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FACTORS INFLUENCING POST-HARVEST LOSS IN MARKETING OF SELECTED VEGETABLE CROPS AMONG MAJOR VALUE CHAIN ACTORS IN ADAMAWA STATE, NIGERIA

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ABSTRACT
This studied the factors influencing post-harvest loss in marketing of selected vegetable crops among major value chain actors in Adamawa State, Nigeria. A multi-stage sampling procedure was used to select the total of 316 marketers comprising 89 wholesalers, 128 retailers and 99 processors. Data were collected using structured questionnaire and analysed using inferential and descriptive statistics. The result of the regression analysis shows that, for tomato wholesalers, age, household size and duration were significant ($P<0.01$) with R^{-2} of 82%, for pepper wholesalers, the result shows that, household size, duration and distance were significant ($P<0.01$) with R^{-2} of 61%, and for okra wholesalers, the result shows that, household size, duration and distance were significant ($P<0.01$) with R^{-2} of 57%. Also, for the tomato retailers the result shows that, age, household size and duration were significant ($P<0.01$) with R^{-2} of 77.75%, for pepper retailers the result shows that, years of marketing experience, duration and distance were significant ($P<0.05$) with R^{-2} of 53.32% and for okra retailers the result shows that, household size, duration and distance were significant ($P<0.01$) and age was significant ($P<0.05$) with R^{-2} of 66.05%. Similarly, for tomato processors, the result shows that age, years of marketing experience, duration and distance were significant ($P<0.01$) with R^{-2} of 80.56%, for pepper processors the result shows that duration and distance were significant ($P<0.01$) and years of marketing experience was significant ($P<0.05$) with R^{-2} of 72.66% and for okra processors, the result shows that, years of marketing experience, duration and distance were significant ($P<0.01$) with R^{-2} of 74.77%. The mode of transportation designed to convey vegetable produce only were the major strategy statement adopted by the wholesaler with mean score of 4.7, while access to capital by financial institutions were the major strategy statement adopted by retailers and processors with mean scores of 4.4 and 4.3 respectively. It is therefore concluded that, age, household size, years of marketing experience, duration and

distance significantly influences the quantity of tomato, pepper and okra. The studied recommended that, training on post-harvest loss management practices be given to the value chain actors (marketers) by the extension agents..

Keywords: Factors, Value Chain Marketers, Vegetable Crops

INTRODUCTION

The socio-economic factors influencing households' vegetable crop production and marketing are central in decision making with the main objective of meeting their subsistence needs and incomes. Socio-economic factors influence allocation of household resources in agricultural production activities undertaken. The outcome of the decision making process of the farm household is reflected in their production pattern, farm productivity, incomes and livelihoods (Theresa *et al.,* 2015).

Post-harvest loss is defined as losses that occur during or after harvest, through the value chain until the crop reaches the consumer (Kate *et al*., 2018). Vegetable crops are the most perishable agricultural produces facing a tremendous loss from harvest to consumption as majority of the farm produce are lost to pest, rodents and deterioration due to lack of proper post-harvest techniques and storage (Nintin *et al.,*2017).

In Nigeria, vegetable crops are produced in different agro-ecological zones by commercial as well as small scale farmers both as a source of income as well as food. The country, even though richly blessed in agricultural resources, have acute fruits and vegetable shortages thus cannot met up with the food and nutrition requirements of the citizenry due to improper post-harvest management of these fruits and vegetables (Sambo *et.al*., 2018).

Aliyu (2018) reported that, Nigeria is losing on the average 50% of the food produced to post-harvest loss with specific commodities recording higher percentage, about 60% for plantain, 70% for tomatoes and other fresh fruits and vegetable are lost after production

The effects of losses after harvest of both quantity (weight losses) and quality deprive farmers and traders of the full benefits of their labour. Concerns about food insecurity have grown in Sub-Saharan Africa due to rapidly growing population and food price volatility (Yahaya and Mardiyya, 2019).

