



EFFECTS OF POST-HARVEST LOSSES ON POVERTY STATUS OF VEGETABLE FARMING HOUSEHOLDS IN KANO STATE, NIGERIA

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ABSTRACT

The study focused on effects of post-harvest losses on poverty status of vegetable farmers in Kano State, Nigeria. Multi-stage sampling technique was used for sample selection and six (6) Local Government Areas (LGAs) were randomly selected from the list of the major vegetable producing LGAs in the State. Vegetable farmers that practice the production of both tomatoes and onions were identified and purposively selected and included in the study making a total of 192 respondents. The data collected were analyzed using frequency counts, percentages, mean, minimum, maximum, cross-tabulation, Post-harvest loss estimation (PHLE) model, Foster-Greer-Thorbecke (FGT) model, and T-test. The results of the socioeconomic characteristics analysis revealed that, 83.9%, 82.3%, and 96.9% of the vegetable farmers were males, married and were within an active working age (15-60yrs) respectively. The farmers indicated vegetable farming as their major source of income (81.2% of the respondents) and only 3.6% of the respondents had formal education up to the tertiary level. Among the two enterprises examined, the mean value of loss per hectare for Tomato was ₦120,905.2, and that of Onion was ₦36,860.16. For the two enterprises combined, the mean value of loss was ₦157,765.3 with a Post-harvest loss index (PHLI) value of 0.25. The study also revealed poverty incidence among vegetable farmers in the study area was 59.9% of the total respondents. From the households that were determined to be poor, 35.7% were only poor because of the post-harvest losses they incurred. It can be concluded based on the findings of this research that, post-harvest losses significantly affect the poverty status of the vegetable farming households in the study area. To reduce problems associated with post-harvest losses and its effects on poverty status, the study recommends improvement in the traditional harvesting and storage methods coupled with improved management practices, training farmers on integrated pest management as well as on post-harvest handling and storage of the crops they handle as this could go a long way to reduce poverty prevalence among the vegetable farmers.

Key words: Vegetables, Post-Harvest Losses, Poverty Status, Farming Households, Kano State, Nigeria.

INTRODUCTION

Vegetables are grown in many countries of the world in outdoor fields, green houses and net houses. World production of vegetables has grown quite rapidly over the years. Statistics by Food and Agriculture Organization (FAO) in 2017 indicated that total production of vegetables in the world was 1,094.34 million metric tons with China as the leading producer of vegetables with a production figure of nearly 554 million metric tons. This is followed by India with approximately 127 million metric tons, while Nigeria was ranked 6th in the world in the same year with a production figure of 16.38 million metric tons (FAO, 2018). Production and marketing of vegetables in Nigeria are among the major sources of income for farmers in the country. Vegetable production has the potential to create employment and generate income, while at the same time providing the much needed micronutrients, antioxidants and phytochemicals that helps to protect people against many forms of diseases (Weinberger and Lumpkin, 2007; Yan and Keding 2009). Studies from the developing countries of Asia and Africa consistently show that farmers engaged in the production of fruits and vegetables earn higher net farm incomes per hectare than farmers engaged in cereal production alone (Ayandiji and Adeniyi, 2011; Adesina, 2012; Abimbola, 2014; Bada *et al.*, 2021.). The high profits and income generated can be used for many different purposes in terms of eradication of hunger and affording access to education and health care.

The growing importance of vegetables offers an opportunity to many smallholder farmers to improve their livelihood. Vegetable production has the potential to contribute to the reduction of food insecurity and poverty by creating more jobs, increasing income from farm sources, and food availability. Despite the growing importance of vegetable production and marketing, many smallholder farmers and actors along the supply chain do not generate sufficient returns to meet their domestic needs. This is as a result of the perishable nature of vegetables that leads to a considerable gap between the gross production and net availability of vegetables with a large quantity being lost through post-harvest losses (Bada *et al.*, 2021). One of the country's agricultural policy thrust specifies that farmers be encouraged to use simple but effective on-farm, off-farm storage facilities and agro-processing technology in order to add value to farm produce and increase their shelf life. In line with this, the Nigerian Stored Products Research Institute (NSPRI) together with Food and Agriculture Organization (FAO) developed techniques such as curing, canning, cooling, processing, etc. for the storage of fruits and vegetables especially tomatoes (Abimbola, 2014). Many of the techniques would require high-energy sources like refrigeration which are not available and affordable to the local farmers. These techniques could help increase the shelf- life of the crops and make them stay longer before they are sold. However, the non-availability of these facilities to local farmers implies that farmers will always be at risk of losing a considerable quantity of harvested produce or have to sell these produce at throw-away prices because they cannot keep them for an extended period of time. Either of the two scenarios has grave implications on the income of farmers and could consequently result into a rapid decline in their welfare which makes them unable to afford other basic necessities of life. As a result, the incidence of poverty is on the increase with biting effects more on rural dwellers who are predominantly farmers. Even though, much is being done by the government to increase productivity of farmers, little attention is given to minimize loss. Reducing post-harvest losses offers more possibility of increasing food availability and consequently, improving welfare of farmers than increasing productivity without managing loss (Adesina, 2012).

