

Effect of Post-Harvest Deterioration on Farmers' Income in Pepper-Based Enterprises: Evidence from Yewa Division of Ogun State, Nigeria

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Abstract

*This study examined the effect of post-harvest losses on the income of local pepper (*Capsicum chinense*) farmers in Yewa division of Ogun State, Nigeria. Specifically, the socioeconomic characteristics of pepper farmers in the study area, the causes of post-harvest commodity deterioration in pepper farming in the study area and the relationship between per capita income loss due to pepper deterioration and selected socioeconomic factors. A total of one hundred and forty (140) farmers were randomly sampled. Descriptive statistics and multiple regression models were used to analyse the study data. This study revealed that majority of the farmers were male with an average age of 46, married; with the vast majority (98.5%) educationally endowed. The average household size and years of farming experience were 5 members and 16 years, respectively. The result also revealed that the pepper farmers generated an average income of ₦638,148.15k annually; and also experiencing an average post-harvest income loss of ₦95, 056.29 per annum. Pest attack and loss of commodity in transit during commodity marketing were identified as the leading causes of post-harvest food loss among the pepper farmers. Distance of farm to market sites (0.230; $p < 0.05$); duration of post-harvest storage in transit (0.154; $p < 0.1$), and quantity of pepper fruit harvested (0.277; $p < 0.01$) statistically increased per capita income loss, respectively; while years of farming experience (-0.238; $p < 0.01$) reduced it among the pepper farmers. Provision of suitable assistance to pepper farmers to address infrastructural deficit (bad roads and lack of storage facilities); training on post-harvest pepper handling and suitable transit packaging techniques for pepper produce in transit, and support on value addition to harvested produce (pepper) were recommended to sustain farmers' interest in the production of pepper.*

Key words: Pepper, Post-harvest deterioration, Farm income loss, Southwestern Nigeria

1.0 Introduction

Agriculture is an important sector in the Nigerian economy, contributing over 30 percent of the gross domestic product (GDP) of the nation (Sasu, 2022) and it also provides food for an over 200 million growing population (Ugwukah, 2022). Agriculture in Nigeria is predominated by smallholder farmers (Alabi *et al.*, 2022), comprising predominantly rural and resource-poor farmers that largely depend on agriculture for their food; and for commercial purposes (Ugwukah, 2022). Among the crops grown by the Nigerian rural farmers, pepper is commonly produced and made available for commercial use (Mustapha *et al.*, 2021) in most food markets.

Pepper is primarily grown in Northern Nigeria (particularly in Kano and Kaduna states), on an estimated 104,000 hectares. Nigeria produces between 757,000 and 770,000 metric tons of the 21.3 million tons of world estimated pepper output (*Capsicum* spp.) and is the largest producing country in Africa, supplying over 70% of the continent's output (FAO, 2020). Nigeria significantly ranked (between 2021–2022), among the top producers of fresh pepper in Africa (competing closely with Egypt as the largest producer), and a major producer of dry peppers (Alabi *et al.*, 2022). Pepper (*Capsicum* spp.) is gaining popularity in personal care applications due to its natural antioxidant and antimicrobial properties. Rapid urbanization and increasing adoption of packaged and processed foods is forcing daily pepper consumption to continue to surge; coupled with the expansion of export markets, which has created additional revenue streams for Nigerian pepper producers (Ekine *et al.*, 2023).

Despite a slight decline in growth rate from 2023 to 2024, Nigeria's pepper import market continues to show steady growth at 6.99% from 2020 to 2024; while the market size is projected to grow at a compound annual growth rate (CAGR) of 5.9% during the forecast period 2026–2032. (NPMGR, 2026). Amidst this widening market demand gap, the domestic pepper production is projected to reach 800,000 metric tonnes by 2030, with the current (2026) volume estimated at about 767,110 metric tons, which represents a 0.3–0.5% annual growth. Despite this marginally increasing annual growth rate, Nigeria currently utilises only about 90,000 hectares of its over 34 million hectares of arable land in the local production of this crop. In comparison with the global record, the world leading global pepper producers in the order of their significance, are China (17+ million tonnes annually - accounting for over 45% of the total global production); Mexico (3 million tonnes annually); Turkey (over 2.5 million tonnes annually); and Indonesia (2.5–3 million tonnes annually). There has been a steady increase in the domestic demand for pepper resulting in a significant decline in the quantity being exported.