Post-harvest loss reduction strategies offer unique income and food security opportunities for the over 200 million people that face food insecurity in the sub-Saharan Africa (FAO, 2019; Kikulwe *et al*., 2018)

RESEARCH METHODOLOGY

The Study Area

Adamawa State was selected for the study because of its abundant water bodies (River Benue, River Gongola and River Yedzaram) and favourable weather that promotes the cultivation of many crops especially vegetables. The State was created in 1991 from the defunct Gongola State and is located in the north-eastern part of Nigeria between

latitude 7^0N and 11N^0 and longitude 11^0E and 14^0E (National Geospatial Intelligence Agency, 2012)

The State is bordered to the north-east by Borno State, Gombe State to the west, Taraba State to the south-west and forms a national border to the east with Cameroon. The State has four agricultural zones according to Adamawa State Agricultural Development Project (AADP) zoning and occupies land area of 36, 917 km and has a projected population figure of 4,502,155 at population growth rate of 30% annually. (National Population Commission [NPC], 2018

Method of Data Collection

Structured questionnaire was designed for all the major value chain marketing actors in post-harvest handling chain (wholesalers, retailers and processors) to obtain information on the factors influencing quantity of post-harvest loss of tomato, pepper and okra and information on management strategy statements adopted by vegetable crops value chain marketers in reducing post-harvest loss of selected vegetable crops.

Method of Data Analysis

Data for the study were analysed using descriptive and inferential statistics.

Model Specification

At marketers level (wholesalers, retailers and processors), the following production model were used:

(i) The linear model:

$$Y = bo + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + e \quad \text{... (1)}$$

where;

Y = Quantity of post-harvest loss of tomato, pepper and okra.
X_1 = Age (years)
X_2 = Household size (number)
X_3 = Experience (years)
X_4 = Duration (time taken before selling the crops) (day/s)
X_5 = Distance from farm/purchase point to point of sale (km)
b_0 = Intercept
b_1.b_5 = Coefficient of the variables
e = Error term

ii) The Semi-log model:

$$Y = b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + b_5\log X_5 + e \quad \text{... (2)}$$

(iii) The Double log model take the form:

$$\text{Log } Y = bo + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + b_5\log X_5 + e \quad \text{... (3)}$$

e = Error term

(iv) The Exponential model takes the form:
$\text{Log } Y = b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+e$ ... (4)
where;

Variables of equations 2, 3 and 4 are explained in equation 1.

Table 1 shows that age, household size and duration were significant at (P<0.01) level of probability for the quantity loss of tomato loss of the wholesalers. This implies that for age, 1unit increase in the age of the respondents will increase the value of the quantity of tomato loss by 0.2415 units. This indicates that the more the respondent's ages in life, the more they improved on their knowledge in handling of losses in tomato quantity in all the operations in the post-harvest chain. More so, 1 unit increase in the household size will increase the value of the quantity of tomato loss by 0.1402.This implication is that, the more the house hold size increases the more the labour supply for the head of the household in handling different operations in the post-harvest chain that will greatly improved in reducing loss in quantity of tomato .Similarly, 1 unit increase in the duration of the crops before sales will increase the value of the quantity of tomato by 0.5941 units. This shows that the longer the time taken for the crops before sell the more it deteriorates due its perishability nature. The coefficient of determination (R^{-2}) was 82%. Table 1 shows that, household size, duration and distance were significant at (P<0.01) level of probability for pepper wholesalers. For the household size, 1 unit increase in household size will lead to an increase in post-harvest loss by 0.1694 units, similarly, 1 unit increase in duration; will increase in quantity loss of pepper by 0.5770 units, while 1 unit increase in the distance will lead to an increase in post-harvest loss by 0.0011 units. The implications is that, the more the distance it takes before the crop reaches the point of sale the more its spoils due its high perishability nature and exposure to the environments by many factors such as mechanical injury.