It is worth noting that several studies have been carried out on the incidence of postharvest losses. Some studies have quantified postharvest losses or examined the human elements contributing to postharvest losses (Abimbola, 2014; Aidoo *et al.*, 2014; Ahmed *et al.*, 2015). Other studies have analyzed the income effect of postharvest management (APO and FAO, 2006; Atanda *et al.*, 2011; Bada *et al.*, 2021). More studies have identified that the challenges of postharvest losses can be solved through effective control of the losses (FAO, 2011; Chukwunta, 2014). Meanwhile, other studies indicated that, effective control of food losses is a function of the human element (FIRO, 2018; FAO, 2019). While these studies have contributed to our understanding of the postharvest loss menace, limited attention is given to the effects of post-harvest losses on households' poverty especially in Kano State. It is in light of the above that this study in addition to examining the value of loss and returns accruing to the vegetable farmers, also seeks to explore the extent to which post-harvest losses affects the poverty status of vegetable farmers in the study area.

The objectives of the study were to:

- i. describe the socioeconomic characteristics of vegetable farmers in the study area;
- ii. estimate the quantity and value of post-harvest losses encountered by vegetable farmers;
- iii. determine the poverty status of the vegetable farming households; and
- iv. determine the effects of post-harvest losses on household poverty among vegetable farmers.

Hypothesis of the Study

The following hypothesis was formulated and tested;

- i. There is no significant influence of post-harvest losses on poverty status of vegetable farming households in the study area

METHODOLOGY

Study Area

This study was carried out in Kano State, Nigeria. The State is located in the Northwest region of Nigeria and it lies between latitudes 10° 33' to 12° 37'N, and longitudes 7° 34' to 9° 25'E. Kano State shares borders with Katsina State to the north-west, Jigawa State to the north-east, Bauchi State to the south-east and Kaduna State to the south-west (Kurawa, 2003). Agriculture is the main stay of the economy of the state with about 70% of the people actively engaged in farming. People in the state are farmers, traders, herdsman, fishermen and civil servants. Production and consumption of vegetable is popular among the teeming population of Kano State. The state has a vast agriculture development potential and vegetables are cultivated in all the three ADP zones of the State.

Sampling Procedure

A multi stage sampling procedure was used for sample selection in the study area. The first stage involved random selection of six (6) Local Government Areas (LGAs) from the list of the fifteen (15) major vegetable producing LGAs in Kano State. The LGAs selected were: Garun Mallam, Kura, Bunkure, Bagwai, Dawakin Tofa and Makoda. The second stage involved random selection of two (2) communities from each of the six (6) LGAs selected making a total of twelve (12) communities. Lastly, from the list of vegetable farmers in each of the communities selected, only farmers that practiced the production of tomatoes and onions

at the same time were identified and purposively selected and included in the study making a total of 192 respondents.

Source and Methods of Data Collection

Data for the study were collected from primary sources through household surveys. The survey interview was carried out through structured questionnaires which were administered to the sampled vegetable farmers by the researcher with the assistance of trained enumerators. Data collected from the respondents were those regarding the socio-economic characteristics of the households such as age, sex, marital status, farming experience, educational level, farm size, household size, household income (such as income from sales of vegetables as well as other sources of income) and quantities of vegetables lost.

Analytical Techniques

Data for the study were analyzed using descriptive statistics, post-harvest loss estimation (PHLE) model, Foster-Greer-Thorbecke (FGT) model, logistic regression model and Paired samples t-test. These models are specified as follows:

Descriptive statistics

Descriptive statistics is one of the simplest and most frequently used tools of analysis in most researches. It is used to describe and summarize relatively large array of data into meaningful forms such that they could be easily interpreted. The descriptive statistics such as frequency counts, percentages, mean, minimum, maximum, and cross-tabulation were employed to describe the socio economic characteristics of the vegetable farmers.