Pepper grown in Nigeria is in high demand, because of its pungency and good flavor. The global increase in the demand for pepper signifies the need for not only to increase the supply of pepper to make up for the increase in the domestic demand, but also production to benefit from exportation potential of global demands as well. In South Western Nigeria, for example, pepper is being massively transported from Northern Nigeria despite the fact that it is also grown in the South West. This indicates that there is a great and urgent need for increased production of pepper most especially in climatically suitable South-Western Nigeria. It is worthy of note that despite the production level of pepper in Nigeria as is, pepper is still being imported (Obayelu *et al.*, 2021). The total production of pepper in Nigeria shortly after the Covid-19 epidemic between 2020 and 2021 was about 753,116 tonnes covering about

99,715 ha (Dijkxhoorn *et al.*, 2021). Unfortunately, Nigeria lost its top ranking among the top pepper growers in Africa barely one year after (Olutumise, 2022).

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). Post-harvest losses refer to the quantitative and qualitative loss of food in various post-harvest operations. This "food loss" is defined as food available for human consumption, but not consumed (Buzby *et al.* 2018) and post-harvest losses can generally be classified as loss of weight due to deterioration, loss of quality, loss of nutritional value, loss of viability, and finally commercial loss (FAO, 2017). Food losses can be qualitative (e.g. reduced nutrient value and undesirable changes to taste, texture, or color, etc) or quantitative (e.g. decreased weight or volume). Conceptually, *food loss* is a subset of *post-harvest losses* (or post-production), and it represents the edible amount of food available for human consumption but is not consumed. *Food waste* is a subset of food loss. According to Bloom (2010), food waste occurs when an edible item goes unconsumed as a result of human act of omission or commission; which is often the result of a farm-to-fork decision made by business owners, governments, and individual consumers.

Recent reports and data analysis supported by the Food and Agriculture Organisation (FAO) highlight that post-harvest losses (PHL) for highly perishable produce like pepper (especially fresh bell pepper) are severe, often reaching 25–35% of total production in developing countries. Specific previous studies in Nigeria indicate that post-harvest loss of fresh bell pepper can even be higher (up to 88%) at the market level compared to the farm level (FAO, LEI, 2015). Mitigating post-harvest losses (PHL) has become a priority area of cooperation between FAO and world development banks. Post-harvest losses represent more than just losses of food. When a certain proportion of crop harvest is lost, the actual crop loss is not just in the form of physical output reduction, but also the equivalent proportion of all the factors that contributed to producing the crop (land, labour, capital, seed, fertilizer, time, among others). In other words, post-harvest food loss translates not only to human hunger and financial distortions to the farmers but into tremendous environmental waste as well (Olutumise, 2022).

Nigeria is one of the leading producers of tomatoes, pepper, plantain, onions, okra and other vegetables (Sanusi and Ayinde, 2013; Ekwere *et al.*, 2023; Ben *et al.*, 2024); with its diverse climate making it possible to produce virtually all agricultural products that can be grown in the tropical and semi-tropical areas of the world. Fresh horticultural produce is, however, highly perishable, with statistics suggesting a post-harvest loss of 30 to 50% in fruits and vegetables output per annum. For instance, it is estimated that as much as 25% fruits, 40% vegetables and 15-20% grains are wasted after harvest. Post-harvest losses in Nigerian pepper (*Capsicum* spp.) production are substantial, estimated at 10-40% annually due to high perishability, poor handling, and inadequate infrastructure. Losses occur heavily during harvesting, transport, and marketing, with causes including physical damage (96.6%), disease/spoilage, and inadequate, traditional storage methods; as well as poor pre-production, post-harvest management, and lack of appropriate processing and marketing facilities. Post-harvest losses can be caused by a wide variety of factors, ranging from growing conditions to handling to retail level. Post-harvest loss has been a bane to food security in Nigeria. Hence, the elimination of post-harvest losses of agricultural products is important to boost food security and availability (Adekola and Maduabuchi, 2020;). A critical role of the agricultural

