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ASSESSMENT OF CAUSES AND EFFECTS OF POST-HARVEST LOSSES OF VEGETABLES AMONG RURAL FARMERS IN NORTH-CENTRAL, NIGERIA

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ABSTRACT: *The study assessed the causes and effects post-harvest losses of selected vegetables among rural farmers in North-Central, Nigeria. Purposive and simple random sampling techniques were employed to select 203 respondents from 5338 registered vegetable farmers from Benue, Nasarawa and Kogi States ADP. Primary data were collected through the use of well-structured questionnaire and analysed with descriptive and inferential statistics. Results show that 61.6% of the respondents were females, married (64.0%), educated (62.6%) with a mean age of 40 years. Major causes of post-harvest losses of vegetables were lack of proper storage facilities ($\bar{x}$ =3.75), poor transportation facilities ($\bar{x}$ =3.55), poor packaging facilities ($\bar{x}$ =3.52), pest and disease infestation ($\bar{x}$ =3.50). Findings also indicate that reduce income of farmers ($\bar{x}$ =3.69), reduce availability of produce ($\bar{x}$ =3.60), increased food insecurity (3.59), among others were the major effects of post-harvest loss by the respondents. ANOVA result of the quantity of vegetables lost by farmers was significant (p=0.040) at 5.0% as against non-significant (p= 0.302) for monetary lost by the farmers across the states. The study concluded that causes of post-harvest losses of vegetables in the area were very strong with serious negative effects on the farmers. It was recommended that Government and private sector should establish agro- processing industries in rural areas for vegetable crops in order to reduce post-harvest losses maximize profit and improve their living standard.*

Keywords: *Assessment, Causes, Effects, Post-harvest, Losses, vegetables*

INTRODUCTION

Vegetables form a substantial percentage of the major food crops cultivated in the tropics and a source of livelihood for a considerable section of the population. They come as edible plant parts like stems, stalks, roots, tubers, bulb, leaves, flowers and are generally consumed raw or cooked, with main dish which add variety to enjoyment, and a sense of satisfaction to the diet because of their appealing colours, flavour and texture (Ahmed, 2013, Ibeawuchi, *et al*; 2015). Examples of vegetables include onion, tomato, okra, pepper, amaranthus, carrot, and melon, among others (Ibeawuchi II., et al. 2015).

Fruits and vegetables play very important roles in nutrition and health, especially as they contain substances which regulate or stimulate digestion, act as laxatives or diuretics, pectins and phenoic compounds which play a part in regulating the pH of the intestines (Ibeawuchi, *et al*; 2015). The production of fresh fruits and vegetables has its own challenges. Their perishability and hugeness make them difficult to manage easily during post-harvest period, unlike that of dry grains. As a result of the perishable nature of the produce and lack of knowledge of the management strategies, as well as shortage of capital, horticulture industry in sub-Saharan Africa countries like Nigeria is still at its infant stage (Gebru and Belew, 2015). According to Age (2017), fruit and vegetable produce are less hardy, perishable and vulnerable to natural and artificial phenomena, and if care is not taken in harvesting, handling, processing, storage and transporting them to the final consumers, they deteriorate or decay fast and become unwholesome for human consumption.

Post-harvest loss is one of the general problems facing production in Nigeria and concerns everyone from the research scientist, to the extension/marketers in the field, to the farmers on the farm, and the government policy formulators (Chukwunta, 2014). Post-harvest losses are the measurable qualitative and quantitative damages or spoilage in the after harvest value chain caused by natural and artificial phenomena (Age, 2017). These losses affect both the quality and quantity of crop produce, thus reducing their economic value and the total income of the producers.

Post-harvest losses can be caused by a wide variety of factors, ranging from harvesting conditions, handling to retail level. The elimination of post-harvest losses of agricultural products is, therefore, important to boost food security in the countries (Gebru and Belew, 2015).