RESULTS AND DISCUSSION

Table 1: Factors Influencing Quantity of Post-harvest Loss of Tomato, Pepper and Okra among Wholesalers

Variables	Tomato Coefficient	Std. error	t-value	Pepper Coefficient	Std. error	t-value	Okra Coefficient	Std. error	t-value
Constant	2.9922	0.1390	19.37***	1.5152	0.3108	4.88***	1.5153	0.3108	4.88***
Age	0.2415	0.0988	2.44***	0.0058	0.0076	0.76NS	0.0058	0.0076	0.76NS
Household size	0.1402	0.0223	6.28***	0.1694	0.0512	3.31***	0.1694	0.0512	3.31***
Years of Experience	0.0630	0.4911	1.28NS	0.0120	0.0099	1.21NS	0.0120	0.0099	1.21NS
Duration	0.5941	0.0938	6.34***	0.5770	0.2021	2.85***	0.5770	0.2021	2.85***
Distance	0.0405	0.0407	0.1NS	0.0011	0.0001	8.46***	0.0011	0.0001	8.46***
R^2	83.00%			63.33%			61.00%		
R^{2-}	82%			61.00%			57.00%		
F-Statistics	81.45***			18.97***			11.51***		

*** = P<0.01, NS= Not Significant
Source: Field Survey (2019)

The coefficient of determination (R^{-2}) was 61.00%. This assertion agrees with Tadesse *et al*. (2018) who reported that distance to nearest market had positive effect on potato post-harvest loss and found to be statistically significant at (P<0.01) significance level.

Similarly, household size, duration and distance were significant at (P<0.01) probability level. This signifies that the larger the household size, the more it supply labour for different operation for the household head that will help in reducing the loss that the respondents will incur,hence1 unit increase in household size will lead to an increase in the value of okra by 0.1694 units.. More so, 1 unit increase in duration of the crops before sells will lead to the increase in the value of loss of okra by 0.5770 units. Hence, duration has an effect on the quantity loss of okra as the more the time it takes before the crop is sold the more it spoil and the more the loss in value of the crop. A unit increase in distance will result to an increase in the value of quantity loss of okra by 0.0011 units. This implies that, the longer the distance it takes before the crops reaches its destination for sales the more it spoils due to its perishable nature and other factors. The coefficient of determination (R^{-2}) is 57.00%.The study agrees with the findings of Zamasiya *et al.* (2014) who found that gender of household head had a negative effect while distance to the market had a positive influence on market participation by smallholder farmers

Table 2 showed that, tomato retailers, age, household size and duration are significant at (P<0.01) level of probability. The result shows that, 1 unit increase in age will lead to a loss in tomato quantity by 0.2853. This implies age, had a role in affecting the quantity loss of tomato in the study area in that, the more the respondents' ages in life, the more they have declined knowledge in handling of the crops in different operations. Similarly, 1 unit increase in household's size leads to an increase of 0.1576 units in the handling of the value of quantity loss of tomato crop. This implies that, the more the household supply , the more it supply labour to the household head and assist in different operations of reducing losses in that crop. This implies that the more the duration it takes before the crop is sold, the more it spoilt due its perishability nature. Also, 1 unit increase in duration will lead to an increase of tomato value by 0.6019 units. The coefficient of determination (R^{-2}) is 77.75%.This study agrees with Kikulwe *et al*. (2018) who reported that sex of the household head, household size, education, monthly production of bananas, specialization (proxies by the proportion of total land under bananas), and an interaction between district and distance to tarmac road significantly influence the level of post-harvest loss Also, Table 2 show that, years of experience, duration and distance were significant at (P<0.05) for pepper retailers. A unit increase in years of experience will lead to increase in post-harvest loss by 0.3460

Table 2: Factors Influencing Quantity of Post-harvest Loss of Tomato, Pepper and Okra among Retailers

		Tomato			Pepper			Okra	
Variables	**Coefficient**	**Std. Error**	**t-value**	**Coefficient**	**Std. error**	**t-value**	**Coefficient**	**Std. error**	**t-value**
Constant	2.6879	0.1413	19.02**	2.9165	0.6514	4.48***	3.0248	0.6737	4.49***
Age	0.2853	0.0992	2.87***	0.6418	0.4695	1.37NS	1.0456	0.4856	2.15**
Household size	0.1576	0.0244	6.45***	0.2230	0.1444	1.54NS	0.3828	0.1493	2.56***
Years of experience	0.0079	0.0407	0.19NS	0.3460	0.1667	2.07**	0.1183	0.1725	0.69NS
Duration	0.6019	0.0908	6.63***	0.6453	0.2955	2.18**	0.9419	0.3056	3.08***
Distance	0.0008	0.0283	0.29NS	0.1209	0.0613	1.97**	0.1522	0.6334	2.40***
R^2	78.62%			64.10%			69.35%		
R^{2-}	77.75%			53.32%			66.05%		
F-Statistics	89.75***			3.99***			5.86***		

