



**IMPACT OF POST-HARVEST PEST INFESTATION ON MAIZE (*ZEA MAYS*)
PRODUCTION IN ISOKO SOUTH LOCAL GOVERNMENT AREA, DELTA STATE**

¹Igene, C. A., ²Belonwu, N. E., and ³Iloba, L.C

¹Department of Agricultural Economics and Extension, Faculty of Agriculture,
Ambrose Alli University Ekpoma, Edo State.

²Department of Agricultural Economics and Extension, Faculty of Agriculture,
University of Delta, P.O. Box 2020, Agbor, Delta State. Nigeria.

³Department of Vocational and Technical Education, Faculty of Education,
University of Delta, P.O. Box 2020, Agbor, delta State. Nigeria

Corresponding Author's Email: eunice.belonwu@unidel.edu.ng, **GSM:** 08126876683,
08033666969. <https://orcid.org/0000-0002-1950-5020>

ABSTRACT

The study investigated the impact of post-harvest pests on maize production in Isoko South Local Government Area (LGA), of Delta State, Nigeria. The research examines the socio-economic characteristics of maize farmers, pest control practices, the effects of pests on maize yield, and the challenges faced by farmers in managing pest infestations. Data were collected from 50 farmers across five local communities using a closed-ended questionnaire and a multi-stage random sampling technique was used to select the respondents. Descriptive statistics and regression methods were employed for data analysis. The findings revealed that most farmers (63.3%) were male, middle-aged, and had at least secondary education. A majority (74%) implemented pest control measures, with cultural control being the most common method. However, 67.3% of farmers reported moderate pest damage, and 14.3% experienced severe damage to their maize crops. Yield losses varied, with many farmers reporting losses of up to 10%, and yields ranging from less than 2 tons to over 6 tons per hectare. Key challenges identified include a lack of knowledge on pest control methods (81.6%), limited access to pest control resources (75.5%), and the high cost of pest management (85.7%). Regression analysis showed significant correlations between farmers' characteristics and post-harvest pest impact. Gender ($B = 1.409$, $p = 0.000$), age ($B = 0.357$, $p = 0.017$), education ($B = 0.662$, $p = 0.000$), marital status ($B = -0.208$, $p = 0.002$), and farming experience ($B = 0.685$, $p = 0.000$) all influence pest management. The study recommends improving pest management strategies through education on Integrated Pest Management (IPM), better access to pest control resources, government subsidies for pest control, and investment in pest-resistant maize varieties. Additionally, enhancing storage facilities and promoting sustainable pest control practices are vital for increasing maize productivity and reducing post-harvest losses.

Keywords: Postharvest, Pests, Maize, Production, Control, Socio-economic

INTRODUCTION

The growing concern over food security, particularly regarding post-harvest losses, has gained significant attention due to the rising global population (Stathers *et al.*, 2020). Post-harvest pest infestations remain a substantial challenge to food production, particularly in developing countries such as Nigeria, where they contribute to considerable food loss, decreased household income, and heightened food insecurity. Ensuring effective post-harvest handling is critical for preserving grain quality and safety as it is transported to consumers and for trade. However, a lack of knowledge among smallholder farmers, coupled with other factors throughout the value chain, poses a major hurdle in reducing both post-harvest losses and maize grain contamination from aflatoxins in Sub-Saharan Africa (SSA) (Kachapulula *et al.*, 2017). Agriculture plays an essential role in SSA, contributing significantly to the region's GDP, with maize serving as a cornerstone crop for food security, livestock feed, and industrial uses (FAO, 2017; Okon *et al.*, 2022). Global maize cultivation spans around 142 million hectares, with SSA accounting for 30% of global consumption (Santpoort, 2020). Despite its importance, maize production in SSA faces considerable challenges, especially



from post-harvest pests, which result in extensive damage to stored crops. Post-harvest losses are generally categorized as both quantitative and qualitative reductions in crop attributes between harvest and consumption. These losses stem from a range of factors, including enzymatic, physical, macro-biological, and microbiological processes (Paltrinieri & Staff, 2014; Paniagua *et al.*, 2014). Among the major contributors to these losses are post-harvest pest infestations, such as insects and fungi, with pests like weevils, beetles, and moths causing significant damage to stored maize. Studies show that pest damage can lead to losses of 20-30% of total maize yields (Tefera, 2016), and the lack of effective pest management only worsens the situation (Akowuah *et al.*, 2015).

In Nigeria, traditional maize storage systems, often built with locally available materials, fail to protect against pest damage. These basic storage methods expose maize to biotic threats, especially insects and fungi, which aggravate post-harvest losses (Kumar *et al.*, 2017). While improved storage technologies such as metal silos and PICS bags have been shown to reduce losses significantly (Tefera, 2016; Gitonga *et al.*, 2020), their adoption remains limited. This is a critical issue, as post-harvest pest damage leads to an annual loss of \$1.6 billion in Eastern and Southern Africa, accounting for 13.56% of the region's maize production (Zorya *et al.*, 2019). In Tanzania, a major producer of maize, post-harvest losses range from 1-4.5% during harvesting and 2.8-17% during storage (Mutungi & Affognon, 2013), contributing to seasonal and geographic maize shortages and price fluctuations as farmers are forced to sell their produce immediately after harvest (Shee *et al.*, 2019). Additionally, pest infestations represent a significant economic threat to smallholder farmers in SSA, who rely on maize as their primary livelihood. These losses hinder farmers' ability to reinvest in agriculture, stalling economic growth and exacerbating food insecurity (Tefera *et al.*, 2016). Despite agriculture being a primary source of income and food in the region, about 20-30% of food crops are lost due to inadequate grain storage technologies (Shee *et al.*, 2019). In Isoko South Local Government Area (LGA), Delta State, Nigeria, there is limited research on the specific impact of post-harvest pests on maize production. This study aims to address this gap by investigating pest species, storage methods, and loss rates in the area, which will inform local pest management strategies and contribute to reducing food insecurity.