sector therefore, is the reduction of food losses and the enhancement of food safety and quality (Atanda *et al.*, 2011).

In Nigeria, farmers are of great significance to the economy as more than 70% of the population is employed in the agricultural sector. Investing in pepper production is therefore, one of the ways of curbing unemployment, income generation, and sourcing for foreign exchange in recent years (Adaigho and Tibi, 2018). Nonetheless, agricultural problems, such as post-harvest losses still persist as a major menace to food sufficiency in Nigeria. Post-harvest losses account for 20-40% of forfeiture in gains, as harvesting, processing/ storage techniques are inefficient. This results in great fluctuations in supply of crop produce and hence unstable prices. The handling procedures used in technologically advanced countries to reduce post-harvest losses are not fully recognized or adopted in developing countries.

Since most sustainable handling procedures are not fully observed within the Nigerian agriculture sector, storage, packaging, transportation, proper handling techniques and standardization ethics are not practically in existence with respect to perishable crop production. This leads to the considerable losses of agricultural produce. Thus, as more fresh pepper fruits are needed to meet up with the increasing demand of the growing population, and as more produce is transported to the less-producing areas of the population segment; and as more fresh produce are stored away to obtain year-round supply, post-harvest loss prevention technology becomes more paramount (Ovharhe *et al.*, 2021). Post-harvest losses have been highlighted as one of the major causes of food shortage in Nigeria (Oyewo *et al.*, 2018).

1.1 Nexus between Post-harvest Losses on the Income Level of Pepper Farmers

Fresh fruits like capsicum peppers have a relatively short shelf life because of the presence of several abiotic and biotic stresses. The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and a lack of coordination between different actors in the supply chain (Dijkxhoorn *et al.*, 2021). At the global level, volumes of lost and wasted food in high income regions are higher in downstream phases of the food chain, but just the opposite in low-income regions where more food is lost and wasted in upstream phases (FAO, 2013).

According to Akinlade *et al.*, (2014) both quantitative and qualitative losses occur in horticultural crops between harvest and consumption. Qualitative losses (such as loss of caloric and nutritive value, loss of acceptability by consumers, and loss of edibility) are more difficult to assess than quantitative losses of fresh fruit and vegetable crops. While reduction of quantitative losses is a higher priority than qualitative losses in developing countries, the opposite is true in developed countries where consumer dissatisfaction with producing quality results in a greater percentage of the total postharvest losses. Adeoye *et al.* (2014) is of the opinion that food losses may be direct or indirect. A direct loss is disappearance of food by spillage, or consumption by insects, rodents, and birds. An indirect loss is the lowering of quality to the point where people refuse to eat it. Generally there are no accepted methods for evaluating post-harvest losses of fresh produce. Whatever evaluation method used may be the result referred only to a described situation (Biratu *et al.*, 2021). Egyiret. *al.*, (2008) further stated that in the appraisal of an existing marketing operation, the accurate evaluation of losses occurring is a problem. These losses may be suspected to be too great but there may be no figures to support this view because records do not exist, records, if available, do not cover a long enough period of time; the figures available are only estimates made by several

observers; records may not truly represent a continuing situation; for example, losses may have been calculated only when unusually high or low, loss figures may be deliberately over- or understated for commercial or other reasons in order to gain benefits or to avoid embarrassment.

