# Effect of Post-Harvest Losses on Food Security among Yam Farmers in Nigeria

**Ogheneruemu, Obi-Egbedi and Joy Omoanuse Ifoga**

Department of Agricultural Economics, University of Ibadan, Nigeria
Corresponding author's email: gheneobi@gmail.com

**Abstract**
Nigeria is the largest producer of yam in the world, although postharvest loss leading to wastage in farm produce, inputs and investments could impact negatively yam farmers' income and consequently, food security. Studies are limited on postharvest loss of yam and its link with food security in Nigeria. Therefore, the effect of postharvest loss on the food security of yam farmers in Nigeria was investigated. The Nigeria General Household Survey (GHS) 2018/2019 dataset by the National Bureau of Statistics was used for the study and data on 1,647 yam farmers were extracted. Results revealed that 76.4% of the farmers were male, 70.7% were married, and 77.7% had primary education or higher. On average, farm size was 0.75 hectares, age was 54.5 years, post-harvest loss 0.278 t/ha and yield 8 t/ha. Most yam farming households (90.5%) had low-level post-harvest loss of <2 t/ha. The food security line was ₦905.24, while food security incidence, depth and severity were 51.49%, 27.60% and 18.78%, respectively. Thus, most yam farmers in Nigeria were food insecure. Postharvest loss reduced the probability of food security among yam farmers in Nigeria, alongside age and farm size, while having secondary and tertiary education, household size and being a cooperative member improved it. Conclusively, postharvest loss worsens the food insecurity of yam farmers in Nigeria. Therefore, the government should favour policies that reduce yam postharvest loss, while emphasizing educational attainment among yam farmers beyond the primary level.

*Keywords: Postharvest Loss, Food Security, and Yam Farmers*

## Introduction

Nigeria is the top producer among 55 countries of the world that grow yams (FAOSTAT, 2023). The country's production of 50.4 million tonnes accounts for 67.0% of the global production, followed by Ghana with a share of 11.1% and Côte d'Ivoire with 10.5% (FAOSTAT, 2023). Africa's yam production accounts for 97% of the global production (ibid). Similarly, the largest area harvested of yam resides in Africa, with Nigeria having the largest area of 5.9 million ha which is 68% of the global area harvested of yam. Côte d'Ivoire has the second largest area of 1.4 million ha, accounting for 16.6% of the global area harvested of yam, while Ghana follows with 0.4 million ha, which is about 5.2% of the global area harvested of yam (ibid). Concerning yield, however, Africa does not feature among the top countries. Guyana, Saint Lucia and Japan have the highest yam yields in the world with 66.4 t/ha, 27.3 t/ha and 23.7 t/ha, respectively (ibid). Ghana has the highest yam yield in Africa and the sixth highest in the world with 18.4 t/ha, while Nigeria has the 30th highest yam yield globally with 8.5 t/ha (ibid). This shows the low productivity of yam in Africa particularly in Nigeria where an increase in the area harvested mostly contributes to increased output.

Yams are an important food crop in Nigeria and rank fifth behind cassava, maize, guinea corn and cowpea (FAO, 2019). About 45.7 million tonnes worth 21.1 billion USD are consumed in the country with a per capita consumption of 252kg (Verter and Becvarova, 2015). Yam production and processing procedures are mostly traditional, and consequential in yam losses and income to the farmers, although both human and environmental factors come into play in bringing about yam losses. Almost $10 billion worth of food crops are lost in Nigeria annually in postharvest losses, which is estimated to be about half of the total quantity of foods produced (Elemo, 2017). Postharvest loss includes all produce losses incurred in the marketing chain (Goldsmith *et al*., 2015). In this study, postharvest loss of yam is seen as the quantity of yams lost between the time of harvest and the sale of the yams by the farmers. Yam storage systems are inadequate in terms of both quality and quantity, thus constituting the major cause of postharvest losses among yam farmers in Nigeria (Adamu, 2014). Over one-fifth of harvested yams is lost (ibid), thus affecting farm incomes and forming

disincentives to yam production. This could further increase the risk of farmers' poverty and food insecurity among the farmers in the country. Addressing the postharvest loss problem can improve the incomes of poor farmers while making more food available for poor people thereby improving nutritional outcomes (Brander, 2021).