The research will also explore sustainable pest control practices, particularly Integrated Pest Management (IPM), which has been proven to enhance maize farming resilience (Ajala *et al.*, 2018; Morais *et al.*, 2019). By evaluating both traditional and modern pest control techniques, the study seeks to promote environmentally sustainable solutions. Additionally, emerging technologies such as remote sensing and precision agriculture for early pest detection will be explored to improve pest management efficiency. The findings will provide valuable insights to enhance maize productivity and food security in Isoko South and other similar SSA regions. This study is essential for understanding the specific effects of post-harvest pests on maize production in Isoko South, Delta State, where maize is crucial for food security and livelihoods. It will contribute to region-specific data, offering strategies to reduce losses, improve storage practices, and develop effective pest management approaches tailored to Isoko South's unique conditions. Ultimately, the primary objective is to examine the impact of post-harvest pests on maize production in Isoko South LGA, Delta State.

The specific objectives are to:

- (i) Determine the socio-economic characteristics of maize farmers in the study area.
- (ii) Determine the types of post-harvest pests control practiced by the farmers in the study area
- (iii) Examine the effects of post-harvest pests in maize production in the study area
- (iv) Determine the effects of post-harvest pests on maize yield in the study area
- (v) Determine the challenges affecting post-harvest pests control in the study area

MATERIALS AND METHODS

The Study Area

Isoko South Local Government Area is located in Delta State, within Nigeria's South-South geopolitical zone. It consists of several towns and villages, including Aviara, Uzere, Umeh, Irri, Emede, Igbide, Oleh, Olomoro, and Enwhe, with the administrative center situated in Oleh. The area



has a population of 100,569 people, predominantly from the Isoko ethnic group (National Population Census, 2006). The Isoko language is widely spoken, and key cultural events include the Oliho and Omode festivals. Notable attractions in Isoko South include the Araya Bible Tourist Center and the Ivrogbo sand beaches. The region is a hub for Christianity. Covering 668 square kilometers, Isoko South has an average temperature of 26°C and experiences high humidity (89%), with several rivers, canals, and streams flowing through the area. It features mangrove forest characteristics and receives about 3100mm of rainfall annually. Isoko South is rich in crude oil, natural gas, and kaolin, with both local and international oil companies operating there. In addition to oil, agriculture, fishing, pottery, and trade are significant economic activities. Farmers grow crops like cassava, maize, oil palms, plantains, and yams, and livestock raised in the area includes pigs, poultry, goats, cattle, and fish.

Sampling Technique:

Considering the purpose of the study to assess the Impact of post-harvest pests on maize production in Isoko South Local Government Area, The respondents were selected using a multi-stage random sampling technique. The first stage ~~is the~~ involved purposive selection of Isoko South Local Government Area due to its high agricultural activity and proximity. The second stage was the random selection of five (5) local communities from the Local Government Area. The selected communities were; Irri, Emede, Igbide, Oleh and Olomoro. The third stage was the random selection of 10 farmers from each community, given a total of 50 respondents which was used for analysis.

Data Analysis Techniques:

The research used descriptive measurement, including tables and summaries of the data in the form of means, frequencies, and standard deviations. Descriptive analysis provided an effective summary of the data, making it easier to draw inferences. Data was entered, corrected, and smoothed using SPSS version 23, with a questionnaire serving as the study instrument to ensure consistency and completeness. To highlight the statistical importance of the variables in the model, the multiple regression approach was employed to estimate one variable from another.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents

Table 1 presents the demographic and farming characteristics of respondents in the study on the effects of post-harvest pests on maize production in Isoko South Local Government Area.

Gender:

The data presented in Table 1 indicates the gender distribution of the respondents, with 63.3% of them being male and 36.7% female. The higher proportion of male respondents may suggest that men are more likely to participate in maize production in the area. This could imply that gender dynamics influence the management of post-harvest pests, potentially affecting access to pest control resources and knowledge. This finding aligns with Ssebagala *et al.* (2016), who noted that males are more actively involved in agricultural activities and in providing information about post-harvest handling technologies.

Age:

The data in Table 1 reveals that the majority of respondents are aged between 31 and 50 years, with 28% falling within the 31-40 age range, 33% in the 51-60 range, and 25% above 60 years. This age distribution indicates that a large portion of respondents are middle-aged to elderly, which may influence their willingness to adopt new farming techniques or pest control methods, as older farmers might be more resistant to changing established practices. This finding is in line with (Nathan *et. al.*, 2015) that noted that the older the farmer the more experienced he is in farming and it is expected that this will lead to higher yield and higher net farm income

Educational Qualification:

The results indicate that the majority of respondents have attained tertiary education, with 55% reporting this level of education. Secondary education follows with 28%, while a smaller proportion have no formal education (11%) or only primary education (5%). The higher educational attainment, especially tertiary education, suggests that these farmers may possess a greater understanding of pest management techniques and may be more willing to adopt scientific methods to reduce post-harvest losses caused by



pests. This aligns with Ayado (2017), who found that exposure to higher levels of education is positively and significantly linked to the adoption of better post-harvest management practices.