This study therefore, profiled the socioeconomic characteristics of pepper farmers in Yewa division of Ogun State; identified some of the causes of post-harvest deterioration in pepper production; and estimated the determinants of per capita income loss due to pepper deterioration in the study area in order to determine the effects of post-harvest deterioration on farmers' income in Pepper-based enterprises in the Yewa Division of Ogun State, Nigeria

2.0 Methodology

2.1 The Study Area

The study was conducted in the Yewa Division of Ogun State (formerly known as Egbado Division). Yewa Division of Ogun State comprises 5 local Governments (Yewa-South, Yewa-North, Imeko-Afon, Ipokia and Ado-Odo/Ota LGAs). This area spreads to about 5878Km². The division is bound by the Republic of Benin in the west, Oyo state in the east, Lagos in the south and Ifo local government area in the north. The prominent economic activities include crop farming, livestock and fish farming and trading. The climatic conditions support the growth of a wide distribution of herbaceous plants and shrubs. Economic cropping is often directed to the production of maize, cassava, vegetables and spices. The area consists of a majority Yoruba ethnic group and a minor population of nomadic Fulani pastoralists.

2.2 Source of Data, Method of Collection and Sampling Procedures

Primary data were obtained directly from the pepper farmers and farmers who also engage in the direct sales of the commodity either to the retailers or to the consumers. Multi-stage sampling techniques were used to select the study sample. From the five (5) LGAs in the division, two (2) LGAs (namely Yewa-North and Imeko-Afon) were selected at the first stage based on the prevalence of arable crop farming, especially pepper. At the second stage, five (5) villages were randomly selected from each LGA, and finally, fourteen (14) pepper farmers were randomly selected resulting in 140 farmers, out of which five questionnaires were discarded due to incomplete information. Therefore, information from 135 respondents was analyzed using both descriptive and inferential tools. A set of pre-coded factors were presented to the farmers to elicit information on their perceived causes of post-harvest pepper deterioration. The farmers' responses were profiled based on combination of casual factors, and then the ensuring data subjected to relevant descriptive statistics.

2.3 Socioeconomic Characteristics of Local Pepper Farmers

Descriptive statistics were used to describe the socioeconomic characteristics of the surveyed local pepper farmers in the study area, including such tools as frequency tables and percentages. The socioeconomic characteristics of interest included age, sex, household size, educational attainment, farm size and farming experiences of the pepper farmers, among others.

2.4 Effect of Post-harvest Pepper Deterioration on Farmers' Income

Multiple regression analysis was used to establish a relationship between per capita income loss due to pepper deterioration; selected farmer's demographic factors; and crop agronomic factors; following Alawode and Abegunde (2016).

The empirical model that was used is specified as follows:

$$P = f(X_1, X_2, X_3, X_4, X_5, X_6, \dots, X_{10}, U) \dots \text{Equation 2.1}$$

Where:

P= per capita income loss (₦/annum)

Usually, pepper being a persistent annual crop has the agronomic capability of yielding fruits for period of (6) months and above, under good weather condition.

Per capita income loss was computed as the ratio of total income loss (difference between expected income (₦/kg) from pepper in its fresh state and the actual income (₦/kg) from pepper in its deteriorated form) to the number of farmers surveyed. Mathematically, per capita income loss as a result of post-harvest pepper deterioration was estimated using this equation:

$$PCIL = \frac{TIL}{TFS} \dots \text{Equation 2.2}$$

Where:

PCIL = per capita income loss

TIL = total income loss

TFS = total number of farmers surveyed

Following Morris, K.J and Kamarulzaman, N.H (2014); total post-harvest loss (PHL) is computed as:

$$PHL = \sum (Q_{ql} + Q_{wl}) \dots \text{Equation 2.3}$$

Where:

Q_{ql} and Q_{wl} represents the losses estimated in terms of commodity (pepper) quantity loss and quality loss due to field spoilage and deterioration in storage and in transit, respectively.