Nutrition and food security have been issues of concern in Nigeria, particularly in the principal dimensions of food availability, accessibility and utilization. Food security aims that people should have adequate food and also that the body should utilized the food. Food security is a global priority, being the second Sustainable Development Goal (SDG2) to be achieved by 2030. However, the chances of Nigeria's attainment of the goal appear rather slim. The Global Food Security Index (GFSI) rank of Nigeria has been dismal since 2013 while it was ranked 94th among 113 countries in 2019. Nigeria is facing the challenge of food insecurity, especially in the Northeastern and North-Central states where conflicts/insurgency, kidnapping, armed banditry, cattle rustling and weather extremes are aggravating the food insecurity situation. High poverty levels with the consequent low purchasing power of people at household and national levels make food affordability very challenging. About four in every 10 Nigerians are poor while a quarter of the population who are not poor are vulnerable to poverty (World Bank, 2022). Over one-third of children under five in the country are stunted, while wasting affects almost 10% of them (NDHS, 2019). Two out of ten children are underweight while two out of 100 are overweight (ibid). Sixty-eight out of every 100 children and 58 out of every 100 women are anaemic (ibid). This paints a depressing situation of calorie intake and food security in Nigeria to which yam can make immense contributions, although, the problem of postharvest yam losses threatens the potential of the food crop for food security attainment in Nigeria.

The attention to examining the link of postharvest loss of yam with the food security of the farmers is limited in the literature. Past empirical studies have quantified postharvest losses (Adisa *et al*, 2015), or examined the predictors of postharvest losses (Ansah and Tetteh, 2016). In addition, Hodges *et al*. (2011) identified the challenge of postharvest losses and effective solutions. Moreover, unemployment and poverty have been identified as the main source of food insecurity, especially in rural areas (FAO, 2022). While these studies have contributed to our understanding of postharvest loss and food security, both concepts have only been linked by Tanye (2016) in Ghana. Thus, indicating that information on the subject is scanty. Given that postharvest losses of yam can further exasperate the situation by wasting the available food produced, it is imperative to study its effect on food security. The study is important in Nigeria if the country will meet the Sustainable Goal of zero hunger by the year 2030. Hence, the following research questions are raised: What are the socio-economic characteristics of yam farmers in Nigeria? What are the levels of yam losses and their determinants? What is the food security status of yam farmers in Nigeria? What are the effects of postharvest loss on the food security of yam farmers in Nigeria?

## Materials and Methods
### Study area
The study area was Nigeria. The West African country shares land border with Niger in the north, Chad in the northeast, Cameroon in the east, and Benin in the west. Its coast in the south is located on the Gulf of Guinea in the Atlantic Ocean. The total land area is 924, 000km$^2$, located between longitude 4° and 14°N and latitude 2° and 14°E hence, a tropical climate type of damp and very humid seasons. The country has two broad vegetation types namely: forest and savannah. Nigeria is marked by two distinct seasons: wet and dry season. Generally, the south has about 8 - 10 months of rainfall with an annual mean rainfall amount of 400 - 1,100mm. Temperature ranges between 20 – 30$^{\circ}$ C between the rainy to dry seasons (Ugbah *et al*., 2020). Most people are employed in agriculture, while some commonly grown food crops include: yam, cassava, potatoes, maize, rice, guinea corn, sorghum and cowpea among others.