Marital Status:

The results show that the majority of respondents are married (55%), followed by single respondents (30%), with smaller proportions being divorced/separated (6.7%) or widowed (8.3%). Married respondents are likely to have greater access to labor for farming, which could positively impact the management of post-harvest pests. In contrast, single farmers may face more challenges in terms of labor, potentially hindering their ability to manage pests effectively. This finding is consistent with Tschirley *et al.* (2012), who reported that married individuals are more actively involved in maize production in India.

Farming Experience:

The data reveals that most respondents have between 5 and 10 years of farming experience (40%), with an average of 8.38 years. This indicates that the majority of farmers in the study area possess substantial experience and are likely familiar with post-harvest pest challenges. However, they may still benefit from updated training or support to enhance their pest management strategies. Additionally, both education and farming experience are crucial for farmers in understanding and adopting sustainable practices, which are key to improving farming performance (Bese *et al.*, 2021).

Farm Size (in hectares):

Table 1 shows that the most common farm size is between 1 and 3 hectares (35%), with an average farm size of 2.57 hectares. Due to the relatively small size of their farms, farmers may lack the resources to invest significantly in pest control methods, potentially resulting in higher post-harvest losses. Additionally, limited farm size may hinder the ability to implement large-scale or commercial pest control strategies. Gumede *et al.* (2025) found that most farmers cultivate small plots, typically around 1 hectare, and primarily grow yellow maize. However, even a 2-hectare farm is often insufficient to provide for the needs of a typical family (Gebissa 2021; Gebeyanesh Zerssa *et al.*, 2021).

Table 1: Socio-economic Characteristic of Participants (N=176).

Characteristics	Categories	Frequency	%	Mean
Gender	Male	25	63.3	
	Female	24	36.7	
Age (years)	21-30	8	13	47.83
	31-30	17	28	
	51-60	20	33	
	Above 60	15	25	
	No formal Education	7	11	
Education	Primary	3	5	
	Secondary	17	28	
	Tertiary Education	33	55	
	Single	18	30.0	
Marital Status	Married	33	55.0	
	Divorced/Separated	4	6.7	
	Widowed	5	8.3	
Farming experience	< 5years	21	35.0	8.38 years
	5-10	24	40.0	
	11-20 years	11	18.3	
	Above 20 years	4	6.7	
Farm size	Less than 1 hectare	16	26.7	2.57 hectares
	1-3 hectares	21	35.0	
	4-6 hectares	15	25.0	
	More than 6 hectares	2	3.3	
	Missing	5	8.3	
	5	1	1.7	

Source: Field survey 2023

*Multiple response



Practice of Postharvest

The results show that 74% of respondents actively engage in post-harvest pest control, indicating a strong awareness of the negative impact of pests on maize production in Isoko South. These farmers are likely implementing measures such as drying, fumigation, or pesticide use to reduce post-harvest losses, which could improve the quality of their produce and increase market value. However, 25% of respondents do not use pest control methods, leaving them vulnerable to higher post-harvest losses. This could be due to factors like lack of awareness, resources, or knowledge about pest management. The absence of pest control in this group may result in significant reductions in maize quality and quantity, negatively affecting both household food security and income from maize sales. Only 1% of respondents did not answer the question regarding pest control, a negligible proportion that does not significantly impact the overall findings.

Table 2: Respondent's Opinions on the Practice of Postharvest Pest Control

Post-Harvest Pest Control Practice	Freq.	%
Practice Post-Harvest Pest Control	71	74
Do Not Practice Post-Harvest Pest Control	24	25
No Response	1	1.0

Source: field survey, 2023

Type of Postharvest Pest Control

Table 2 reveals that a smaller proportion of farmers (22%) use chemical methods, such as pesticides or insecticides, for post-harvest pest control. While these chemicals can be effective, their improper use may have harmful environmental and health consequences. The limited adoption of chemical control methods suggests that farmers may either be cautious about the associated risks or lack access to the necessary chemicals. This highlights the need for educational programs on the proper use of chemicals and the promotion of safer, more sustainable alternatives.

Only 4% of respondents rely on physical methods, such as trapping, removal, or mechanical means, for pest control, making it the least commonly used method. This low adoption rate may suggest that physical methods are perceived as labor-intensive or less effective compared to other approaches. Farmers may prefer methods that are more efficient and less time-consuming, which limits the use of physical controls despite their sustainability.

The most widely used method (42%) is cultural control, involving practices like crop rotation, sanitation, or the use of resistant maize varieties to reduce pest populations. This indicates that many farmers in Isoko South prefer traditional or preventive approaches to pest management. Cultural control is often sustainable and cost-effective, as it does not require high external inputs, though its effectiveness may vary based on pest species and environmental conditions. Additionally, 32% of farmers adopt integrated pest management (IPM), which combines various control methods in a complementary manner. The use of IPM suggests a growing awareness of its benefits and a shift toward more sustainable, environmentally friendly practices, aligning with Mwangi *et al.* (2015), who found that IPM is widely used in maize production.