The percentage post-harvest loss (PHL(%)) is therefore, estimated as:

$$\%PHL = (TQP - PHL) * 100 \dots \text{Equation 2.4}$$

Conceptually, total income loss (TIL) is estimated as the monetary value of the total post-harvest loss (PHL), estimated as:

$$TIL = P_{y^*} * PHL \dots \text{Equation 2.5}$$

P_{y^*} Represents the adjusted average selling price of deteriorated pepper that is usually arrived at through bargaining

Where: $P_{y^*} < P_y$

The explanatory variables hypothesized to influence per capita income loss (₦/annum) in pepper farming due to commodity deterioration and post-harvest losses, include:

X_1 = Pre-harvest working days (man days)
 X_2 = Number of work days devoted to pepper harvesting (man days)
 X_3 = Distance from farm to market (km)
 X_4 = Number of days commodity (pepper) spend on the farm after harvesting (days)
 X_5 = Area of land cultivated (hectare)
 X_6 = Quantity of pepper harvested (kg)
 X_7 = Number of hired labour utilized
 X_8 = Number of family labour utilized
 X_9 = Years of farming experience
 X_{10} = Method of packaging/storage adopted during transit (1 = bagging; 0 otherwise)
 U = Error term

3.0 Results and Discussion

3.1 Socioeconomic Characteristics of Local Pepper Farmers

The study examined the socioeconomic characteristics of the local pepper farmers. The selected characteristics are age, marital status, gender, years of formal education, years of farming experience and annual income of farmers. The result obtained from the survey data analysis is presented in Table 3.1.

Age is an important factor that affects level of productivity. The ability of the farmer to take advantage of emerging opportunities that could improve the productivity level could be influenced by their age. The mean age of the pepper farmers was 46 years, which suggests that the pepper growing population segment comprise young farmers that are able to adopt new technology. Farming experience is used as a measure of management ability, the more experienced the farmer is, the more his ability to make farm decision. The results in Table 3.1 depict that a large proportion (43.0%) of the pepper farmers had an average farming experience of 16 years. Experience is very important in farming, especially when dealing with perishable agricultural produce, like pepper (*Capsicum annum*). An experienced farmer would be kept abreast of the intricacies of the agronomic practices required for effective farm management practices that minimize both on-farm and post-harvest losses, especially those that are related harvest time, storage, and in-transit produce.

The result revealed that the vast majority (98.5%) of the pepper farmers possessed one form of formal education or the other which is similar to the study by Antia-Obong, *et al.*, (2021) where poultry farmers had 95.28% of some form of formal education. Accordingly, adequate education enhances quality decision making processes in arable crop farming, especially when dealing with perishable crops. It indirectly influences farmers' understanding of the farming dynamics and ways to reduce post-harvest loss.

3.2 The Causes of Post-harvest Commodity Deterioration in Pepper Farming

Figure 3.1 details the causes of post-harvest commodity deterioration in pepper in the study areas. The attribution variables covered ranged from animal/pest attack on the part of the respondents to lack of requisite processing equipment. The results revealed that animal and pest attack was the major cause of post-harvest losses as indicated by 50.4% of the farmers, followed by loss in transit during marketing with 43.7%. Meanwhile, lack of storage facilities constituted the least cause of harvest losses, as affirmed by only 7.4% of the farmers.

