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Assessment of the Causes and Effects of Post-harvest Losses of Fruits among Rural Farmers in North-Central, Nigeria

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ABSTRACT
The study assessed post-harvest losses of selected fruits among rural farmers in North-Central, Nigeria. Purposive and simple random sampling techniques were employed to select 182 fruit farmers from 4865 registered fruit 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 75.3% of the respondents were males, married (58.2%), educated (64.3%) with a mean age of 45 years and a mean household size of 6 persons. Major causes of post-harvest losses of fruits were; lack of proper storage facilities ($\bar{x}$=3.69), lack of agro-based industries (3.63%), poor transportation facilities ($\bar{x}$=3.59), high temperature ($\bar{x}$=3.59) and microbial attack ($\bar{x}$=3.58). Findings also indicate that reduce income of farmers ($\bar{x}$=3.69), environmental pollution/degradation ($\bar{x}$=3.60), increased food insecurity (3.59) were the major effects of post-harvest losses of fruits in the area. ANOVA result showed a significant difference in quantity (p=0.004) and monetary lost (p=0.013) of fruits at 5.0% level of probability each across the states. The study concluded that post-harvest losses of fruits in the area were caused by many strong factors and also has serious negative effects on the farmers. It was recommended that Government and private sector should establish agro- processing industries in rural areas for fruits in order to reduce post-harvest losses, maximize profit and improve their living standard.

Keywords: Assessment, Post-harvest, Losses, Management, Strategies, fruits

INTRODUCTION
Fruits and 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 fruits 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).

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). Production of fruits and vegetables for marketing and consumption also has comparative advantage to generate income as compared to cereals, as they require shorter time for production, yield more and have more market outlets (Rahiel *et al.,* 2018). 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. 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. In Nigeria, enormous quantities of fruits and vegetables are produced. For instance, 3.8 million tonnes of onions, 6 million tonnes of tomatoes, 10 million tonnes of plantain and 35 million tonnes of citrus are reportedly produced annually (Pandey *et al.,* 2013). In spite of the high production figures churned out, the populace still suffer acute shortage of food and vegetables due to losses along the value chain. Olayemi *et al* (2012) estimated that as much as 25% and 40% fruits and vegetables, respectively, are lost after harvest in River State, Nigeria due to poor post-harvest handling measures. If food loss is not reduced,

food production in developing countries will need to increase by an estimated 70 percent, and this requires an investment of $83 billion per year (Rockfeller Foundation, 2015). Therefore, there is need to ensure food security by increasing food production, while reducing losses along supply chain.

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). 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)

The specific objectives were to;

i. describe selected socio-economic characteristics of the respondents;
ii. ascertain perceived causes of post-harvest losses of fruits;
iii. ascertain the perceived effects of post-harvest losses of fruits.

The following hypotheses were tested:

i. There is no significant difference in the quantity of fruits lost across the States in North-Central Nigeria
ii. There is no significant difference in the monetary value of fruits 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°N and 8 1/2° N longitude 7 1/2° E and 10° 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°C and 38 °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 182 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 182 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 (Ho_1) and (Ho_2) were tested using Analysis of Variance (ANOVA).

Model Specification

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

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

$$SSB = \sum nj\,(X-X)^2$$

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

Where F = Value by which the statistical significance of the mean differences was judged

SSB = Sum of squared deviation between samples

n= number of observations

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

Selected Socio-economic Characteristics of the Respondents

The result of socio-economic characteristics of fruit farmers is presented in Table 1. The result showed that majority (75.3%) were males. The dominance of male farmers could be due to the fact that men in the study area were more involved in fruit crops production than the women. The result agrees with those of Rahiel *et al.,* (2018) who reported that majority (92%) of respondents sampled on assessment of potential and post-harvest losses of fruits and vegetables in Northern Region of Ethiopia were males.

The age distribution of respondents indicates that 22.0% fall within the age bracket of 31 to 40 years, while 36.3% were within the age range of 41 and 50 years. Majority (58.3%) of the farmers were, therefore, between 31 and 50 years. The result further shows that the respondents had a mean age of 45 years. This implies that fruits production in the study area is carried out by farmers within the productive age, who have the strength to carry out the tedious operations involved. This result agrees with the findings of Kughur *et al.,* (2015) which revealed that youths 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 older counterparts. The findings is further supported by those of Elemasho *et al.,* (2017) who reported that majority (60.6%) of the respondents were within the active age group of 25 – 45 years, with the mean age being 41.0 years.