Table 3: Type of Pest Control used by the Respondents

Type of pest control	Freq.	%
Chemical control	11	22
Physical control	2	4
Cultural control	21	42
Integrated pest management	16	32

Application of Postharvest Pest Control Methods

The table outlines the frequency of post-harvest pest control methods applied by maize farmers in Isoko South Local Government Area. The results show that a significant portion of farmers (42.9%) apply pest control measures every harvest season, indicating strong awareness of the



persistent threat of post-harvest pests. This consistent approach suggests farmers are actively working to mitigate losses. Around 26.5% of farmers apply pest control measures every other harvest season, which suggests a moderate level of awareness, though they may perceive the pest threat as seasonal. This less frequent application could leave them more vulnerable during years of higher pest infestations. A smaller group (8.2%) applies pest control only once a year, which may result from limited resources, lack of awareness, or perceived lower risk. Applying pest control just once annually may be insufficient to prevent significant losses, especially in high-risk years. Additionally, 22.4% of farmers apply pest control methods rarely. This low frequency may stem from factors like inadequate knowledge, resources, or the belief that pest problems are infrequent. Rare application of pest control is concerning as it increases vulnerability to post-harvest losses, suggesting the need for targeted education and resources to improve pest management practices.

Table 4: Application of Postharvest Pest Control Methods

control methods	Freq.	%
Every harvest season	12	42.9
Every other harvest season	13	26.5
Once a year	4	8.2
Rarely	11	22.4

Source: field survey, 2023

Effects of Postharvest Pests on Maize Production

Type of post-harvest pests experienced

The table outlines the types of post-harvest pests encountered by maize farmers in the Local Government Area. It reveals that the largest proportion of farmers (38.8%) report rodents as a major post-harvest pest affecting their maize production. Rodents can cause significant damage by consuming maize grains, contaminating them with urine and feces, and spreading diseases. The prevalence of rodents indicates that farmers in Isoko South face substantial challenges in protecting their stored maize from these pests, which can result in considerable post-harvest losses. This underscores the need for improved pest control measures, including better storage facilities, traps, and other rodent management strategies.

A significant portion of farmers (36.7%) report dealing with multiple pests, such as weevils, moths, and rodents. This indicates the complexity of post-harvest pest issues in the region, as the coexistence of different pest species makes management efforts more challenging. Integrated pest control strategies, combining chemical, physical, and cultural methods, may be necessary to effectively address the diverse pest pressures.

Weevils are mentioned by 18.4% of respondents as a post-harvest pest. These pests are notorious for infesting stored grains, particularly maize, by feeding on and destroying the kernels. Their presence suggests that storage conditions may not be optimal, leading to significant losses in maize quality and quantity. Improving storage techniques, such as using sealed containers or applying insecticides, may help mitigate weevil damage.

Moths, reported by only 6.1% of respondents, are the least common post-harvest pest. Although less prevalent, they can still damage kernels and contribute to contamination. Farmers may need to focus on proper cleaning and storage practices to effectively manage moth infestations. This is consistent with findings by Megerssa *et al.* (2021), who reported that 58.7% of Ethiopian farmers identified insects as the most common pest of stored maize, with maize weevils and maize grain moths being the most significant. Additionally, Mwangi *et al.* (2015) and Dowell and Dowell (2017) also highlight rodents and grain insect pests such as maize weevils as common threats in maize production.



Table 5: Type of Postharvest Pests Experienced

Post-harvest pest	Freq.	%
Weevils	9	18.4
Moths	3	6.1
Rodents	19	38.8
All of the above	18	36.7

Source: field survey, 2023

Extent of Damage Caused by Postharvest Pests Effects of Postharvest Pests on Maize Yield

The table outlines the extent of damage caused by post-harvest pests to maize crops in Isoko South Local Government Area. A significant portion of respondents (67.3%) report experiencing moderate damage, indicating that while pest infestations are problematic, they are not entirely devastating for most farmers. Although moderate damage does not result in complete crop failure, it still leads to considerable post-harvest losses, diminishing both the quality and quantity of maize available for consumption or sale. This level of damage can negatively affect the profitability of maize farming, resulting in potential economic losses. The findings suggest a need for timely and effective pest control measures to minimize the impact of pests.

A smaller percentage of respondents (14.3%) report severe damage from post-harvest pests. Severe damage can have a more significant effect on maize production, leading to major losses in both yield and market value. This could indicate poor pest management practices or uncontrolled pest infestations, requiring urgent intervention to implement more effective pest control strategies and improve storage conditions.

Only 10.2% of farmers report minimal damage, suggesting that some farmers are successfully managing pest infestations or face naturally low pest pressures. However, even this minimal damage could accumulate over time if not managed effectively. Additionally, 8.2% of respondents report a mix of minimal, moderate, and severe damage, reflecting varying levels of pest pressure or pest control effectiveness. This variability highlights the challenges in managing pest threats across different farms. Maize's nutritional value and profitability are significantly impacted by these post-harvest losses (Emana *et al.*, 2017).

Table 6: Extent of Damage Caused by Postharvest Pests

Extent of Damage	Freq.	%
Minimal damage	5	10.2
Moderate damage	33	67.3
Severe damage	7	14.3
All of the above	4	8.2

Source: field survey, 2023

Average Maize Yield per Hectare

The average maize yield per hectare, as reported by farmers in the table, shows that the largest proportion of farmers (46.9%) achieve an average yield of 4 to 6 tons per hectare. This suggests that most farmers in Isoko South are attaining moderate yields, which can be considered typical for the region. However, post-harvest pests have the potential to significantly reduce these yields by damaging stored maize. Even when pests do not affect the harvest directly, their impact during the post-harvest storage phase can lead to considerable losses, ultimately reducing the amount of maize available for sale or consumption. Therefore, enhancing post-harvest pest control could be a key strategy to prevent the loss of valuable maize yields.