### Data and Sampling technique
Secondary data were used for the study, obtained from the fourth wave of the General Household Survey (GHS) 2018/2019 data set for Nigeria, collected by the National Bureau of Statistics. The survey covered 5,000 households in Nigeria which were enumerated systematically across the six geopolitical zones of the country. The data focused on details of household income activities, expenditure, consumption and agricultural activities. Observations from 1,647 household heads who engaged in yam production were extracted for this study. Information extracted includes the socioeconomic characteristics of yam farmers such as age (years), gender, education (years of formal education), household size, marital status, occupation, per capita income, membership of cooperation, farm size and land ownership. In addition, information on inputs used in yam production (such as cost of seeds used, cost of herbicide, cost of fertilizer and cost of pesticides), postharvest loss and food security of the households were extracted.

### Data analytical techniques
Descriptive statistics such as mean, frequency and standard deviation were used to describe the socioeconomic characteristics of yam farmers. The postharvest loss (PHL) was determined by adding up the total quantity sold to the total quantity consumed and then subtracting the sum from the total quantity harvested and categorized into three groups: low (0-0.99), moderate (1.01-2) and High (>2) percent. The PHL is given in metric tonnes per hectare (t/ha).

PHL(kg) = Total quantity harvested – [total quantity sold + total quantity consumed]… (1)

Foster-Greer-Thorbecke's (FGT) measure of food security was employed to analyse the food security status of the yam farming households. The food security

line was estimated as two-thirds of the mean per capita household food expenditure (MPCHFE). Thus, food-secure households were classified as households with MPCHFE above or equal to the food security line, while food-insecure households were those with MPCHFE below the food security line. A food insecurity profile of the respondents was constructed using the three food insecurity indices; food insecurity incidence (F0), food insecurity depth (F1) and food insecurity severity (F2).

$$F\alpha = \frac{1}{n} \sum_{i=1}^{q} (\frac{z - yi}{z})^{\alpha} \ldots (2)$$

Where:
n = number of households in a group
q = the number of insecure households
Z = food security line
$y_i$ = the per capita expenditure (PCE) of the household,
α = degree of food security aversion
A probit regression model was used to estimate the effect of postharvest loss on food security.
Specifically, we assume that the model takes the form.

$$Y^* = X_{\beta}^{T} + C \ldots (3)$$

Where:

$$\varepsilon = N(0,1)$$

Then Y can serve as an indicator of whether the latent variable is positive

$$Y = \{1 \, Y^* > 0\} = \{1 \, Xi\beta + \varepsilon > 0\} \ldots (4)$$

0 otherwise
Where:
Y = Food security (1=Food secure, 0=Food insecure)
X1 = Postharvest loss (tons/ha)
X2 = Sex (1=Male, 0=Female)
X3 = Age (years)
X4 = Primary education (1=Yes, 0=Otherwise)
X5 = Secondary education (1=Yes, 0=Otherwise)
X6 = Tertiary education (1=Yes, 0=Otherwise)
X7 = Married (1=Yes, 0=Otherwise)
X8 = Household size (number of persons)
X9 = Employment status (No.)
X10 = Membership of cooperatives (1 = Yes, 0 = Otherwise)
X11 = Farm size (Hectares)
X12 = Credit access (1 = Yes, 0 = Otherwise)

## Results and Discussion
### Socioeconomic characteristics of yam farmers in Nigeria
The description of the socio-economic characteristics of yam farmers in Nigeria is presented in Table 1. The results revealed that about 76 percent of yam farmers in Nigeria were males, indicating that yam production is a male-dominated activity. This may not be unconnected with the laborious nature of yam production which most females may be unable to contend with since yam production is highly energy-demanding. This finding agrees with the National Population Commission (NPC) 2006 that men dominate the workforce in Nigerian agricultural communities. It is also in agreement with Obi-Egbedi and Ojo (2019) who found that yam

production was male-dominated in Ekiti State of Nigeria. On average, the farmers were aged 54.5 years, while about one-third of the farmers were over 60 years of age. This shows an ageing population of yam farmers in Nigeria although, most yam farmers were still within their economically active age. This agrees with the findings of Olatinwo et al., (2022) for yam farmers in Kwara State of Nigeria. Moreover, about 71 percent were married, hence couples and families predominate among the farmers. This may be implicative for reduced cost of labour since more family labour might be used, which could in turn reduce post-harvest losses in yam production. Married household heads are likely to have larger family sizes compared to single household heads as found by Adeoye et al. (2022).