Analysis of the marital status of the respondents showed that most (58.2%) of the respondents were married. This means that married people were more involved in farming and may receive assistance from their spouses in carrying out their activities on the farm. This corroborates the findings of Elemasho *et al.,* (2017) who reported that most of the farmers in Rivers State were married. This reflects on social responsiveness as married people would likely be more responsible to innovations to increase their productivity, so as to be able to cater for the family.

Analysis of household size of the respondents further indicated that most households (59.9%) had about 5 to 9 persons. The result also revealed a mean household size of 6 persons. The respondents, therefore, had the advantage of having family labour which will reduce or eliminate the use of hired labour. This further implies that labor for post-harvest activities is likely to be readily supplied by the family members. The findings is in line with those of Mbah *et al.,* (2017) who reported that majority (83%) of the respondents in Benue State had household size of 6-10 persons, and a mean household size of about 6 persons. The result on educational status of respondents revealed that majority of the respondents (64.3%) had formal education, with 23.1%, 20.3% and 20.9% of them having attained primary, secondary and higher education respectively. The high percentage of literate households among the sampled respondents implies that the respondents are capable of understanding and using new innovations as possession of formal education could ease the process of utilization. They also have the ability to obtain process and use information relevant to post-harvest management technology. The result agrees with Elemasho *et al.,* (2017) who reported that majority of the respondents in Rivers State were literates, and this could encourage effective use of post-harvest technologies.

In terms of farming experience, it was found that majority (50.5%) of the respondents had farming experience of about 15 to 24 years, and a mean farming experience of 20 years. This implies that most of the farmers were highly experienced in farming activities, and can avert risk to a reasonable level. This result agrees with Elemasho *et al.,* (2017) who reported in his study on factors affecting adoption of post-harvest technologies of selected food crops in Rivers State, Nigeria, that the mean years of farming experience 15.9 years. The distribution of respondents according to their farm income revealed that 36.8% had annual income of ≤ 249,999, while majority (53.3%) had between 250,000 and 499,999 naira. The respondents also had an annual farm income of 189,560.4 naira. The result showed that the income of the farmers is moderate which may positively influence the utilization of improved post-harvest management technology, as well as ability of the farmers to invest or bear risk. The result corroborates that of Mbah *et al.,* (2017)

who found that fruits and vegetable farmers obtained reasonable amount of money from the sale of their produce which empowered them economically in Benue State.

Perceived causes of post-harvest losses of fruits

The result of the mean scores on the causes of post-harvest losses of fruits in the study area is presented in table 2. The result showed that the overall causes of post-harvest losses of fruits recorded a grand mean ($\bar{x}$=3.40) higher than the mean cut-off ($\bar{x}$=2.55). The highest mean scores were observed on lack of proper storage facilities ($\bar{x}$=3.69), lack of agro-based industries ($\bar{x}$=3.63), poor transportation facilities ($\bar{x}$=3.59), high temperature ($\bar{x}$=3.59) and microbial attack ($\bar{x}$=3.58). The standard deviations on the causes of post-harvest losses of fruits 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 fruits in the area. This finding agrees with those of Yahaya and Mardiyya (2019), Age (2017) and Desta (2018), who identified causes of post-harvest losses of fruits and vegetable to include; careless handling during harvesting, processing, transportation, storage etc., microbial attack, inadequate methods in harvesting, high ambient temperature and lower atmospheric humidity. Others are 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 and among others.

Perceived Effect of Post-Harvest Loss of Fruits

Result on the perceived effects of post-harvest losses of fruits in North-Central, Nigeria is presented in table 3. The result shows that the overall perceived effect of post-harvest losses of fruits in the area, on a 4-point rating scale was serious, with a grand mean ($\bar{x}$=3.50) which is higher than the decision mean cut-off ($\bar{x}$=2.55). The result shows serious effects on all the variables listed. The highest mean scores were observed on reduce income of farmers ($\bar{x}$=3.69), environmental

pollution/degradation $\bar{x}$(=3.60), increase food insecurity ($\bar{x}$=3.59) and reduce quality of produce ($\bar{x}$=3.58). The standard deviation on the effect of post-harvest losses of fruits was all less than1. This indicates uniformity in responses of the respondents that post-harvest losses of fruits have serious effect in the area. The findings confirm 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 and reduction on availability of vegetables for household consumption. This is further supported by Kughur *et al.,* (2015) who reported that food losses have several adverse impacts on the farmer's income, consumer prices, nutritional quality of the produce, as well as loss of the actual crop, loss in the environment resources, labour needed to produce the crop and livelihood of the individuals involved in the production process.