Minimizing post-harvest losses along the supply chain can be the only effective resource that can help strengthen food security, fight hunger, reduce agricultural land needed for production, and develop rural areas and improve the living

conditions of farmers, especially in Africa and Asia (FAO, 2016). These losses play a key role in the lives of millions of small agricultural producers, affecting the available quantities of food and the commercial value of goods. In addition to economic and social impact, post-harvest losses also have an impact on the environment, as the land, water, and energy (the main means of agricultural production) used for the production of lost food are also wasted along with food. Unused food also causes additional Carbon-dioxide (CO_2) emissions, ultimately affecting the environment. FAO (2015a) estimates a Carbon-dioxide, emission of 3.3 Gton equivalent for food that was produced but not consumed.

Losses and waste of food generate many negative effects that can directly or indirectly affect the main pillars of food security: food availability, access to food, food use, as well as stability of accessibility, and access to food over time (Barbara, 2019). Considering the criticality of post-harvest losses and reduction in food security, it is very important to understand the structure and scale of post-harvest losses of agricultural produce around the world, especially in Nigeria, as well as to identify their causes and possible solutions (Barbara, 2019)

Satisfying the demand for food for a growing population in the world is becoming a great challenge for humanity. It is estimated that by 2050, the population will increase to 9.1 billion people, and about 70% of additional food will be needed for their feeding (Obiedzińska, 2017; Kiaya, 2014). Progressing urbanization, climate change, and land management for the production of energy crops and other, unrelated to food, deepen these concerns related to the increase in food demand. Post-harvest losses, however, are a contentious and critical issue (Kitinoja, Saran, Roy, Kader, 2011; FAO, 2015b; FAO, 2014a). About one-third of the world's food (about 1.4 billion tons), estimated at around USD 1 trillion, is lost annually during the post-harvest operations and post-harvest treatments (FAO, 2016). Different solutions and proposals that reduce the post-harvest losses require relatively small investments and can bring high results compared to increasing plant production.

The specific objectives were to;

i. describe selected socio-economic characteristics of the respondents;
ii. ascertain perceived causes of post-harvest losses of vegetables;
iii. ascertain the perceived effects of post-harvest losses of vegetables on farmers in the area.

The following hypotheses were tested:

i. There is no significant difference in the quantity of vegetables lost across the States in North-Central Nigeria
ii. There is no significant difference in the monetary value of vegetables lost across the States in North-Central Nigeria**.**

MATERIALS AND METHOD

The study was conducted in the North-Central geo-political region of Nigeria, otherwise referred to as middle belt. The region comprised six (6) States, and the Federal Capital Territory. The States are Benue, Kogi, Nasarawa, Plateau, Kwara and Niger, with a total land mass of 296,898 km^2 lying roughly between latitude 6 $1/2^0$N and 8 $1/2^0$ N longitude 7 $1/2^0$ Eand 10^0 E (Federal Ministry of Agriculture (FMARD), 2015a). The region has a projected total population of 31,735728 people at 3 % growth rate (NPC, 2006). The region is bounded in the North by Bauchi, Kaduna, Zamfara, and Kebbi States; in the South by Cross- River, Ebonyi, Enugu, Edo, Ondo, Ekiti, Osun and Oyo States; in the East by Taraba State and Cameroon; and in the West by the Republic of Benin.

The region has favourable agro-ecological climate for arable crops, tree crops and livestock production, and enjoys two distinct seasons; rainy season, beginning from April to October, and the dry season, from November to March. Average annual rainfall varies between 1,250mm and 175mm from the Southern to the northern parts with annual temperature variations of 32^{o}C and 38 ^{o}C. The States stretch across the transition belt between the forest and savannah vegetation (FMARD, 2015b; National Bureau of Statistics, 2018).

The region is predominantly rural with agriculture being the mainstay of it economy. The main crops produced are rice, yam, cassava, sesame, maize, sorghum, millet, groundnut, cowpea, soybeans, fruits and vegetables. Animals like goats, sheep, cattle, pigs, and poultry are reared (FMARD, 2015b)

The population of the study consists of 4865 (ADP, 2018) mango and orange farmers in Benue, Nasarawa, and Kogi States of North-Central Nigeria.