Further, the results showed that about 22 percent of the yam farmers did not have formal education, whereas 36 percent had primary education, 34 percent had secondary education and 8 percent had tertiary education. This implies that most yam farmers in Nigeria were educated and able to employ new farming techniques which could lead to reduced yam losses. This result agrees with the findings of Mebratie et al., (2015). Concerning the household size, the results revealed an average of about 7 persons. This indicates a fairly large number of people eating from the same cooking pot and living together in the study place. This could imply a good source of family labour for yam production. The result is in line with Ansah and Tetteh, (2016) who found that yam farmers in Ghana had a household size of 8 persons. However, over 85 percent of yam farmers in Nigeria do not belong to cooperatives. It is expected that production loans and other necessary inputs will be more easily accessed by members of a cooperative society. Consumption loans also help to smooth household consumption which could improve food security. Farm size was 0.8 hectares, on average, implying that yam cultivation in Nigeria is mainly small-scale. This is in line with Heller et al. (2022) who found that most yam farmers in Soth-West Nigeria cultivated less than one hectare of land, whereas, Ansah and Tetteh (2016) found about 3 ha for yam farmers in Ghana. Finally, about 84 percent of the yam farmers did not access credit for their production enterprise. This corroborates the findings of Olatinwo et al., (2022) who found that less than 5% of yam farmers in Kwara state, Nigeria access credit from banks. This could be due to the demand for collateral and other credit access requirements by banks.

### Level of postharvest loss among yam farmers
The level of postharvest loss among yam farmers is presented in Table 2. The results show that the mean postharvest loss was 0.278 t/ha. The post-harvest loss was categorized into three groups: low (0-0.99), moderate (1.01-2) and High (>2). About 90 percent of the yam farmers had a low level of post-harvest loss, while moderate and high levels of post-harvest loss were found for 1.40% and 8.14% of the farmers. The low level of post-harvest loss found for most yam farmers may be because the farmers devised various means of

preserving yam during and after harvest thus limiting the level of losses among the yam farmers. Moreover, yam has a relatively longer shelf life than other tuber crops (Wumbei *et al*., 2022). This could increase profitability among the yam farmers and contribute to food security improvement among the yam farmers.

### Food security status among yam farmers
The distribution of the food security status among yam farmers is shown in Table 3. The food security line (Z) was two-thirds of the mean per capita household food expenditure and was calculated to be ₦905.24. Hence, food security incidence was 51.49%, food security depth was 27.60%, and food security severity was 18.78%. This shows that over half of the yam farmers in Nigeria were food insecure.

### Effect of postharvest loss on food security among yam farmers
The effect of postharvest loss on food security among yam farmers is revealed in Table 4. The results revealed a log-likelihood of -1068.5472 and pseudo $R^2$ of 0.0639 indicating that the variance in the dependent variable was explained by the independent variables collectively. Hence, the changes in the resultant variables led to changes in food security among yam farmers. Postharvest loss had a negative and significant relationship with food security at 1%. A unit increase in postharvest loss among the yam farmers decreased the probability of being food secure for a yam farming household by 0.03%. Hence, an increase in postharvest loss will worsen the food insecurity of the households. On the other hand, secondary and tertiary education of a household head had a positive and significant relationship with food security at 1%. Thus, having secondary and tertiary education increased the probability of a yam farming household being food secure by 15.83%. This implies that farmers with secondary and tertiary education are more likely to be food secure than farmers with no formal education or just primary education. An increase in educational level improves farmer's uptake of improved farming techniques thereby increasing their output and consequently, their food security level. Owoo (2021), supported that post-secondary education increases households' probability of food security. Moreover, being married increased the likelihood of yam farmers' food security by 19.72% and was significant at 1%. Hence, being married contributes to food security among the yam farmers relative to being unmarried. The household size also had a positive and significant relationship with food security at 1%. Hence, an increase in household size by one person led to an increase in the probability of a household being food secure by 2.06%. This could be because large household size contributes to family labour hence, larger household size provides more labour for farming activities. This result disagrees with the findings of Adeoye *et al*. (2022), who found that rural households with fewer household members improve labour food security, whereas Owo (2021) found a positive relationship between household size and food security,