*** = P<0.01, ** = P<0.05, * =P<0.1 NS= Not Significant
Source: Field Survey (2019)

Similarly, 1 unit increase in duration will lead to increase in post-harvest loss of pepper by 0.6453, while 1 unit increase in the distance of the crops will lead to an increase in pepper quantity loss by 0.1209 units the coefficient of determination (R^{-2}) is 53.32 %.

The study agrees with the findings of Ashish *et al*. (2018) who reported that weather; timely labour availability and storage facility was found significant factors affecting post harvest losses at farm level negatively.

Similarly, household size, duration and distance are significant at (P<0.01) level of probability and age is significant at (P<0.05) level of probability for okra retailers. The result reveals that 1 unit increase in the household size will lead to the increase in the value of quantity loss of okra by 0.3828 units. This agrees with the findings of Mary (2021) who reported that the results from multiple linear regression show that unreliable market, lack of credit, age of grape at harvest, quantity of grapes harvested and experience are the major statistically significant determinants (P<0.05) that influenced the post-harvest losses of grapes at farm level. This signifies that the larger the household size, the more it supply labour for different operation for the household head that will help in reducing the loss that the respondents will incur.

More so, 1 unit increase in duration of the crops before sells will lead to the increase in the value of quantity loss of okra by 0.9419 units. Hence duration has an effect on the quantity loss of okra as the more the time it takes before the crop is sold the more it spoil and the more the loss in value of the crop. A unit increase in distance will result to an increase in the value of quantity loss of okra by 0.1522 units This assertion agrees with Tadesse *et al*. (2018) who reported that larger number of working age family size provides higher labour force to undertake potato production and post-harvest handling activities. The coefficient of the variable indicated that the increase in one number of working age family size reduced quantity post-harvest by 2.2499 quintal or the decrease in one number of working age family size increased quantity post-harvest loss by 2.2499 quintal.

A unit increase in the age of respondents leads to an increase in the value of quantity loss of okra by 1.0456 units. This implies age had a role in affecting the quantity loss of okra in the study area in that, the more the respondents' ages in life, the more their knowledge in handling losses of the crops in different operations depreciate to its lowest minimum due poor memory retentions.. The coefficient of determination (R^{-2}) is 66.05%. Table 3 shows that, age, years of experience, duration and distance are significant at (P<0.01) level of probability. This indicates that, for age, 1unit increase in the age of the respondents will increase the value of the quantity of tomato loss by 0.2625 units. This indicates that the more the respondent's ages in life, the more they improved on their knowledge in handling of losses in

Table 3: Factors Influencing Quantity of Post-harvest Loss of Tomato, Pepper and Okra among Processors

	Tomato			Pepper			Okra		
Variables	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value
Constant	1.5086	1.0833	1.39*	0.1402	0.0223	6.28***	1.2321	0.2844	4.33***
Age	0.2625	0.1001	2.62***	0.3652	0.6613	0.55NS	0.0030	0.0074	0.40NS
Household size	0.2342	0.1999	1.17NS	0.3227	0.1733	1.86NS	0.0065	0.0133	0.48NS
Years of experience	0.8765	0.2563	3.42***	0.4814	0.2222	2.17**	0.0287	0.0086	3.33***
Duration	0.6276	0.0923	6.8***	0.5941	0.0939	6.34***	0.2069	0.0819	2.53***
Distance	0.3355	0.0888	3.78***	0.2845	0.0770	3.70***	0.1354	0.0230	5.90***
R^2	81.56%			76.61%			76.06%		
R^{2-}	80.56%			72.66%			74.77%		
F-Statistics	82.25***			82.25***			6.06***		

*** = P<0.01, ** = P<0.05, * =P<0.1 NS= Not Significant
Source: Field Survey (2019)

Tomato quantity in all the operations in the post-harvest chain. A unit increase in the years of experience will leads to an increase in the value of quantity loss of tomatoby 0.8765 units. This implies that the more the years of experience in post-harvest loss handling of the vegetable crop, the more increase in knowledge and experience in handling of the crops and minimizing loss in the course of its handling in the post-harvest chain. Moreover, a unit increase in duration of the crops leads to an in the value of quantity loss of tomato by 0.6276 units.