A sample size of 203 respondents was selected using a multi-stage sampling procedure. In the first stage, three States from the region were purposively selected, based on their level of production of fruits and vegetable crops. The States selected include Benue, Nasarawa and Kogi States. The second stage also involved purposive selection of two Local Government areas from each of the States selected, based on their level of involvement in the production of fruits and vegetable crops. The Local Governments from Benue State include; Ushongo and Gboko, while Akwanga and Lafia were selected from Nasarawa State. Also from Kogi State, Ajaokuta and Ankpa were selected bringing the total Local Government Areas to six (6).

The third stage of selection involved the use of simple random sampling technique in the selection of two communities from each of the Local Government Areas selected, making a total of twelve (12) communities. The communities include Mbayeh and Ikyov from Ushongo, Mbayion and Yandev from Gboko Local Government Area of Benue State.

Rinze and Andaha in Akwanga, Bad and Shapu from Lafia Local Government Area of Nasarawa State, while Ankpa 1 and Enjema (iv) as well as Adogo and Badoko were selected from Ankpa and Ajaokuta Local government Areas of Kogi State respectively.

The last stage of sampling was selection of 203 respondents through simple random sampling technique corresponding to 3.8% of the sample frame obtained from the various State's Agricultural Development Projects (ADPs) to ensure proportionality.

Primary data were collected by using structured questionnaire. Data collected for this study were analyzed by using both descriptive and inferential statistics. Objectives 1-3 were achieved by using descriptive statistics such as frequencies, means percentages and standard deviation. Hypothesis one ($H0_1$) and ($H0_2$) were tested using Analysis of Variance (ANOVA).

2.1 Model Specification

ANOVA model that was used to test hypotheses 1 and 2 is implicitly specified as;

$$F = \frac{MSSB}{MSSW} = \frac{SSB}{SSW} = \frac{n-k}{k-1}$$

$$SSB = 3nj\ (X-X)^2$$

$$SSW = 3n\ (Xi-X)^2$$

Where F = Value by which the statistical significance of the mean differences was judged
SSB = Sum of squared deviation between samples
n= number of observation
k= number of samples
nj= sample size from population j
Xj = mean of sample for population j
X = grand mean
Xii = nth observation from population

RESULTS AND DISCUSSION

3.1 Selected socio-economic characteristics of vegetable farmers

The distribution of the respondents according to their socioeconomic characteristics is presented in Table 3.1

The result showed that most (61.6%) of the respondents were female, while the rest (38.4%) were male. The dominance of female farmers suggests that vegetable production in this area may be mostly practiced by women. This agrees with Kughur, *et al.,* (2015) who concluded that females were more involved in fruits and vegetable production due to the fact that its production practices were relatively less laborious and less taxing compared to other crops like yam, groundnut, soybeans, rice etc. The findings further corroborates Ukohol, *et al*., (2018) who also reported that women were more engaged in post-harvest operations such as transportation, processing and marketing of agricultural produce.

The result showed that 32.0% of the farmers fell within the age bracket of 31-40 years, while 24.1% were within 41 and 50 years of age. The result further shows that the respondents had a mean age of 40 years. This implies that majority (56.1%) of the respondents were between the ages of 31 and 50 years. Therefore, it could be inferred that the vegetable farmers in the area were mostly in their active and productive age. This can be of a great advantage in terms of putting their energy and strength towards the management of post-harvest losses. This is in conformity with Kughur, *et al.,* (2015) who also found that farmers within the age bracket of 21-30 years were more involved in planting of fruits and vegetable crops since the activity require people who are energetic and strong to cultivate large size of farm than their counterparts.

With respect to marital status, the result showed that most (64.0%) of the respondents were married. This implies that married people are more involved in vegetable production, and may receive assistance from their spouses in carrying out some activities on the farm. The finding is supported by Elemasho, *et al.,* (2017) and Atibioke, *et al*., (2012) who observed that most of the farmers in their study areas were married. Marriage they said serves as a means of generating family labour and since women and children are able to participate in crop production, processing and marketing, use of technologies was related to marital status.

Analysis of household size of the respondents further indicated that most households (69.0%) had about 5 to 9 persons. The result also revealed a mean household size of 8.0 persons. This implies that labor for vegetable production and post-harvest activities is likely to be readily supplied by the family members. The findings agree with those of Elemasho, *et al*. (2017) who reported from their study on factors affecting adoption of post-harvest technologies of selected food crops in Rivers State, Nigeria, that the mean house-hold size was 6 persons per family.