Membership of cooperatives significantly and positively influenced the probability of being food secure at a 1% level. Belonging to cooperative societies increased the probability of food security by 12.84%. Thus, yam farmers who are members of cooperative societies are more likely to be food secure than farmers who are not. This finding is in line with the results of Gibremichael (2014), Verhofstadt and Maertens (2015), Chagwiza *et al*. (2016) and Ahmed and Mesfin (2017) that cooperatives have capacities to improve the living standard of their members through many pathways and play vital roles in promoting food security of their members. Conversely, farm size had a negative and significant relationship with food security at 5%, indicating that an increase in farm size led to a decrease in the probability of food security among the yam farmers by 1.93% significant at 1%. This implies that the probability of food security decreases with an increase in the farm size. This is not expected although Alidu *et al*., (2016) also showed that farm size has an indirect relationship with food security. Finally, access to credit led to an increase in the probability of food security among yam farmers. This may be because having access to credit could help farmers improve productivity and also cultivate more land. This finding is in agreement with FAO (2022) that credit improves food security, Ahmed and Mesfin (2017) also found that agricultural credit is an effective instrument for improving well-being.

### Conclusion
The study aimed to establish the link between postharvest loss of yam and food security. Data obtained from the 2018/19 wave of the General Household Survey for Nigeria was used to explain the effect of yam postharvest loss on the food security of the yam farming households. Data analysis was achieved by using descriptive statistics, Foster-Greer-Thorbecke food security measures and a probit regression model for data analysis. A low postharvest loss of 0.28 t/ha on average was found among yam farmers in Nigeria. More than half the yam farmers were food insecure, while postharvest loss, age and farm size reduced the probability of food security among the farmers. Food security was improved by having secondary and tertiary education levels, being married, household size and membership in a cooperative society. The study concluded that postharvest loss reduces the probability of food security among the yam farming households in Nigeria. Moreover, having secondary and tertiary education, household size, being married and being a member of cooperatives improves the probability of food security among the yam farming households. On the other hand, age and farm size reduce the probability of food security among the households Based on the findings of this study, government and non-governmental organisations should initiate policies that aim to reduce postharvest loss. Government policy on education should consider increasing the level of farmer education beyond merely the basic level to increase yam farming households' food security.

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**Table 1: Socio-economic characteristics of yam farmers in Nigeria**