Post-Harvest Loss Estimation (PHLE) Model:

The Post-harvest loss estimation (PHLE) model was used to quantify vegetable losses at harvest and post-harvest stages. Suleiman (2015) used principles of computing and index estimation to develop a model for estimating post-harvest losses. For statistical estimation, the total PHL at any post-harvest stage for a given commodity and region is the sum of crop losses occurring at each of the stages. The major post-harvest activities carried out on the supply chain are harvesting, sorting, packaging, storage, and transportation. The PHLE model is expressed as:

Total PHL = Sum of PHL at each stage of the food supply chain

$$TPHL = \sum [\sum H_i + \sum S_i + \sum P_i + \sum R_i + \sum T_i] \dots\dots\dots (1)$$

Where:

TPHL = Total Post-Harvest Losses (kg/ha)

H_i= Post-harvest loss during harvest (kg/ha)

S_i= Post-harvest loss during sorting (kg/ha)

P_i= Post-harvest loss during packaging (kg/ha)

R_i= Post-harvest loss during storage (kg/ha)

T_i= Post-harvest loss during Transportation (kg/ha)

$i = 1, 2, 3, \dots, n$

Total Post-Harvest Loss Index (TPHLI) is given by:

$$TPHLI = \frac{TPHL}{TH} \dots\dots\dots (2)$$

Where:

TPHLI = Total Post-harvest loss index

TPHL = Total post-harvest loss (kg/ha as determined under equation 1)

TH = Total harvest (kg/ha)

An Index value of zero (0) indicates no loss encountered and a value of one (1) indicates 100% loss. Therefore, indices towards zero (0) indicate a lower rate of loss while indices close to one (1) indicate a severe loss.

Foster-Greer-Thorbecke (FGT) model

To establish poverty status of the vegetable farmers in the study area, the study used the income method of estimating poverty by Foster *et al.*, (1984). Before calculating the household poverty status, there is the need however to construct a poverty line. The relative approach was adopted for this study takes a proportion of mean total per capita income as the poverty line. Using the income approach, the poverty line was thus calculated as follows:

$$HPCI = \frac{HI}{HHS} \dots\dots\dots (3)$$

Where:

HPCI = Household per Capita Income (₦)

HI = Household Income (₦)

HHS = Household Size

$$THPCI = \sum HPCI \dots\dots\dots (4)$$

Where:

THPCI = Total Household per Capita Income (₦)

HPCI is as defined in equation 3

$$MTPCI = \frac{THPCI}{TNR} \dots\dots\dots (5)$$

MTPCI = Mean Total per Capita Income

THPCI is as defined in equation 4

TNR = Total number of Respondents

$$PL = MTPCI \times 2/3 \dots\dots\dots (6)$$

Where:

PL = Poverty Line, and

MTPCI is as defined in equation (5)

A household is therefore considered not poor if its per capita annual income falls above or is equal to the poverty line. On the other hand, a household is considered poor if its per capita annual income falls below the poverty line.

The FGT poverty index is therefore expressed as follows:

$$P_{\alpha} = \frac{1}{n} \sum_{i=1}^q \left(\frac{z-y_i}{z} \right)^{\alpha} \dots \dots \dots (7)$$

Where:

P = Foster, Greer and Thorbecke Index ($0 \leq P \leq 1$)

n = Total number of respondents i.e. farm households sampled

q = Number of respondents below the poverty line i.e. poor people

z = Poverty line

y_i = Per capita household income of the i^{th} respondent.

$\left(\frac{z-y_i}{z} \right)$ = Proportion of shortfall in income below the poverty line.

α = Non-negative poverty aversion parameter (0, 1 or 2).

The analysis of the poverty status of the households was decomposed into three indicators i.e. prevalence of poverty (P_0), poverty depth (P_1) and severity of poverty (P_2).

If $\alpha = 0$, the index become $P_0 = (q/n)$. This gives the head count ratio or the incidence of poverty which is the percentage of respondents in poverty i.e. whose per capita income is below the poverty line.

If $\alpha = 1$, it reflect both incidence and depth of poverty or the proportion of the poverty line that the average poor will require to attain to the poverty line.