Similarly, 1 unit increased in the distance it takes to selling point increase the value of the total quantity loss (Y) by 0.3355 units. This implies that the longer the distance it takes before the vegetable crops reaches the point of sale, the more it deteriorates in quality and quantity because of their easy perishable in nature; they need to be sold off in short distances and nearby markets to avoid loss. The coefficient of determination (R^{-2}) is 80.56%. This agrees with the findings of Mary (2021) who reported that the quantity of grapes purchased/handled, the time grapes stayed in the market before being sold and the distance from the farm to the market positively and significantly affected post-harvest loss of grape traders. This indicates that the larger the quantities of grapes bought by traders the higher the mean percentage loss of grapes at traders' level at ($P<0.01$), other factors held constant. This is because large quantities of grapes purchased demands ready market and proper management practices in maintaining quality. Since traders have no storage facilities at their premises, it becomes difficult for them to maintain grape quality, resulting into post-harvest losses.be due to geographical differences, the crop under study and post-harvest management practices.

Also, duration and distance are significant at ($P<0.01$) level of probability; years of experience is significant at ($P<0.05$) level of probability. The result therefore indicates that 1 unit increase in duration before the crop is sold will increase the in the value of quantity loss of pepper by 0.5941 units. This implies that the duration i.e. time taken before selling of crops has effects on the quantity of pepper loss. The more the duration the more it spoils and the more the loss in the quantity of the crop his agrees with the findings of Mebratie *et al.* (2015) who stated that the number of days in finishing selling showed a positive impact on the proportion of the spoilage of tomatoes and bananas. Similarly, 1 unit increase in the years of experience of pepper respondents will lead to an increase in the value of quantity loss by 0.4814 units. Similarly, 1 unit increase in distance leads to an increase in the value of quantity loss of pepper by 0.2845 units. This implies that the longer the distance it takes before the crops are disposed for the more likely it will spoil due its perishable nature and some factors that affect it such as mechanical injury. The coefficient of determination (R^{-2}) is 72.66%.

Also, for okra processors, years of experience, duration and distance to point of sale were significant at ($P<0.01$) level of probability. From the result it indicates that, 1 unit increase in years of experience of the respondents will lead to an increase of total okra quantity by 0.0287 units. This implies that the respondents have experience in the field of handling loss of the crops. Similarly, 1 unit increase in duration will lead to an increase of okras total quantity by 0.2069 units. This implies that the more the crops stays without been sold the more it get spoilt. Similarly 1 unit increase in the distance to point of sale will result to an increase in the value of quantity loss of okra by 0.1354 units.

The coefficient of determination (R^{-2}) is 74.77%. The result agrees with the findings of Ashish *et al*. (2018) used multiple regression analysis in a study in Nigeria to estimate the socio-economic determinants of commercialization among smallholder farmers. The study established that household size, income, farming experience, farm size, distance to market and membership in associations significantly influenced commercialization among the smallholder farmers.

Table 4: Management Strategy Statements among the Value Chain Actors (marketers) in Reducing Post-harvest Loss

	Statement	Wholesalers (n =89)	Retailers(n = 128)	Processors (n = 99)
i.	Mode of transportation designed for conveying of fresh produce only	4.7	4.2	4.2
ii.	Good quality roads should be provided by the government	4.7	4.2	4.1
iii.	Cold/dry storage facilities should be provided	4.5	4.2	4.2
iv.	Monitoring of produce quality should be ensured.	4.5	4.1	3.9
v.	Careful handling of the produce should be adhered..	4.2	4.3	4.2
vi.	Use of modern packaging be adopted	4.2	4.1	4.0
vii.	Facilities for training should be provided by the government	4.2	4.2	4.2
viii.	Handlers should be trained in their operations	4.3	4.2	4.1
ix.	Access to capital by financial institution be encouraged.	4.7	4.4	4.3
x.	Effective measures against animals should be promoted.	4.6	4.2	4.3