Table 3.1. Socioeconomic characteristics of the sampled pepper farmers

Factor	Frequency	Percentage	Mean
Age			45.57
≤ 30	13	9.6	
31-<40	38	28.1	
41-<50	39	28.9	
51-<60	36	26.7	
>60	9	6.7	
Gender			
Male	77	57	
Female	58	43	
Household size			5.24
1—4	63	46.7	
5—8	65	48.1	
9—12	4	3.0	
>12	3	2.2	
Education level			
No formal education	2	1.5	
Primary education	58	43.0	
Secondary education	64	47.4	
Tertiary education	11	8.1	
Farm size (Ha)			1.54
0.1-2.0	125	92.6	
2.1-4.0	8	5.9	
4.1-6.0	2	1.5	
>6.0	0	0	
Farm experience			15.71
≤ 10	48	35.6	
11-20	58	43.0	
21-30	25	18.5	
31-35	4	3.0	
>35	0	0	
Marital Status			
Single	3	2.2	
Married	104	77.0	
Divorced	12	8.9	
Widow	14	10.4	
widower	2	1.5	
Total income/production cycle (₦)			₦638,148.15k
≤ 200,000	38	28.1	
200,001-400,000	42	31.1	
400,001-600,000	16	11.9	
600,001-800,000	19	14.1	
>800,000	20	14.8	
Income loss in peper production (₦)			₦95,056.29k
≤ 100,000	92	68.1	
100,001-300,000	40	29.6	
300,001-500,000	2	1.5	
>500,000	1	0.7	

Source: Field Survey, 2023

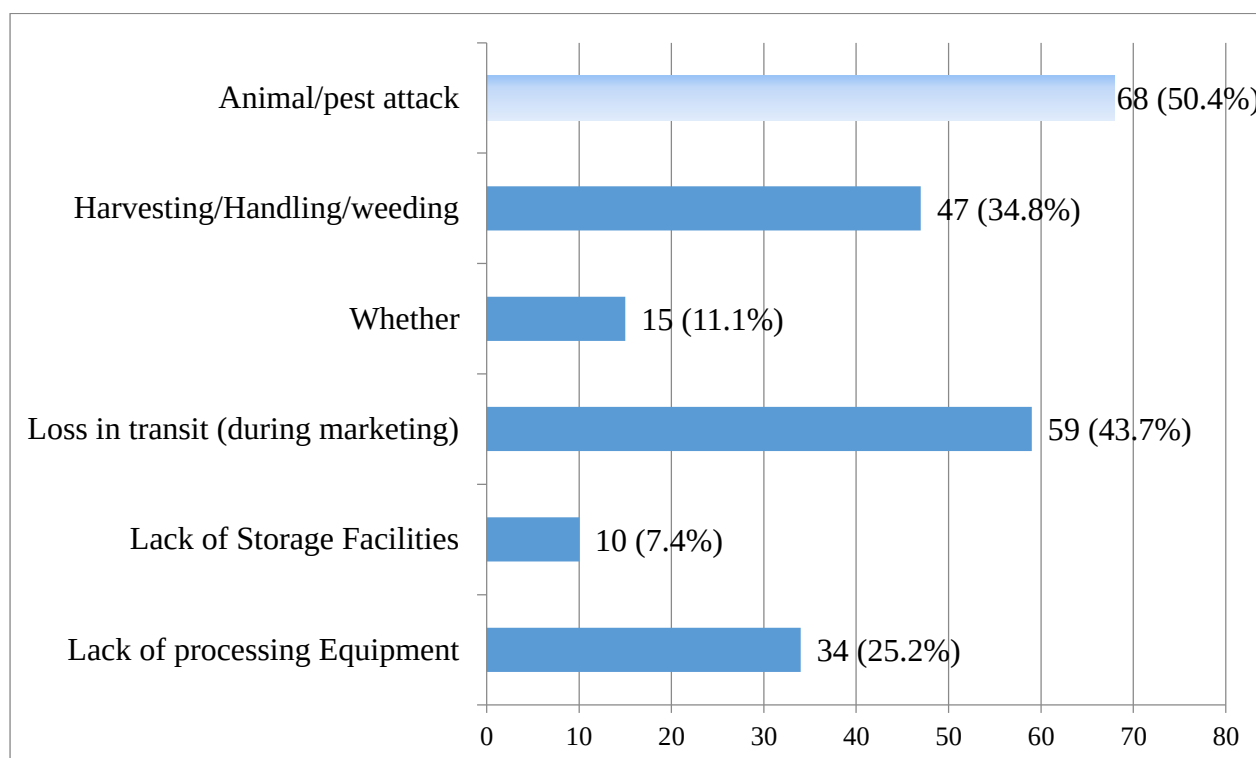


Figure 3.1: Post-harvest deterioration in pepper farming in Yewa axis of Ogun State