In terms of educational level, the study revealed that most (62.6%) of the vegetable farmers had formal education with 25.6%, 23.2% and 13.8% of them having attained primary, secondary and higher education respectively. The high percentage of educated farmers in the area implies that the farmers could have a better understanding of agricultural information they receive. This agrees with Mbah *et al.,* (2017) who reported that most of the vegetable crop farmers in

Benue State, Nigeria had formal education and were literate enough to be able to adopt any new innovation to boost their vegetable crop production.

The distribution of respondents, according to farming experience showed that most (43.4%) of the respondents had farming experience of within 15 to 24 years, and a mean farming experience of 17.0 years. This shows that most of the farmers have been involved in farming activities for a long time and can avert risk to a reasonable level. This result agrees with Elemasho, *et al.,* (2017) who reported that the mean years of farming experience of food crop farmers in Rivers State was 15.9 years.

The result of analysis with respect to farm income showed that majority (82.3%) of the respondents had an annual income of ≤ 249,999 naira. The result further revealed that the vegetables farmers had a mean annual income of 174,167.5 Naira. This implies that the annual farm income of vegetable farmers in the area is low, and may not positively influence the utilization of improved post-harvest management technology, as well as their ability to invest or bear risk. This is in line with the findings of Ukohol, *et al.,* (2018) who reported that the farm income of most farmers in the Benue State was low which could affect their level of investment and ability to bear risks.

Table 3.1: Selected socio-economic characteristics of vegetable farmers in the study area

Variables	Frequency (n = 203)	Percentage	Mean ($\bar{x}$)
Gender			
Male	78	38.4	
Female	125	61.6	
Age (years)			
20 – 30	36	18.8	
31 – 40	55	32.0	
41` – 50	49	24.1	40
51 – 60	32	15.8	
61 – 70	19	9.4	
Marital status			
Married	130	64.0	
Divorced	`17	8.4	
Household size (numbers)			
1– 4	16	7.9	
5– 9	140	69.0	8
10- 14	43	21.1	
15 -19	4	2.0	
Education (years)			
No formal Education	76	36.0	
Primary Education	52	43.4	
Secondary Education	47	14.3	
Tertiary Education	28	4.4	
Farming experience (years)			
5 – 14	73	36.0	
15– 24	88	43.4	17
25 – 34	29	14.3	
35 – 34	13	4.6	
Annual farm income (₦)			
100,000 - 249,999	167	82.3	174,167.5
250,000 – 499,999	35	17.7	

Source: *Field Survey, 2023*

Perceived causes of post-harvest losses of vegetables

The result in Table 3.2 shows the mean scores on the perceived causes of post-harvest losses of vegetables.

The result showed that the overall causes of post-harvest losses of vegetables in the area, on a 4-point rating scale was strong, with a grand mean ($\bar{x}$=3.43) higher than the mean cut-off ($\bar{x}$=2.55). The highest mean scores were observed

on lack of proper storage facilities ($\bar{x}$=3.75), poor transportation facilities ($\bar{x}$=3.55), poor packaging facilities ($\bar{x}$ =3.52) and pest diseases infestation ($\bar{x}$=3.50). The standard deviations on the causes of post-harvest losses of vegetables were all less than 1. This indicates uniformity in responses of the respondents that all the factors identified were actually the causes of post-harvest losses of vegetables in the area.

This findings agrees with those of Yahaya and Mardiyya (2019), Age (2017) and Desta (2018), Ashish Guaraha and Chandrakar (2018), Mbah, *et.al*., (2017) who identified post-harvest causes of fruits and vegetable losses to include; careless handling during harvesting, processing, transportation, storage etc., microbial attack, inadequate methods in harvesting, high ambient temperature and lower atmospheric humidity. Others were exhausted water and food reserves in the produce, respiration and fermentation, poor ventilation of produce warehouse, dehydration, pest and disease infestation and premature harvesting as well as, lack of knowledge on proper post-harvest handling practices, contaminants/ filthy environment, transportation and breakdown of vehicles, poor marketing facilities, lack of proper storage and marketing facilities, lack of agro-based industries, risk and uncertainty among others.