A smaller proportion of farmers (24.5%) report yields of more than 6 tons per hectare. These farmers are likely adopting more efficient farming techniques and may have better access to resources, training, and pest management tools. Despite achieving higher yields, post-harvest pests could still threaten these harvests if effective pest control measures are not in place. The relatively high yields



suggest that improving post-harvest pest management could help maximize these farmers' productivity and protect their harvests.

About 20.4% of farmers report yields between 2 to 4 tons per hectare, indicating that they may be facing challenges in pest management, soil fertility, or other factors limiting their yield potential. If these farmers lack proper pest control practices, the impact of post-harvest pests could further reduce their yields. Supporting these farmers with better pest management tools could help increase their yields.

Finally, a smaller percentage (8.2%) of farmers report yields of less than 2 tons per hectare, which suggests significant challenges such as poor soil quality, limited resources, or ineffective pest management. Post-harvest pest damage could exacerbate these challenges, negatively affecting their livelihoods. These farmers would benefit from targeted support, including pest control training, improved storage, and access to farming inputs. Kaminski and Christiansen (2014) found that post-harvest losses in maize crops in Uganda, Tanzania, and Malawi ranged from 1.4% to 5.9%, underscoring the importance of effective pest management.

Table 7: Average Maize Yield per Hectare

Average per yield	Freq.	%
Less than 2	4	8.2
2-4	10	20.4
4-6	23	46.9
More than 6	12	24.5

Source: field survey, 2023

Percentage of Maize Yield Lost

The table presents the percentage of maize yield lost due to post-harvest pests, showing that most farmers (67.3%) report minimal losses (less than 10%) in their maize yield. This suggests that most farmers are managing their pest problems reasonably well, but even small losses can be significant, especially for large-scale or resource-limited farmers. Over time, these losses can accumulate and affect profitability. Therefore, it is crucial for farmers to continue improving pest control methods to minimize these losses.

Nearly one-third of farmers (32.7%) report losses between 10-25%, indicating a more serious pest issue. This suggests that these farmers may face higher pest pressure or lack adequate pest control measures. A 10-25% loss in yield can have a considerable economic impact, especially for small-scale farmers, reducing both the available harvest and income. These farmers would benefit from better pest management practices, such as improved storage, integrated pest management techniques, and training to prevent further losses. These findings align with recent studies, such as Soltani *et al.* (2016), which reported potential yield losses of 50% and 51% due to uncontrolled weeds in the United States and Illinois.

Table 8: Percentage of Maize Yield lost

% of maize yield lost	Freq.	%
Less than 10%	33	67.3
10-25%	16	32.7

Source: field survey, 2023

Major Challenges Affecting Postharvest Pest Control

A significant majority of farmers (81.6%) strongly agree that the lack of knowledge on pest control methods is a major challenge. This suggests that many farmers may be unaware of the best practices for managing post-harvest pests, leading to ineffective pest management and increased losses. To address this, there is a clear need for educational programs, workshops, and training on pest control strategies and best practices to help farmers improve their pest management and reduce post-

harvest losses. This finding aligns with Ochilo *et al.* (2019), who reported that a lack of knowledge about control methods is a challenge in maize production.

A large proportion of farmers (75.5%) strongly agree that the lack of access to pest control methods is another significant challenge. Even if farmers are aware of effective pest control practices, they may lack access to the necessary resources such as pesticides, traps, or proper storage solutions. Addressing this challenge requires improving access to affordable pest control products and services, which could help reduce pest damage and post-harvest losses. This aligns with Pratt *et al.* (2017), who highlighted the high cost of pest control as an issue in maize production.

Additionally, the majority of respondents (85.7%) strongly agree that the high cost of pest control methods is a significant barrier, preventing many farmers from adopting effective pest management strategies. To address this, subsidizing the cost of pest control products or providing low-cost alternatives could make pest management more accessible. While most respondents (55.1%) disagree that insufficient storage facilities are a major issue, some farmers (28.6%) still consider it a concern. Improving storage infrastructure could help prevent infestations and reduce losses. The lack of infrastructure and proper handling knowledge significantly contribute to post-harvest losses in developing countries (Bendinelli *et al.*, 2020). Thyberg *et al.* (2016) also argued that inadequate policy support and regulations for small-scale farmers exacerbate post-harvest losses.

Table 9: Major Challenges Affecting Post-Harvest Pest Control

Major Challenges	Level of challenge	Freq.	%
Lack of knowledge on control methods	Disagree	1	20
	Agree	8	16.3
	Strongly Agree	40	81.6
Lack of Access to control methods	Disagree	1	2.0
	Agree	11	22.4
	Strongly Agree	37	75.5
High cost of control methods	Agree	7	14.3
	Strongly Agree	42	85.7
Insufficient storage facilities	Strongly Disagree	14	28.6
	Disagree	27	55.1
	Neutral	8	16.3

Source: field survey, 2023

Determinants of the Effects of Postharvest on Maize

The regression analysis revealed significant correlations between farmers' characteristics and the impact of post-harvest pests on maize production.