Mean Score = 3.0

Source: Field Survey (2019)

Table 4 shows that, the mode of transportation be designed for conveying fresh produce only and access to capital by financial institution mean score of 4.7 for the wholesalers. Good quality of roads that should be provided by the government and access to capital by financial institution also ranked first for the wholesalers with a mean score of 4.7. Similarly, for the retailers, access to capital by financial institution had a mean score of 4.4. as their major strategy For the processors, access to capital by financial institution and effective measures against animals had a mean value of 4.3.Since all the mean scores of the value chain marketing actors was greater than 3.0, the management strategies adopted by them will go a long way in reducing post-harvest loss in the study area. This agrees with the finding of Leelanda *et al*. (2021), who reported that adequate and good transportation reduces the loss in quantity and quality of crops. Similarly, for the wholesalers, access to capital by financial institution and effective measures against animals had a mean score of 4.6. Also, for the retailers, result shows that, the careful handling of the produce to adhere had a mean score of 4.3.

Similarly, for the processors, mode of transportation designed to convey for fresh produce only, the cold/dry storage facilities should be provided by the government and facilities for training be provided by the government had a mean score of 4.2. It can therefore be deduced that the management strategies adopted by all the actors can reduce loss of the vegetable crops in the study area since all their mean scores is greater than 3.0.

Similarly, for the wholesalers', cold/dry storage facilities be provided by the government and adequate monitoring of produce quality be ensured had a mean score of 4.5.

Also, for the retailers, the result shows that, careful handling of the produce and good quality of roads be provided by the government, adequate facilities for training should be provided by the government , the handlers to be adequately trained and effective measures against animals had a mean scores of 4.1. Also, for the processors the result of Table 4 indicates that, good quality of roads that should be provided by the government, and the handlers to be adequately trained had a mean score of 4.1. These strategies adopted by all the value chain marketing actors have tendency of reducing vegetable crop loss in the study area as their mean values was greater than the bench mean value of 3.0. The study agrees with the findings of Collins *et al*. (2015) who reported that implementation of technologies and new handling techniques, with the aim of enhancing produce quality and prolonging produce shelf life.

Also, for the wholesalers the result shows that, handlers should be adequately trained in their operations had a mean score of 4.3. For the retailers', the result indicates that, monitoring of produce quality be ensured and the use of modern packaging had a mean score of 4.1. Similarly for the processors, result shows that, the use of modern packaging had a mean score of 4.0. Since the mean scores of all the value chain marketing actors was greater than 3.0, therefore, these management strategies statements adopted, will go a long way in reducing loss of the vegetable crops in the study area.

The implication is that losses in both quantity and quality will reduced and the marketers will gain profit from the sales of their produce since the crops are not damaged or injured to mechanical injuries , bruises or any form of distortions. The study agrees with the findings of James *et al*. (2017) who reported that physical damage is normally caused during the packaging of the unprocessed products which is affected by numerous biological factors contributing in turn to food losses.

For the wholesalers, careful handling of the produce should be adhered, the use of modern packaging and adequate facilities training should be provided by the government had a mean score of 4.2, while for the processors , monitoring of produce quality be ensured had a mean score of 3.9. It can be concluded that these management strategies statements adopted by the value chain marketing actors can reduced loss of vegetable crops in the study area since the mean scores was greater than the bench mean score of 3.0. The implication is that, the handlers if not trained or educated in the field of post-harvest handling, they will not be careful with crops as it moves across the post-harvest chain which at the end they will be encountering loss in each stage, and this will affect the profit which they could have make at the initial place and their economic activities. The study agrees with the finding of Khan *et al*. (2020) who reported that post-harvest losses are responsible for the less return back to the farmers, effect to

processors and cause loss for traders and country income also effect in foreign exchange.

CONCLUSION AND RECOMMENDATIONS

The studied concluded that, age, household size, years of experience, duration and distance significantly influences the quantity of post-harvest loss on tomato, pepper and okra. The studied recommends the provision of good quality roads by the government and access to capital by financial institution to value chain marketing actors to improve their enterprise.

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