Source: Field Survey, 2023

Table 3.2. Regression result of the determinants of per capita income loss due to pepper deterioration in the study area

Variables	Symbol	Coefficients	t-value
Constant		-	-0.965
Work days (pre-harvest)	X_1	0.050	0.613
Work days (pepper harvesting)	X_2	-0.033	-0.297
Distance from farm to market (km)	X_3	0.230**	2.247
Post-harvest storage duration (days)	X_4	0.154*	1.871
Farm size	X_5	-0.091	-0.833
Quantity of fruit harvested (kg)	X_6	0.277***	3.135
Hired labour (Mandays)	X_7	0.050	0.511
Family labour (Mandays)	X_8	-0.020	-0.223
Farming experience (years)	X_9	-0.238***	-2.791
Pepper storage technology	X_{10}	-0.404	-1.609
R^2 – value		0.566	
Adjusted R^2 – value		0.504	
F – value		5.874***	

***, **, * Coefficient significant at 1%, 5% and 10% respectively.

Source: Field Survey, 2023

3.3 Effect of Post-harvest Pepper Deterioration on Farmer's Income

The result of regression analysis is presented in Table 3.2. The coefficient of R^2 (0.566) and F-statistics (5.874) showed that the model is well fitted. Distance of farm to the market (0.230; $p < 0.05$); post-harvest storage duration (0.154; $p < 0.1$), and quantity of fruit harvested

(0.277; $p < 0.01$) statistically increased per capita income loss to the pepper farmers at 5%, 10%, and 1% level respectively; while years of farming experience (-0.238; $p < 0.01$) reduced it at 1% level of significance. By implication, this result suggests that pepper farms that are located relatively too distant away from the market, and pepper fruits that spend too long in the storage enclosure are prone to deterioration/spoilage in transit and in storage, and thus, income loss to farmer becomes inevitable. Similarly, when large quantities of pepper fruits are harvested without a ready market, or an alternative preservation arrangement, produce deterioration and consequently, income losses are imminent. On the other hand, farmers with long years of experience in pepper production, and most often times, direct sales of the commodity to the market, have mastered the appropriate storage technology and timing of commodity delivery over the years. Thus, per capita income loss to experienced pepper farmers that are due to post-harvest losses have been reduced drastically.

4.0 Conclusion and Recommendations

Post-harvest food and income loss is a visible occurrence among producers of perishable arable crops, especially pepper. Targeted reduction of this menace of post-harvest food and income losses of agricultural produce has serious implications for food security especially in developing economies like Nigeria. The effect of post-harvest food loss on the income level of pepper farmers was estimated in this study, using data obtained from one-hundred and twenty (120) pepper-based farmers. The finding revealed the pepper farmers in Yewa division of Ogun State are mostly middle aged men, mostly endowed with secondary school education, and therefore, capable of adopting appropriate technology that may help to reduce post-harvest losses. The study findings further revealed that distance of farm to the market; duration of post-harvest storage especially in transits, and the quantity of fruit harvested statistically increased per capita income loss to the pepper farmers; while years of farming experience reduced it.

By way of recommendation, suitable assistance should therefore be accorded the pepper farmers to sustain their interest in the production of pepper crop. These include addressing issues that border on infrastructural deficit, like poor roads that cause delay in farm-to-market transit of perishable crops, and lack of storage facilities for perishable agricultural commodities. In the same vein, adequate training should be given to the pepper farmers on post-harvest pepper handling techniques, suitable transit packaging techniques for pepper produce, as well as value addition to perishable farm produce, so as to mitigate against substantial pepper commodity losses both at the farm level, and in transit.

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