Gender ($B = 1.409$, $p = 0.000$) shows a positive relationship, indicating that gender significantly influences how pests affect maize production. The p-value of 0.000 suggests that gender is a crucial factor in pest management.

Age ($B = 0.357$, $p = 0.017$) also significantly impacts pest effects, with older farmers likely facing a different pest challenge compared to younger ones.

Educational qualification ($B = 0.662$, $p = 0.000$) has a significant positive impact, suggesting that farmers with higher education are better at managing post-harvest pests.

Marital status ($B = -0.208$, $p = 0.002$) shows a negative relationship, indicating that married farmers may experience different challenges in pest management, possibly due to the priority of ensuring household food security, as noted by Ajijola *et al.* (2015).

Farming experience ($B = 0.685$, $p = 0.000$) also positively affects pest management, suggesting that more experienced farmers are better equipped to reduce pest-related challenges. Given that these socio-economic characteristics are statistically significant, the study rejects the null hypothesis (H_0), confirming that they play a key role in managing post-harvest pests. Interventions addressing pest impact should consider these factors to improve pest control strategies. The constant term is negative but not statistically significant ($p = 0.163$), indicating that when other variables are



held constant, socio-economic factors do not significantly affect pest impact on maize production. These findings contradict the conclusion drawn by Sani *et al.* (2023), which states that the overall value of postharvest losses negatively affects maize producers' per capita income and, consequently, their welfare.

Table 10: Relationship between the Socio-Economic Characteristics of Farmers and the Effects of Post-Harvest Pests on Maize Production

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig
Constant	-.954	.660		-1.447	.163
Gender	1.409	.103	.462	13.715	.000
Age	.357	.192	.448	1.866	.017
Educational Qualification	.662	.117	.468	5.662	.000
Marital status	-.208	.188	-.112	-1.105	.002
Farming experience	.685	.155	.715	4.430	.000

Source: field survey, 2023

Perceived Relationship between Effects of Postharvest Pests and Maize Yield in the Study Area

The regression analysis reveals that several factors such (application of post-harvest pest control methods($b = -206$, $t = -6.098$, $\text{sig} = 0.000$), type of post-harvest pests experienced($b = -084$, $t = -2.331$, $\text{sig} = 0.030$);, average maize yield per hectare ($b = 0.168$, $t = 3.133$, $\text{sig} = 0.005$), lack of knowledge on control methods ($b = -311$, $t = -9.890$, $\text{sig} = 0.000$), high cost of control methods ($b = 0.013$, $t = 0.252$, $\text{sig} = 0.004$), insufficient storage facilities ($b = 0.329$, $t = 8.853$, $\text{sig} = 0.000$) has significant influence on maize yield, indicating that these factors play crucial roles in influencing maize production and to boost maize yield, it is essential to improve pest management strategies, invest in training for farmers, reduce the costs of pest control methods, and enhance storage facilities. Addressing these issues will help improve the overall productivity and sustainability of maize farming in the study area. while others like (extent of damage caused by post-harvest pests ($b = -035$, $t = -1.247$, $\text{sig} = 0.227$), percentage of maize yield lost ($b = 0.001$, $t = 0.013$, $\text{sig} = 0.990$), lack of access to control methods ($b = -043$, $t = -1.330$, $\text{sig} = 0.198$) have no meaningful impact. these factors, while they may have an impact on maize production, are not the primary drivers in this particular study. the findings suggest that the effectiveness of pest control practices, the types of pests involved, and challenges related to knowledge and storage infrastructure are more influential in determining maize yield than the extent of damage, percentage of yield lost, or access to control methods. therefore, improving pest management strategies and addressing knowledge gaps and storage issues should be prioritized over focusing solely on damage and access to control methods

Table 11: Relationship between Effects of Postharvest Pests and Maize Yield in the Study Area

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig
Constant	-954	.660		-1.447	.163
Application of post-harvest pest control methods	-206	.034	-.282	-6.098	.000
Type of post-harvest pests experienced	-.084	.036	-.091	-2.331	.030
Extent of damage caused by post –harvest pests	-.035	.028	-.044	-1.247	.227
Average maize yield per hectare	.168	.054	.209	3.133	.005
Percentage of maize yield	.001	.051	.000	.013	.990
Major challenges face in controlling post-harvest pests (lack of knowledge on control methods)	-.311	.031	-.303	-9890	.000
Major challenges face in controlling post-harvest pests (lack of access to control methods)	-.043	.033	-.047	-1.330	.198
Major challenges face in controlling post-harvest pests (High cost of control methods)	.013	.053	.014	.252	.004
Major challenges face in controlling post-harvest pests (insufficient storage facilities)	.329	.037	.391	8..853	.000

Source: field survey, 2023

CONCLUSION AND RECOMMENDATION

The study concluded that post-harvest pests have a substantial negative impact on maize production, leading to reduced yields and profitability. It highlighted the urgent need for improved pest management strategies, education, and access to affordable pest control resources.

The study recommends the implementation of education and awareness programs to enhance farmers' knowledge of pest control methods, particularly focusing on Integrated Pest Management (IPM) practices. It also suggests improving farmers' access to pest control resources such as pesticides and storage solutions. Government support through subsidies for pest control materials is crucial, especially for smallholder farmers. Further research into the long-term effects of different pest control methods is necessary to evaluate their economic viability. Additionally, there is a need for consistent application of pest control measures every harvest season and the promotion of sustainable practices, including the adoption of IPM. Tailored interventions based on socio-economic characteristics, such as age, education, and farming experience, would help enhance pest control efforts. Lastly, investing in pest-resistant maize varieties could provide long-term solutions to reduce pest damage and increase maize productivity.

