances of their households being food secure. Decrease in income is expected to decrease the purchasing power of the respondents and their access to more quantitative and qualitative food. This agrees with Oluyole (2011), Ahmed (2014) and Mohiuddin *et al.* (2016) who reported that an increase in income increases the likelihood of the marketer being food secure. The coefficient of marketing experience (x_3) is positive and statistically significant at 5% level. An experienced marketer is expected to have more insight on how to reduce losses to enhance food security. This agrees with Adeoye *et al.* (2009) who observed that experience is the most important tool for acquiring new ideas and skills that bear positively on scope of enterprising, income and profit.

Results from Table 5 also show that enterprise size is an important factor that has an effect on the food security status of the marketers. The coefficient of enterprise size (x_4) is positive and statistically significant at 1% level. This implies that the larger the enterprise size the higher the expected level of income which will enhance access to food in sufficient quantities and qualities resulting in more food secure households This agrees with Abimbola (2014).

The coefficient of age (x_5) is shown in Table 3.4 to be negative and statistically significant at 5% level. This implies that as marketer's age increases, the likelihood of being food secure decreases. Young and energetic marketers are expected to handle the marketing of tomatoes better than the older and weaker marketers. Also older marketers may not have the ability to obtain off-farm farm jobs and income which younger marketers can do, thus, increasing the food

security of households headed by younger men. This agrees with the finding of Bakari and Usman (2013), Iyade (2013), and Dorothy and Ikechi (2013) who reported that vegetable marketing is mostly dominated by young people who can withstand the rigours of vegetable marketing.

The result from Table 5 further indicated that the coefficient of years for formal education (x_6) is positive and statistically significant at 1% level. This implies that increase in years of formal education level increased the likelihood of tomato marketing household to be food secure. Education affords marketers' increased capacity for more efficient marketing of tomatoes to reduce losses, hence increasing their income. Food security incidence increases with increase in level of education (Omonona *et al.,* 2007). Low education hampers more profitable entrepreneurship. This also agrees with Ikechi and Shelaby (2018) who reported that educational level affects market information and interpretation and hence has great impact on vegetable marketing.

It was also revealed from the result of the study in Table 5 that the household size (x_7) had a positive coefficient and was statistically significant at 1% level. This implies that there is direct relationship between household size and food security status of the household members. This agrees with Ikechi and Shelaby (2018) who reported that a lot of vegetable marketers had more people in their household indicating that larger households will contribute more to family labour and equally entails great mouth to feed.

The findings presented on Table 5 further revealed that the coefficient sex (x_8) is negative and not significant. This implies that the more household heads are female, the more the food insecure the household will be. This is in line with the findings of Olayemi *et al.* (2011). The coefficient of marital status (X_9) is positive but statistically not significant. Table 5 also indicated that household expenditure (x_{10}) had a positive coefficient and was statistically significant at 1% level. This implies that there is a direct relationship between household expenditure and food security status. In other words, household food security status is expected to increase as household monthly expenditure increases. The more the household expands, the more likely more expenditure will be made on food to household's food being the most basic of household consumption expenditure. This finding is in line with Babatunde *et al.* (2007) that household food security decreases as food consumption increases.

Household consumption (x_{11}) has negative coefficient and was statistically significant at 5% level. This implies that there is an inverse relationship between consumption and food security status. In other words, food security status is expected to decrease as a result of unit increase in food consumption. This study is in line with Oluyole (2011) who opined that food security status of household decreases with an increase in food consumption. The larger the household size, often the larger the consumption, thus, the less the food security.

Conclusion

The study examined the effect of tomato post-harvest losses on households' food security and drawn the following conclusions; Majority of the sampled marketers' households were food insecure. This was found to be attributed to the large volume of tomato postharvest loss

encountered by the tomato marketers in the study area which tends to reduce household income and therefore, household food budget. However, household that had no postharvest tomato losses were significantly more food secure than households that had postharvest tomato losses. Furthermore, Marketers had been able to market their tomatoes without losses, food security situations of their households would have been significantly higher and many more households would have been above the food security line.

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