If $\alpha = 2$, the index measure the severity of poverty which is the mean of square proportion of the poverty gap. When multiplied by 100, it gives the percentage by which a poor household's per capita income should increase to push them out of poverty

Paired Samples T-Test

The Paired samples t-test compares the means of two related groups in order to determine whether there is statistical evidence that the associated population means are significantly different. This tool was used to test if there is a significant difference between per capita income with loss and per capita income without loss of vegetable farming households.

Hypothesis:

$H_0: \mu_1 = \mu_2$ (the sample means of household poverty status with and without losses are equal)

$$T = \frac{\bar{x}_1 - \bar{x}_2}{S_{\bar{x}}} \dots \dots \dots (8)$$

Where:

T = the size of the difference relative to the variation in the two sample sets.

\bar{x}_1 = sample mean of per capita income minus value of loss

\bar{x}_2 = sample mean of per capita income plus value of loss

$S_{\bar{x}}$ = Standard error

RESULTS AND DISCUSSION

Socio-economic Characteristics of Vegetable Farmers in the Study Area

Socio-economic characteristics of vegetable farmers play an important role in the production of vegetables. These characteristics can to some extent influence the amount of post-harvest losses encountered as well as the poverty status of vegetable farming households. The result from Table 1 indicates males constituting about 83.9% of the total respondents dominate vegetable production in the study area. Traditionally, sex segregation gives room for the division and assignment of responsibilities among people. Males tend to undertake more tedious and outdoor jobs while females were left with simpler and indoor activities such as backyard poultry production. Differences in opportunities between males and females could lead to differences in household income and poverty status. Households headed by females are likely not to have enough labour for farming activities especially for harvesting as compared with households headed by males because of the cultural setting in the study area. This affects the level of post-harvest losses encountered which consequently, affects the level of income generated. Because of this, households headed by females are more likely to be poor as compared to households headed by males. The result from Table 1 also indicates respondents of age 30 years and below constituted about 44.8% of the sample respondents. That is, those in their active and working age dominate vegetable production in the study area. The dominance of active and productive individuals has implication on sustainability of vegetable production as experience is passed on from generation to generation. In addition, it is a pointer to improvement in labour and productivity such that young people are likely to adopt new technologies than older people. Older people tend to adhere strictly to traditional methods while the young tend to be more willing to adopt new technologies in order to increase productivity as well as prevent post-harvest losses. Thus, the probability of a household being poor is more likely with older heads of households. Regarding marital status, about 82.3% of the vegetable farmers were married. Marriage makes an individual more responsible and influences taking economic decisions more accurately. This result is in line with the findings of Ayandiji and Adeniyi, (2011) who reported that 86.4% of tomato farmers in Imeko-Afon local government area of Ogun State were married. The implication of this result is that majority of the respondents would be responsible, and can take major decisions to sustain domestic household demand. It also has implication on post-harvest losses since; married farmers are likely to have access to more family labour especially for harvesting. The time taken to do harvesting may be longer for a single household leading to loss from over ripening and in an attempt to rush the work, fruits are badly handled which could result in mechanical damage of fruits.

Table 1: Socio-economic Characteristics of the Respondents (n=192)

Socio-economic Variables	Freq.	%
Sex of Respondents		
Male	161	83.9
Female	31	16.1
Age of Respondents		
Below 30	86	44.8
31-40	74	38.5
41-50	17	8.9
51-60	9	4.7
61 and above	6	3.1
Marital Status		
Single	34	17.7
Married	158	82.3
Household Size		
1-5	64	33.3
6-10	50	26.0
11-15	37	19.3
16-20	21	10.9
21 and above	20	10.4
Level of Education		
Islamic literacy	35	18.2
Primary	80	41.7
Secondary	70	36.5
Tertiary	7	3.6
Primary Occupation		
Farming	156	81.2
Civil Service	4	2.1
Trading	16	8.3
Others	16	8.3
Vegetable Farming Experience		
1-5	9	4.7
6-10	52	27.1
11-15	61	31.8
16-20	45	23.4
21 and above	25	13.0
Farm Size		
0.1-2ha	54	28.1
2.1-5ha	66	34.4
5.1ha and above	72	37.5

Source: Field survey, 2023

Result from the table further indicates that, majority (33.3%) of the vegetable farmers had household sizes between 1 and 5. Most often, family members in the house provide the labour for farming activities. This implies that household size has a positive effect on the required labour for tomato/onion enterprises in the study area. Household size also has a bearing on poverty status of households depending on the composition of the household members. The probability of being poor is more likely with large household sizes that are unproductive.