Table 3.2: Perceived causes of post-harvest losses of vegetables in North-Central, Nigeria

Causes	Very strong =4	Strong =3	Mild =2	Weak =1	Total	$\bar{x}$	Std. Dev.	Rank
Lack of proper storage facilities	157 (628)	43 (129)	1 (2)	2 (2)	761	3.75	0.43	1st
Poor transportation facilities	119 (476)	79 (237)	3 (6)	2 (2)	721	3.55	0.49	2nd
Premature harvesting/over ripening	102 (408)	93 (279)	5 (10)	3 (3)	700	3.45	0.55	8th
Poor processing facilities	103 (412)	92 (276)	1 (2)	6 (6)	696	3.43	0.54	10th
Poor packaging facilities	110 (440)	90 (270)	2 (4)	11)	715	3.52	0.52	3rd
Poor handling of produce causing injuries	112 (448)	76 (228)	7 (14)	8 (8)	698	3.44	0.57	9th
Poor marketing system	91 (364)	101 (303)	6 (12)	5 (5)	684	3.37	0.55	16th
Pest and diseases infestation	116 (464)	77 (231)	6 (12)	4 (4)	711	3.50	0.56	4th
Contaminants/filthy environment	88 (352)	98 (294)	7 (14)	10 (10)	670	3.30	0.56	18th
Lack of agro-based industries	117 (468)	71 (213))	6 (12)	9 (9)	702	3.46	0.56	6th
Microbial attack	107 (428)	87 (261)	8 (16)	1 (1)	706	3.48	0.60	5th
High temperature	111 (444)	76 (228)	15 (30)	1 (1)	703	3.46	0.65	6th
Poor ventilation/high humidity	101 (404)	82 (246)	17 (34)	3 (3)	687	3.38	0.70	14th
Reaction of food constituents	74 (296)	95 (285)	33 (66)	1 (1)	648	3.19	0.72	19th
Inappropriate policies	85 (340)	97 (291)	20 (40)	1 (1)	672	3.31	0.67	17th
Lack of human, economics and technical resources	98 (392)	92 (276)	7 (14)	6 (6)	688	3.39	0.60	11th
Poor education or knowledge	98 (392)	86 (258)	18 (36)	1 (1)	687	3.38	0.67	14th
Inefficient communication	93 (372)	98 (294)	10 (20)	2 (2)	688	3.39	0.60	11th
Unfavourable cultural practices	95 (380)	93 (279)	14 (28)	1 (1)	688	3.39	0.60	11th
Grand mean($\bar{x}$)						**3.43**		

Source: *Field Survey, 2023*

Perceived effect of post-harvest losses of vegetables

Result on the perceived effects of post-harvest losses of vegetable crops in the study area is presented in Table 3.3

The overall effect of post-harvest losses of vegetables was serious, with a grand mean ($\overline{x}$=3.54) which is higher than the decision mean cut-off ($\overline{x}$=2.55). The result shows serious effects on all the variables listed. The highest mean scores were observed on reduce income of farmers ($\overline{x}$=3.69), reduce availability of produce ($\overline{x}$=3.60), increase food insecurity ($\overline{x}$=3.59), and reduce quality of produce ($\overline{x}$=3.57). The standard deviation on the effect of post-harvest losses of vegetables was all less than1. This indicates that there is uniformity in the responses of the respondents as regards the effects of post-harvest losses of vegetables in the area. The findings corroborates those of Mbah, *et al*., (2017) who identified the major effects of post-harvest losses as reduction in income generation, reduction in quality of produce, unstable supply of produce, high cost of vegetable crops, decrease in nutritional content of the produce, loss of investment made by the farmer, reduction on availability of vegetables for household consumption, as well as reduction in market value of produce.