| Socio-economic variables | Frequency(N=1,647) | Percentage |
|---|---|---|
| **Sex** | | |
| Male | 1258 | 76.38 |
| Female | 389 | 23.62 |
| **Age** (years) | | |
| ≤ 20 | 11 | 0.67 |
| 21 - 30 | 84 | 5.10 |
| 31 - 40 | 195 | 11.84 |
| 41 - 50 | 400 | 24.29 |
| 51 - 60 | 422 | 25.62 |
| >60 | 535 | 32.4 |
| Mean±SD | 54.5±14.9 | |
| **Marital status** | | |
| Single | 61 | 3.70 |
| Married | 1,165 | 70.73 |
| Divorced | 49 | 2.98 |
| Widowed | 372 | 22.59 |
| **Educational level** | | |
| No formal | 367 | 22.28 |
| Primary | 590 | 35.82 |
| Secondary | 555 | 33.70 |
| Tertiary | 135 | 8.20 |
| **Household size** | | |
| 1-5 | 728 | 44.2 |
| 6-10 | 719 | 43.66 |
| 11-15 | 159 | 9.65 |
| >15 | 41 | 2.49 |
| Mean±SD | 6.5±3.9 | |
| **Membership of cooperative** | | |
| No | 1,413 | 85.79 |
| Yes | 234 | 14.21 |
| **Farm size (Hectares)** | | |
| <1 | 1,159 | 70.37 |
| 1.0001 -5 | 455 | 27.63 |
| >5 | 33 | 2.00 |
| Mean±SD | 0.8±0.7 | |
| **Credit Access** | | |
| Yes | 271 | 16.45 |
| No | 1,376 | 83.55 |

*Source: Author's computation (GHS 2018/2019)*

**Table 2: Level of postharvest loss**

| Post-Harvest Loss Categories | Frequencies | Percentages |
|---|---|---|
| Low | 1,490 | 90.47 |
| Moderate | 23 | 1.40 |
| High | 134 | 8.14 |
| Total | 1,647 | 100 |
| Mean= 0.278 | | |
| Std dev. = 0.825 | | |

*Source: Author's Computation GHS, (2018/2019)*

**Table 3: Food security status of yam farmers in Nigeria**

| Food Security | Frequency | Percentage |
|---|---|---|
| Food Insecure | 848 | 51.49 |
| Food Secure | 799 | 48.51 |
| Total | 1,647 | 100 |
| Mean Per Capita Household Food Expenditure =₦1357.863 | | |
| Food Security Line() =₦905.24 | | |
| Food Security Incidence=0.514876 | | |
| Food Security Depth=0.275998 | | |
| Food Security Severity=0.187844 | | |

*Source: Author's Computation GHS (2018/2019)*

**Table 4: Probit regression of the effect of post-harvest loss on food security among yam farmers**

| Food security Status | Coef. | Std. Err. | Z | P>z | dy/dx |
|---|---|---|---|---|---|
| Post-Harvest Loss | -0.0003*** | 0.0002 | -2.73 | 0.0060 | -0.0001 |
| Sex( Female) | -0.2458 | 0.1617 | -1.52 | 0.1280 | -0.0918 |
| Age | -0.0059*** | 0.0024 | -2.47 | 0.0140 | -0.0022 |
| Educational (Primary) | 0.1288 | 0.0880 | 1.46 | 0.1430 | 0.0482 |
| Educational(Secondary) | 0.4182*** | 0.089 | 4.72 | 0.0000 | 0.1583 |
| Educational (Tertiary) | 0.7667*** | 0.1387376 | 5.53 | 0.0000 | 0.2844 |
| Marital Status(Married) | 0.5547*** | 0.1875 | 2.96 | 0.0030 | 0.1972 |
| Household Size | 0.0554*** | 0.0094 | 5.88 | 0.0000 | 0.0206 |
| Employment Status(No) | 0.0519 | 0.0664 | 0.78 | 0.4340 | 0.0193 |
| Membership of cooperatives(Yes) | 0.3460*** | 0.0949 | 3.65 | 0.0000 | 0.1285 |
| Farm Size(Ha) | -0.0492** | 0.0252 | -1.95 | 0.0510 | -0.0183 |
| Credit Access(Yes) | 0.0547 | 0.0868 | 0.63 | 0.5290 | 0.0203 |
| _cons | -0.7837 | 0.2173 | -3.61 | 0.0000 | |
| Log likelihood = -1068.5472 | | | | | |
| Prob> chi$^2$ = 0.0000 | | | | | |
| Pseudo R$^2$ = 0.0639 | | | | | |

*Source Author's Computation GHS, (2018/2019)*
*** = 1% , ** = 5% and * = 10%*