Regarding level of education, Table 1 indicated that 41.7% of the vegetable farmers had only primary education, while 36.5% had secondary education. Only 3.6% of the respondents had tertiary education. Low level of education could be a contributory factor to post-harvest losses in vegetable production because only farmers with sound knowledge can think critically, ask questions and take decisions independently. Such farmers appreciate and adopt most of these post-harvest technologies available in order to increase their productivity as well as minimize loss and consequently, increase their incomes. Also, level of education can determine the poverty status of a household. Household heads that are more educated earn higher incomes than their less educated counterparts. Also, Table 1 indicated that 31.8% of the vegetable farmers had farming experience between 11 and 15 years. Only 4.7% of the vegetable farmers had farming experience between 1 and 5 years. The implication of this result is that, majority of the respondents were well experienced in their business which would influence their efficiency due to knowledge about local conditions. It is expected that experience could reduce post-harvest losses among vegetable farmers and would go a long way to improve household welfare. Furthermore, Table 1 shows that 37.5% of the respondents are large scale operators with farm sizes from 5.1ha and above. The implication of this result is that, majority of the vegetable farmers produce primarily for commercial purpose not for subsistence and therefore, profit oriented. A severe post-harvest loss will result in reducing farm returns which could affect their ability to afford basic necessities of life, and consequently lower their living standard. Therefore, one will expect better management and care if the vegetable farmers produce for commercial purposes.

Estimation of Post-Harvest Losses

Quantity of post-harvest losses in kilogram per hectare

The estimation of the quantity of post-harvest losses encountered by each vegetable farmer was estimated to see the amount of crop lost from the total harvest. This is carried out for both the two enterprises on kg per hectare bases. The result of the analysis is presented in Table 2.

Table 2: Total Quantity of Tomatoes and Onions Harvested/Lost in kg per ha (n=192)

Item	Minimum (kg/ha)	Mean (kg/ha)	Maximum (kg/ha)
Total quantity of tomato harvested	52.50	7,584.58	70,500
Quantity of tomato lost	3.75	2,122.19	20,700
Total quantity of onion harvested	127.50	2,716.70	42,500
Quantity of onion lost	30.00	393.56	3,400

Source: Computed from Field Survey, 2023

Table 2 depicts the result of the descriptive statistics of total quantity of Tomatoes and Onions harvested and the post-harvest losses encountered by vegetable farmers in kg/ha. From the Table, the quantities of tomatoes harvested ranges widely from a minimum of 52.50kg/ha to a maximum of 70,500kg/ha with a mean harvest figure of 7,584.58kg/ha. From this, the maximum quantity of tomato lost/ha was 20,700kg, the minimum quantity lost/ha was 3.75kg, while the mean quantity of tomato lost/ha was 2,122.19kg. This implies that on the average, 2,122.19 kg/ha of tomato was lost in the study area. Also from the Table, the quantities of onions harvested ranges widely from a minimum of 127.50kg/ha to a maximum of 42,500kg/ha with a mean harvest figure of 2,716.70kg/ha. Out of this, the minimum, mean, and maximum quantity of onion lost//ha were 30kg, 393.56kg, and 3,400kg respectively. It can be concluded that the losses recorded in tomato enterprise was higher than the losses encountered in onion enterprise. This is partly due to the fact that tomatoes are more perishable than onions, and the

more perishable a commodity is, the greater the loss that is expected to occur. Another reason why losses were recorded more in tomato enterprise is because, harvesting in onion was carried out once, while that of tomato was done in sequence up to ten times and at every harvest, losses occur which contributed to the total post-harvest losses encountered in the tomato enterprise.

Value of Post-Harvest Losses in Naira per Hectare

In order to estimate the value of loss, in each crop, the unit selling price/kg for each crop was multiplied by the total kg of crop lost. For onion enterprise, price per bag of onion was divided by the weight of the bag (kg) to obtain the price per kg. Then, total kg lost/ha was multiplied by price/kg to obtain the value of loss per/ha. For tomato enterprise, the same procedure was used (price per basket divided by the weight of the basket to obtain price/kg) except here, average price was used because harvesting was carried out in sequence, and at every harvest price per basket varies which causes the price per kg to vary also. Therefore, to obtain the value of loss/ha of tomato enterprise, average price/kg was multiplied with total kg lost/ha. The result of the analysis is presented in Table 3.