Test of Hypotheses

Table 4 shows the test of significant difference in quantity of fruits lost across the States of central, Nigeria. The results showed the mean quantity of fruits lost as 297.500kg (SD=103.1206), 482.9032kg (SD =280.3829) and 413.7845 kg (SD = 236.3093) for Nasarawa, Benue and Kogi respectively. The study found that there was a significant difference in quantity of fruits loss across the States in North-Central Nigeria with f-value of 5.669, significant (.004) at 5% level of probability. This can be explained possibly as a result of flow of information and knowledge on post-harvest losses among fruits famers across the States. This is supported by Aysel *et al.,* (2019) who observed that adequate knowledge and information on post-harvest losses will lead to improvements in post-harvest technologies such as good harvesting practices and packaging systems which are vital to minimize post-harvest losses and to improve quality characteristics of fresh produce so that more fresh produce is actually consumed.
Hypothesis 2.

Table 5 shows the test of significant difference in quantity of fruits lost across the States of North-central, Nigeria. The results showed the

mean income loss of ₦320, 694.92 (SD=174411.27), ₦236, 750.00 (SD=89822.77) and ₦737, 781.25 (SD = 75429.84) for Benue, Nassarawa and Kogi respectively, with f- value of 4.482 significant (0.013) at 5% level of probability. This implied that there was a significant difference in income lost from fruits across the States in North-Central Nigeria. The hypothesis which state there is no significant differences in the income loss among fruit farmers across the States of North-Central Nigeria is hereby rejected.

Table 1: Selected socio-economic characteristics of fruit farmers in the study area

Variables	Frequency (n = 182)	Percentage	Mean ($\bar{x}$)
Gender			
Male	137	75.3	
Female	45	24.7	
Age (years)			
21 – 30	13	7.1	
31 – 40	40	22.0	
41 – 50	66	36.3	45
51 – 60	41	22.5	
61 – 70	22	12.1	
Marital status			
Married	106	58.2	
Otherwise	76	44.9	
Household size (numbers)			
1– 4	19	10.4	
5– 9	109	59.9	6
10- 14	48	26.4	
15 -19	6	3.3	
Education (years)			
No formal Education	65	35.7	
Primary Education	32	23.1	
Secondary Education	47	20.3	
Tertiary Education	38	20.9	
Farming experience (years)			
5 – 14	42	23.1	
15– 24	92	50.5	20
25 – 34	33	18.1	
35 – 34	15	8.3	
Annual farm income (₦)			
100,000 - 249,999	87	36.8	
250,000 – 499,999	97	53.3	

500,000 – 749,999	14	7.7	189,560.4
750,000 – 999,999	3	1.7	
1,000,000 – 1,249999	1	0.6	

Source: *Field Survey, 2023*

Table 2: Perceived causes of Post-harvest Losses of Fruits North-Central, Nigeria