REFERENCES

- Ajala, S.O., Nour, A.M., Ampong-Nyarko, M., & Odindo, M.O. (2018). Evaluation of maize genotypes (*Zea mays* L.) as a component of integrated stem borer (*Chilo partellus* Swinhoe) management in the coastal region of Kenya. *African Journal of Agricultural Research*, **5**(8): 758–763.
- Ajijola, O.A., Yagishita, D., Reddy, N.K., Yamakawa, K., Vaseghi, M., Downs, A.M., Hoover, D.B., Ardell, J.L., & Shivkumar, K. (2015). Remodeling of stellate ganglion neurons after spatially targeted myocardial infarction: Neuropeptide and morphologic changes. *Heart Rhythm*, **12**(5): 1027–1035. <https://doi.org/10.1016/j.hrthm.2015.01.045>
- Akowuah, J.O., Mensah, C.C., & Roskilly, A. (2015). Effects of practices of maize farmers and traders in Ghana on contamination of maize by aflatoxins: Case study of Ejura-Sekyedumase Municipality. *African Journal of Microbiology Research*, **9**: 16–66.
- Ayado, S. (2017, June 19). Discordant tunes over the Yam Export Policy in Nigeria. *Leadership Newspaper*.



- Bese, D., Zwane, E., & Cheteni, P. (2021). The use of sustainable agricultural methods amongst smallholder farmers in the Eastern Cape province, South Africa. *African Journal of Science, Technology, Innovation and Development*, **13**: 261–271.
- Bendinelli, W.E., Su, C.T., Péra, T.G., & Filho, J.V.C. (2020). What are the main factors that determine post-harvest losses of grains? *Sustainable Production and Consumption*, **21**: 228–238. <https://doi.org/10.1016/j.spc.2019.09.002>
- Dowell, F.E., & Dowell, C.N. (2017). Reducing grain storage losses in developing countries. *Quality Assurance and Safety of Crops and Foods*, **9**(1): 93–100. <https://doi.org/10.3920/QAS2016.0897>
- Emana, B., Afari-Sefa, V., Nenguwo, N., Ayana, A., Kebede, D., & Mohammed, H. (2017). Characterization of pre- and postharvest losses of tomato supply chain in Ethiopia. *Agriculture and Food Security*, **6**(3), 11. <https://doi.org/10.1186/s40066-016-0085-1>
- FAO. (2017). Rome. Available at <http://www.fao.org/faostat/en/#data/>
- FAO. (2017). Case studies in the small-scale agriculture and fisheries subsectors. *Milk Value Chain-Food loss analysis: Causes and solutions*. https://www.save-food.org/cgi-bin/md_interpack/lib/all/lob/return_download.cgi/isf1702_Milk_WEB.pdf?ticket=g_u_e_s_t&bid=5906&no_mime_type=0
- Gebissa, W. (2021). The challenges and prospects of Ethiopian agriculture. *Cogent Food & Agriculture*, **7**(1). <https://doi.org/10.1080/23311932.2021.1923619>
- Gitonga, Z.M., De Groote, H., Kassie, M., & Tefera, T. (2020). Impact of metal silos on households' maize storage, storage losses, and food security: An application of a propensity score matching. *Food Policy*, **43**: 44–55. <https://doi.org/10.1016/j.foodpol.2013.08.005>
- Gumede, B.C., & Kuria, S.K. (2025). Postharvest practices and farmers' knowledge in managing maize pests in the Eastern Cape Province, South Africa. *Insects*, **16**(1); 48. <https://doi.org/10.3390/insects16010048>
- Kaminski, J., & Christiaensen, L. (2014). Post-harvest loss in sub-Saharan Africa—What do farmers say? *Global Food Security*, **3**: 149–158.
- Kaminski, J., & Christiaensen, L. (2014). Post-harvest loss in sub-Saharan Africa: What do farmers say? *Policy Research Working Paper No. 6831*. World Bank Publication: Washington, D.C.
- Kachapulula, P.W., Akello, J., Bandyopadhyay, R., & Cotty, P.J. (2017). Aflatoxin contamination of groundnut and maize in Zambia: Observed and potential concentrations. *Journal of Applied Microbiology*, **122**(6): 1471–1482.
- Kumar, D., & Kalita, P. (2017). Reducing postharvest losses during the storage of grain crops to strengthen food security in developing countries. *Foods*, **6**(1): 8. <https://doi.org/10.3390/foods6010008>
- Megerssa, M., Negeri, M., & Getu, E. (2021). Farmers' perceptions, existing knowledge, and current control methods of major stored maize grain insect pests in West Showa, Ethiopia. *Archives of Phytopathology and Plant Protection*, **54**: 1778–1796.
- Morais, A.A., & Pinheiro, J.P. (2019). Breeding for resistance to insect pests. In R. Fritsche-Neto & A. Borém (Eds.), *Breeding for resistance to biotic stress*.
- Mwangi, M., & Kariuki, S. (2015). Factors determining the adoption of new agricultural technology by small-scale farmers in developing countries. *Journal of Economics and Sustainable Development*, **6**: 208–216.
- Mwangi, J.K., Mutungi, C.M., Midingoyi, S.K., Faraj, A.K., & Affognon, H.D. (2017). An assessment of the magnitudes and factors associated with post-harvest losses in off-farm grain stores in Kenya. *Journal of Stored Products Research*, **73**: 7–20.
- Nathan, S.D., du Bois, R.M., Albera, C., Bradford, W.Z., Costabel, U., Kartashov, A., Noble, P.W., Sahn, S.A., Valeyre, D., Weycker, D., & King, T.E. Jr. (2015). Validation of test performance characteristics and minimal clinically important difference of the 6-minute walk test in patients with idiopathic pulmonary fibrosis. *Respiratory Medicine*, **109**(7): 914–922. <https://doi.org/10.1016/j.rmed.2015.04.008>