Table 3: Total Harvest Values and Post-Harvest Loss Values in Naira (n=192)

Item	Minimum (₦)	Mean (₦)	Maximum (₦)
Price per kg of tomato	1.13	57.61	233.33
Total harvest value for tomato per ha	2,800	427,567.21	5,122,980
Value of tomatoes lost per ha	441.75	120,905.2	1,748,115
Price per Kg of onion	25	76.54	411.76
Total harvest value for onion per ha	5,250	2,773,85.47	8,050,000
Value of onion lost per ha	1,750	36,860.16	770,000
Combined value of tomato and onion lost per ha	4,675.0	157,765.3	2,518,115

Source: Computed from Field Survey, 2023

Table 3 presents the descriptive statistics of harvest values and post-harvest loss values of vegetable farmers in naira/ha. From the Table, the mean price per kg for Tomato and Onion were ₦57.61 and ₦76.54 respectively. This prices were used in obtaining the total harvest values and the value of loss per ha for the two enterprises. Also from the Table, the mean harvest values for Tomatoes and Onions per ha are ₦427,567.21 and ₦277,385.47 respectively. This implies that, average revenue generated from tomato enterprise is more than that obtained for onion enterprise. However, the value of loss/ha for tomato ranges widely from a minimum of ₦441.75 to a maximum of ₦1,748,115 with a mean value of ₦120,905.2. For onions, the minimum, mean and maximum values of losses/ha were ₦1,750, ₦36,860.16 and ₦770,000 respectively. It can be deduced from the result that the value of loss/ha was greater for tomato enterprise than for onion enterprise. The findings also imply that, post-harvest losses incurred in tomato enterprise could have more negative effect on household income than losses incurred in onion enterprise. Furthermore, the result from the table indicated that, the mean value of loss/ha for tomatoes and onions combined was ₦157,765.3. This is an indication of the magnitude of post-harvest losses encountered by the vegetable farmers in the study area.

Post-Harvest Loss Index (PHLI) and Sales to Production Ratio (SPR) in Naira/ha

The Post-harvest Loss Index (PHLI) signifies the proportion of crop lost from total harvest. An index value of zero (0) indicates no loss encountered and a value of one (1) indicates 100% loss. Therefore, indices towards zero (0) indicate a lower rate of loss while indices close to one (1) indicate a severe loss. The Sales-to-Production Ratio (SPR) on the other hand, is the opposite of PHLI; it shows the percentage of commodity sold from the total produce harvested.

The sum of SPR and PHLI gives 100%. Table 4 presents the descriptive statistics of PHLI value and SPR of vegetable farmers in naira/ha (the mean value was used as the index value).

Table 4: Values of PHLI and SPR of Vegetable Farmers in Naira/ha (n=192)

PHLI/SPR	Min	Mean	Max	Std. Error
PHLI of Tomato	0.01	0.28	0.75	0.0080
PHLI of Onion	0.02	0.19	0.80	0.0101
TPHLI (tomato+onion)	0.03	0.25	0.57	0.0640
SPR Tomato	0.25	0.72	0.99	0.0082
SPR Onion	0.20	0.81	0.98	0.0101

Source: Computed from field survey, 2023

From Table 4, the mean value of PHLI for tomato was 0.28, indicating an average of 28% of the tomatoes harvested was lost as a result of the major causes of post-harvest losses. Also from the Table, the mean value of PHLI for onion was 0.19, indicating an average of 19% of the onions harvested were lost as a result of the major causes of post-harvest losses. The combined mean value of PHLI for tomatoes and onions was 0.25, which also indicates an average of 25% of the harvested crops were lost as the commodity moves from harvest to the point of sale. In a similar study involving tomato producers in Kano State, Bada *et al.* (2021) reported mean PHLI value of 23.2% of the total tomatoes harvested. Furthermore, the table also shows the mean SPR for tomato was 0.72, indicating an average of 72% of the tomatoes harvested were not lost. The Table further shows that, the mean SPR for onion was 0.81, indicating that, on average, 81% of the onions harvested were not lost. Considering the mean values of PHLI and SPR for tomatoes and onions, average loss was greater for tomato than onion enterprise. Going further, looking at the combined PHLI (0.25), it can be deduced that, on the average, a quarter (25%) of the household income that is supposed to come from farm earnings was lost as a result of the incidence of post-harvest losses. This has serious implication on income of households and their likelihood of being poor. Income loss could affect the ability of households to access food, clothing, shelter and healthcare.