Causes	Very strong =4	Strong =3	Mild =2	Weak =1	Total	$\bar{x}$	Std. Dev.	Rank
Lack of proper storage facilities	141 (564)	30 (90)	7 (14)	4 (4)	672	3.69	0.52	1st
Poor transportation facilities	115 (460)	63 (189)	1 (2)	3 (3)	654	3.59	0.50	3rd
Premature harvesting/over ripening	69 (216)	107 (321)	5 (10)	1(1)	394	2.17	0.56	19th
Poor processing facilities	113 (452)	63 (189)	4 (8)	2(2)	651	3.58	0.49	5th
Poor packaging facilities	103 (412)	73 (219)	2 (4)	4 (4)	639	3.51	0.52	7th
Poor handling of produce causing injuries	92 (368)	82 (246)	2 (4)	6 (6)	624	3.43	0.52	10th
Poor marketing system	82 (328)	94 (282)	2 (4)	4 (4)	618	3.40	0.52	11th
Pest and diseases infestation	80(320)	91 (273)	7 (14)	4 (4)	611	3.36	0.57	15th
Contaminants/filthy environment	81 (324)	91 (273)	3 (6)	7 (7)	610	3.35	0.53	16th
Lack of agro-based industries	125 (500)	50 (150)	4 (8)	3 (3)	661	3.63	0.52	2nd
Microbial attack	118 (472)	57 (171)	2 (4)	5 (5)	652	3.58	0.51	5th
High temperature	115 (460)	61 (183)	4 (8)	2 (2)	653	3.59	0.60	3rd
Poor ventilation/high humidity	87 (348)	78(234)	8 (16)	9 (9)	607	3.34	0.58	17th
Reaction of food constituents	66 (264)	97 (291)	9 (18)	10 (10)	583	3.20	0.58	18th
Inappropriate policies	80 (320)	94 (282)	7 (14)	1 (1)	617	3.39	0.58	12th
Lack of human, economics and technical resources	114 (456)	53 (159)	8 (16)	7 (7)	638	3.51	0.58	7th
Poor education or knowledge	82 (328)	91 (273)	6 (12)	3 (3)	614	3.37	0.56	14th
Inefficient communication	81 324)	93 (279)	6 (12)	2 (2)	617	3.39	0.57	12th
Unfavourable cultural practices	92 (368)	82 (246)	5 (10)	3 (3)	627	3.45	0.58	9h
Grand mean($\bar{X}$)						**3.40**		

Source: Field Survey, 2023

Table 3: Perceived effects of post-harvest losses of fruits in the study area

Perceived Effect	Very serious (4)	Serious (3)	Mild (2)	Less serious (1)	Total	$\bar{x}$	Std. Dev.	Rank
Reduce income of farmers	135 (540)	40 (120)	5 (10)	2 (2)	672	3.69	0.47	1st
Reduce availability of produce	106 (424)	71 (213)	4 (8)	1 (1)	649	3.57	0.54	5th
Low per capital income of the nation	75 (300)	104 (312)	2 (4)	1 (1)	547	3.01	0.54	10th
High level of spoilage	97 (388)	80 (240)	2 (4)	3 (3)	635	3.49	0.52	7th
Low storage or shelf life	109 (436)	69 (207)	2 (4)	2 (2)	649	3.57	0.51	5th
Increase food insecurity	121 (484)	53 (159)	2 (4)	6 (6)	653	3.59	0.50	3rd
Waste of time and labour	82 328)	94 (282)	3(6)	3 (3)	619	3.40	0.56	9th
High level of economic losses	91 (364)	88 (264)	2 (4)	1 (1)	633	3.48	0.52	8th
Reduce quality of produce	120 (480)	55 (165)	4 (8)	3 (3)	652	3.58	0.53	4th
Environmental pollution/degradation	117 (468)	60 (180)	2 (4)	3 (3)	655	3.60	0.51	2nd
Grand Mean						**3.50**		

Source: *Field Survey, 2023*

Table 4: ANOVA Test of Significant Difference in the quantity of fruits lost across the States in the study area

States	N	Mean	Std. Deviation	Std. Error	
Nasarawa	32	297.5000	103.1206	18.2293	
Benue	118	482.9032	280.3829	50.3583	
Kogi	32	413.7845	236.3093	17.5647	
	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Model	601919.946	2	300959.973	5.669	.004
Error	9449662.650	180	53087.992		
Total corrected	10051582.597	182			

Source: *Field Survey, 2023*

Table 5: Test of Significant Differences in the Monetary Value of Fruits Lost by farmers across the States in the study area

States	N	Mean	Std. Deviation	Std. Error	
Benue	118	320694.92	174411.27	16055.86	
Nasarawa	32	236750.00	89822.77	15878.57	
Kogi	32	273781.25	75429.84	13334.24	
	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Model	199578662652.49	2	99789331326.25	4.482	013
Error	3985548485699.15	180	22265633998.32		
Total corrected	4185127148351.65	182			

Source: *Field Survey, 2023*

CONCLUSION AND RECOMMENDATION

The study assessed the post-harvest losses and management strategies of selected fruits and vegetable among rural farmers in North-Central, Nigeria. The study concluded that post-harvest losses of fruits in the area were caused by many strong factors and also has 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

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