- Ochilo, W.N., Nyamasyo, G.N., Kilalo, D., Otieno, W., Otipa, M., & Chege, F. (2019). Characteristics and production constraints of smallholder tomato production in Kenya. *Scientific African*, **2**: 1 - 4.
- Paniagua, A.C., East, A.R., Hindmarsh, J.P., & Heyes, J.A. (2013). Moisture loss is the major cause of firmness change during postharvest storage of blueberries. *Postharvest Biology and Technology*, **79**: 13–19. <https://doi.org/10.1016/j.postharvbio.2012.12.016>
- Paltrinieri, G. (2016). Handling fruits, vegetables, and root crops. *Food and Agriculture Organization of the United Nations*.
- Pratt, C.H., King, L.E. Jr., Messenger, A.G., Christiano, A.M., & Sundberg, J.P. (2017). Alopecia areata. *Nature Reviews Disease Primers*, **3**: 170 - 181. <https://doi.org/10.1038/nrdp.2017.11>.
- Prats Mateu, B., Hauser, M.T., Heredia, A., & Gierlinger, N. (2016). Waterproofing in Arabidopsis: Following phenolics and lipids in situ by confocal Raman microscopy. *Frontiers in Chemistry*, **4**: 10 - 16. <https://doi.org/10.3389/fchem.2016.00010>
- Sani, M. H., Kadau, R., Sani, R.M., & Danwanka, H.A. (2023). Analysis of socio-economic characteristics and post-harvest loss storage facilities used by vegetable crops value chain actors in Adamawa State, Nigeria. *Nigerian Journal of Agriculture and Agricultural Technology*, **3**(1): 210–229. <https://doi.org/10.59331/njaat.v3i1.471>
- Santpoort, R. (2020). The drivers of maize area expansion in sub-Saharan Africa. How policies to boost maize production overlook the interests of smallholder farmers. *Land*, **9**: 1–13.
- Shee, A., Mayanja, S., Simba, E., Stathers, T., Bechoff, A., & Bennett, B. (2019). Determinants of postharvest losses along smallholder producers' maize and sweet potato value chains: An ordered Probit analysis. *Food Security*, **11**(5): 1101–1120. <https://doi.org/10.1007/s12571-019-00949-4>
- Ssebaggala, G.L., Kibwika, P., & Kyazze, B. (2016). Farmers' perceptions and their implications on the use of rice postharvest handling technologies and practices in Eastern Uganda. *Working Paper No. 9245*. RUFORUM, Kampala, Uganda.
- Soltani, N., Dille, J.A., Burke, I.C., Everman, W.J., VanGessel, M.J., Davis, V.M., & Sikkema, P.H. (2016). Potential corn yield losses from weeds in North America. *Weed Technology*, **30**(4): 979–984. <https://doi.org/10.1614/wt-d-16-00046.1>
- Stathers, T., Holcroft, D., Kitinjo, L., Mvumi, B.M., English, A., Omotilewa, O., Kocher, M., Ault, J., & Torero, M. (2020). A scoping review of interventions for crop postharvest loss reduction in sub-Saharan Africa and South Asia. *Nature Sustainability*, **3**(10): 821–835. <https://doi.org/10.1038/s41893-020-00622-1>
- Tefera, T., Kanampiu, F., De Groote, H., Hellin, J., & Mugo, S. (2016). The metal silo: An effective grain storage technology for reducing post-harvest insect and pathogen losses in maize while improving smallholder farmers' food security in developing countries. *Crop Protection*, **30**: 240–245.
- Tefera, T., Mugo, S., & Beyene, Y. (2016). Developing and deploying insect-resistant maize varieties to reduce pre- and post-harvest food losses in Africa. *Food Security*, **8**(1): 211–220.
- Thyberg, K.L., & Tonjes, D.J. (2016). Drivers of food waste and their implications for sustainable policy development. *Resources, Conservation and Recycling*, **106**: 110–123.
- Tschirley, D., Hichaambwa, M., Ayieko, M., Cairns, J., Kelly, V., & Mwiinga, M. (2012). Fresh produce production and marketing systems in East and Southern Africa: A comparative assessment. *Draft Report*.
- Zerssa, G., Feyssa, D., Kim, D.G., & Eichler-Löbermann, B. (2021). Challenges of smallholder farming in Ethiopia and opportunities by adopting climate-smart agriculture. *Agriculture*, **11**(3), 1–26. <https://doi.org/10.3390/agriculture11030192>
- Zorya, S., Morgan, N., & Rios, L.D. (2019). Missing food: The case of post-harvest grain losses in Sub-Saharan Africa. *World Bank*, Washington, D.C., USA.