Analysis of Household Poverty Status of the Respondents

The respondents' poverty status was analyzed using four (4) indicators: the poverty line (PL), incidence/prevalence of poverty (P_0), poverty depth (P_1) and severity of poverty (P_2).

Poverty levels among vegetable farming households

Table 5 presents the poverty indices of vegetable farming households in the study area. The result from the Table indicated a poverty line (PL) of ₦36,832.378 per annum. Therefore, any household with per capita income below this value is considered poor. This poverty line is however very low when compared with the national poverty line (₦137,430) per annum reported by National Bureau of statistics (NBS) for the year 2019 (NBS, 2020). These findings indicated that on the average, vegetable farmers in this study area are living below the national poverty line and therefore, considered poor using the NBS national figures.

Table 5: Poverty Levels among Vegetable Farming Households (n=192)

Poverty indices	Value (NGN)
Mean household per capita income (MHPCI)	55,248.567
Poverty line (PL)	36,832.378
Incidence of Poverty (P ₀)	0.599
Depth of Poverty (P ₁)	0.368
Severity of Poverty (P ₂)	0.224

Source: Computed from Field Survey, 2023

Table 5 also shows that prevalence of poverty among vegetable farming households in the study area was 0.599, indicating that 59.9% of the respondents have per-capita income below the poverty line and are considered poor. This finding is corroborated by NBS (2020) which reported 58.76% poverty rates for agricultural enterprises. The implication of this result is that majority of the vegetable farmers in the study area are poor and therefore likely to struggle with households needs for necessities of life such as food, shelter, healthcare and clothing. The poverty depth was 0.3678, which indicates income shortfall of 36.78% of the average poor from the poverty line. This gap represents the percentage of income required to bring the average poor household to be on the poverty line. In monetary terms, the income an average poor will require to attain the poverty line is ₦13,554.315. Furthermore, the severity of poverty index was 0.224. This index value indicates 22.4% of the households were the poorest among the poor who require the attention of policy makers, the distribution of the standard of living indicators such as healthcare services, clean water and income generating activities.

Further analysis was carried out to identify the characteristics of farmers with extreme values of PHLI and SPR alongside their poverty status to see if they are better off or not. The information obtained is presented in Table 6.

Table 6: Socioeconomic Characteristics of the Extreme Farmers

PHLI/SPR	PS	Sex	Age	MS	HHS	Ed. Lev	F.Ex	FS
min.PHLI/max.SPR(Tom.)	NP	Male	36	Married	9	Tertiary	18	1ha
max.PHLI/min.SPR(Tom.)	P	Male	65	Married	21	Islam. Lit.	33	11ha
min.PHLI/max.SPR(Oni.)	NP	Male	25	Married	4	Secondary	10	1.5ha
max.PHLI/min.SPR(Oni.)	P	Male	49	Married	14	Primary	20	13ha

Note: PS=Poverty status, MS=marital status, HHS=Household size, Ed. Lev=education level, F.Ex=Farming experience, FS=Farm size, P=Poor and NP=Not poor

Source: Computed from Field Survey, 2023

From Table 6, the farmer with the minimum PHLI and maximum SPR values for tomato is a male; he's not poor and had acquired tertiary level of education. He is 36 years old, married with household size of nine (9) persons; cultivates 1ha of farmland and has 18-year experience in farming. Also from the Table, the worse performing farmer in terms of tomato loss (with maximum PHLI and minimum SPR) is also a male, had Islamic literacy, and married with household size of 25 persons. He is 65 years old and has farm size of 11ha with farming experience of 33 years yet was found to be poor.

The Onion farmer with minimum PHLI and maximum SPR values was identified as a male, had secondary level of education and married with household size of four (4) persons. He is 25 years old, cultivates 1.5ha farm with 10-year experience. From the analysis conducted, this farmer lives above the poverty line. The worse performing Onion farmer had the maximum PHLI and minimum SPR values. He was identified as a male; married, with family size of 14

persons. Aged 49 years and has been farming for 20 years. From the analysis conducted, his household was found to live below the poverty line.