Table 3.3: Perceived Effects of post-harvest losses of vegetables in North-Central, Nigeria

Perceived Effect	Very serious (4)	Serious (3)	Mild (2)	Less serious (1)	Total	$\bar{x}$	Std. Dev.	Rank
Reduce income of farmers	145 (580)	55 (165)	1 (2)	2 (2)	749	3.69	0.47	1st
Reduce availability of produce	125 (500)	76 (228)	1 (2)	1 (1)	731	3.60	0.53	2nd
Low per capital income of the nation	104 (416)	93 (279)	4 (8)	2 (2)	705	3.47	0.56	9th
High level of spoilage	121 (484)	71 (213)	5 (10)	6 (6)	713	3.51	0.54	8th
Low storage or shelf life	114 (456)	83 (249)	3 (6)	3 (3)	714	3.52	0.53	6th
Increase food insecurity	123 (492)	77 (231)	2 (4)	1 (1)	728	3.59	0.52	3rd
Waste of time and labour	94 (376)	101 (303)	6 (12)	2 (2)	693	3.41	0.60	10th
High level of economic losses	109 (436)	89 (267)	4 (8)	1 (1)	712	3.51	0.57	8th
Reduce quality of produce	119 (476)	82 (246)	1 (2)	1 (1)	725	3.57	0.54	4th
Environmental pollution/degradation	112 (448)	86 (258)	5 (10)	0(0)	716	3.53	0.55	5th
Grand Mean						**3.54**		

Source: *Field Survey, 2023*

TEST OF HYPOTHESES

4.1 Hypothesis 1

Table 4.1 shows the test of significant difference in quantity of vegetables lost across the States of central, Nigeria.
The results showed the mean quantity of vegetable lost of 297.4074 (SD=154.1826), 240.7344 (SD=102.2778) and 301.1897 (SD = 186.7365) for Benue, Nasarawa and Kogi respectively, with f- value of 3.280 significant (0.040) at 5% level of probability. This implied that there was a significant difference in quantity of vegetable lost across the States in North-Central. The results explained the observation by Sawicka (2019) that maximum amount of vegetable losses occurs during post- harvest due to the lack of adequate infrastructure in storage from physical loss of goods and indirect losses resulting from the loss of quality and nutritional value. The hypothesis which states that there is no significant difference in the quantity of vegetables lost across the States in North-Central Nigeria is hereby rejected

Table 4.1: Test of Significant Differences in the quantity of vegetable lost across the States in North Central Nigeria

Sources	Sum of Squares	Df	Mean Square	F	Sig.
Between groups	149182.839	2	74591.420	3.280	.040
Within groups	4548450.954	201	22742.255		
Total corrected	4697633.793	203			

Source: *Field Survey, 2023*

Hypothesis 2.

Table 4.2 shows the test of significant difference in the monetary value of vegetables lost across the States of North-Central, Nigeria. The results showed the mean income loss of N181, 296.29 (SD=67914.37), N164, 234.38 (SD=61956.93) and N175, 614.04(SD = 68270.93) for Benue, Nasarawa and Kogi respectively, with f- value of 1.204 non-significant at 5% level of probability. This implied that there was no significant different in income loss emanating from the vegetable lost from Nasarawa, Benue and Kogi States by the vegetable farmers. The hypothesis which states that there is no significant difference in the income loss among vegetable farmers across the States of North-Central, Nigeria is hereby accepted.

Table 4.2: Test of Significant Differences in Monetary Value of vegetables Lost across the States of North-Central Nigeria

States	N	Mean	Std. Deviation	Std. Error	
Benue	82	181296.29	67914.37	7546.04	
Nasarawa	64	164234.38	61956.39	7744.55	
Kogi	57	175614.04	68270.93	9042.71	
Total	203	174287.13	66256.68	4661.81	
Sources	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Model	10547464498.835	2	5273732249.42	1.204	.302
Error	871831882035.819	201	4381064733.85		
Total corrected	882379346534.653	203			

Source: *Field Survey, 2023*

CONCLUSION AND RECOMMENDATION

The study assessed the post-harvest losses of selected vegetable among rural farmers in North-Central, Nigeria. Based on the findings, it was concluded that causes of post-harvest losses of vegetables in the area were very strong and that the fruit farmers perceived serious negative effect of post-harvest losses in the area. It was recommended that Government and private sector should establish agro- processing industries in rural areas for vegetable crops in order to reduce post-harvest losses maximize profit and improve their living standard.

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