It can be implied from this result that, educated farmers encountered lesser crop losses as compared with those that had undergone only primary education or had only Islamic literacy. Therefore, the more educated a farmer is, the more likely he would be to take actions that lessen crop loss. Also, as can be seen from the Table, farmers with larger hectares of farmland incurred greater losses when compared with farmers with smaller hectares of farmland. Hence, the bigger the farm size, the greater the loss that is expected to occur. This can be partly attributed to issues regarding resource use efficiency and technical efficiency. Another conclusion that can be drawn from this finding is that, household size and level of education have relationships with poverty status of the farming households. Older and less educated household heads with larger household sizes sustained more crop losses than their younger and more educated counterparts who operated manageable farm holdings.

Effects of Post-Harvest Losses on Households' Poverty Status

Analysis of effect of post-harvest losses on household poverty status was carried out to see the influence of post-harvest losses on household poverty. In order to obtain this, the poverty depth index (0.368) determined in this study was used as a baseline to make the comparison. Recall that the poverty depth shows the amount by which the average poor fall short of the poverty line or the percentage of income required to bring the average poor to the poverty line. Losses sustained by vegetable farmers were estimated and were compared with income shortfall that prevents attainment of poverty line. It is therefore instructive that poor households that sustain losses equal or greater than the income shortfall to be on the poverty line would not have been poor if such losses did not occur. This implies poor households whose value of loss per capita is greater or equal to the poverty depth, were only poor because of the losses sustained. The result of this analysis is presented in Table 7.

Table 7: Effects of Post-Harvest Losses on Household Poverty Status (n=192)

S/No	Variable	Freq.	%
1	Poverty incidence with post-harvest losses	115	59.9
2	Poverty incidence without post-harvest losses	74	38.5
3	Households that would not have been poor without post-harvest losses	41	21.4
Percentage change in the poverty status of the poor households = 35.7%			

Source: Computed from Field Survey, 2023

Table 7 presents the effect of post-harvest losses on household poverty status of the respondents. The result shows incidence of poverty amidst post-harvest losses was 59.9%. However, when the value of loss per capita was compared with the value of the poverty depth, the prevalence of poverty dropped to 38.5%, a reduction of 21.4% out of the poverty threshold. This implies that, 21.4% of the respondents (which is 35.7% of the poor households) were only poor because of post-harvest losses sustained. This is a clear indication that post-harvest losses affect household poverty considerably.

A paired sample T-test was carried out to test if the effect of post-harvest losses on household poverty is statistically significant. Table 3.8 presents the result of the analysis.

Table 8: Paired Samples T-Test Comparing Farmers' Income with and without Post-Harvest Losses

Observation	N	Mean	SD	T-value	P-value
Per capita income minus value of loss	192	54,962.73	58,299.81	12.03	0.000***
Per capita income plus value of loss	192	69,767.58	72,817.33		

Note: *** indicates significant at 1%

Source: Computed from Field Survey, 2023

Table 8 depicts the result of the paired samples t-test between per capita income minus the value of loss and per capita income plus the value of loss. From the table, the t-value is 12.03 with a p-value of 0.000 significant at 1%. This is a clear indication that, per capita income minus value of loss is significantly different from per capita income plus value of loss. Also, the high t-value (12.03) indicates that a large difference exist between the two sets of samples. Therefore, the result suggests that post-harvest loss significantly affects household income and consequently, household poverty status of vegetable farmers in the study area.

CONCLUSION

It can be concluded that post-harvest losses significantly affect the poverty status of the vegetable farming households in the study area. Evidence from the analysis showed that most of the farmers were literate, married men, and vegetable farming was their major source of income. Among the two enterprises examined, losses were greater for tomatoes than onions and on the average, post-harvest losses for the two enterprises combined constituted about one quarter of the total production. This is a serious implication on household poverty as it is bound to affect the income and consequently, the livelihood of vegetable farmers considering the fact that their major source of income is farming. Even though incidence of poverty among vegetable farmers was found to be prevalent from the study conducted, considerable proportion of the poor households were only poor because of the post-harvest losses encountered. This is a clear indication that post-harvest loss influences the poverty status of the vegetable farming households in the study area.

Based on the findings of this research, the following recommendations were put forward:

- i. Government should initiate affordable policies that will improve the traditional harvesting and storage methods coupled with improved management practices. This will help reduce post-harvest losses during harvest as well as make it possible for vegetable farmers to store their farm produce for a longer time.
- ii. Although lack of equipment and infrastructure are key constraints, lack of awareness and capacity amongst farmers should not be underestimated. Therefore, training farmers on post-harvest handling and storage of the crops they handle are very vital to reducing post-harvest losses.

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