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Assessment of Pest Control Methods among Maize (*Zea mays L.*) Production Farmers in Keffi Metropolis of Nasarawa State, Nigeria

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Abstract **Original Research Article**

This study assesses the pest control methods used by maize (Maize mays L.) production farmers in Keffi Metropolis, Nasarawa State, Nigeria. A cross-sectional survey design was adopted in the study. A well-structured questionnaire were used as an instrument for the data collection. 150 maize (Maize mays L.) production farmers revealed that stem-borers are the most common pest, and chemical (pesticides) are the most widely used control method. However, this approach is associated with environmental and health risks. Lack of knowledge and high pesticide costs are significant constraints to effective pest management. The study recommends integrated pest management practices, extension services, and policy support for sustainable agriculture.

Keywords: *Maize Production, Pest Control, Integrated Pest Management, Sustainable Agriculture, Nigeria.*

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I. INTRODUCTION

The term "pest" refers to any living organism that is harmful, dangerous or troublesome, causing annoyance, nuisance, embarrassment, diseases to humans, animals, or plants. Pests are organisms that compete with humans for food, fiber, or other resources (Pedigo, 2002). Pests are animals or plants that are harmful or destructive to crops, livestock, or humans (Ware, 2000). Pests are organisms that cause damage to crops, livestock, or other agricultural products (Dent, 2000).
Maize (*Zea mays L.*) is one of the most widely grown cereal crops globally, serving as a staple food for millions of people, particularly in Africa and Latin America (Shiferaw *et al.*, 2011). According to FAOSTAT (2020), maize production has been increasing steadily over the years, with the global production reaching over 1.1 billion metric tons in 2020.
Maize production is influenced by various factors, including climate, soil type, and farming practices (Lobell & Burke, 2010). Research has shown that conservation agriculture practices, such as mulching and crop rotation, can improve maize yields and reduce soil erosion (Thierfelder *et al*., 2015). Additionally, the use of improved maize varieties, such as those resistant to drought and pests, can also enhance yields and reduce losses (Badu-Apraku *et al.*, 2016).
In Africa, maize is a critical crop for food security, with many smallholder farmers relying on it for their livelihoods (Smale *et al.*, 2011). However, maize production in Africa is often constrained by factors such as limited access to inputs, poor soil fertility, and climate variability (Kihara *et al*., 2016).
Maize (*Zea mays L.*) is one of the most widely grown crops in Nigeria, accounting for over 50% of the country's cereal production (FAO, 2020). Keffi Metropolis in Nasarawa State is a major maize-producing area in Nigeria, with many smallholder farmers relying on the crop for food and income (Adebayo, 2016). Pest control is a critical component of maize (*Maize mays L.*) production, and farmers in Keffi Metropolis use various methods to manage pests, including chemical pesticides, cultural control, and biological control (Ajayi,

2018). However, the use of chemical pesticides is the most common method, despite its environmental and health risks (Oyedele, 2019). Integrated pest management (IPM) practices, which combine physical, cultural, biological, and chemical controls, are considered a more sustainable approach to pest management (Akinbode, 2017).

Despite the importance of IPM, its adoption among maize farmers in Keffi Metropolis is low (Afolabi, 2019). Several factors contribute to this low adoption rate, including lack of knowledge, high cost of pesticides, and limited access to extension services (Adebayo, 2016). Furthermore, the effectiveness of pest control methods used by farmers in Keffi Metropolis has not been well documented, making it difficult to develop targeted interventions to improve pest management practices.

Research has shown that integrated soil fertility management practices, such as the use of organic and inorganic fertilizers, can improve maize yields and soil fertility in Africa (Vanlauwe *et al*., 2015). Maize is also an important crop for animal feed, particularly in the poultry and livestock industries (Steinfeld *et al*., 2006). According to a study by Thornton *et al*. (2010), maize accounts for a significant proportion of the feed used in the poultry industry, highlighting its importance in animal production.

In terms of nutritional value, maize is a good source of carbohydrates, fiber, and several essential vitamins and minerals (Nuss & Tanumihardjo, 2010). However, maize is often low in certain essential amino acids, such as lysine and tryptophan, which can limit its nutritional value (Prasanna *et al*., 2001).

To improve maize production and nutritional value, researchers have been exploring various biotechnological approaches, including genetic modification and marker-assisted breeding (Moose & Mumm, 2008). According to a study by Babu *et al*. (2017), genetically modified maize varieties with improved nutritional content, such as increased levels of vitamin A, have been developed and are being tested in various parts of the world.

Maize (*Zea mays L.*) is susceptible to various pests that can significantly impact crop yields and quality. Here are some of the most common pests found in maize farms and stores: a. Insect pests including seedcorn maggot - the maggot bores into seeds and seedlings, potentially causing seedling death. Seedcorn beetle - adult beetles attack germinating seeds and seedlings, leading to stunted growth. Wireworms - wireworms feed at the base of young plants, causing stunted growth and death. Black cutworm - cutworms feed at the base of young plants, cutting them off soon after emergence. Maize stalk borer - stalk borers create holes in young unfurled upper leaves and bore into the stalk, potentially causing plant death. Corn earworm - earworms cause damage to leaves, tassels, and especially silks and ears, reducing pollination and grain-set. Fall armyworm - fall armyworms can cause significant damage and crop yield losses if not managed properly. Corn aphids - aphids pierce plant roots and leaves, causing retarded growth and reduced yields. Maize thrips - thrips can decrease maize plant productivity and cause remarkable damage. White grubs - white grubs can cause significant problems and losses in maize during plant growth stages. Black field earwigs - earwigs can cause damage to maize, particularly in Africa and China. Migratory locusts - locusts can cause significant damage to maize crops.

b. Diseases including maize streak virus - transmitted by leafhoppers, causing white to yellowish streaking on leaves. Maize lethal necrosis disease - caused by co-infection of maize by Maize chlorotic mottle virus and Sugarcane mosaic virus. Gray leaf spot - fungal disease causing lesions on leaves, potentially leading to significant yield losses. Northern corn leaf blight - fungal disease causing elongated grayish-green to tan lesions on leaves. Southern corn leaf blight - fungal disease causing similar symptoms to Northern Corn Leaf Blight. Common rust - fungal disease causing orange-brown pustules on leaves. Downy mildew - fungal disease causing limited plant growth, chlorosis, and reduced grain production. Head smut - fungal disease infecting young maize seedlings, causing systemic infection.Maize (*Zea mays L.*) production is affected by various pests, including insects, diseases, and weeds.

Maize (Zea mays L.) is a vital crop globally, playing a multifaceted role in food security, economic development, and industrial applications (Badu-Apraku *et al*., 2016; Shiferaw *et al*., 2011). Its importance can be seen in several areas: Food security - maize is a staple food for millions of people in Latin America, Africa, and Asia, providing carbohydrates, fiber, and essential vitamins and minerals (Prasanna *et al*., 2020). According to the Food and Agriculture Organization (FAO, 2020), over 1 billion tons of maize are produced annually worldwide, with a significant portion being consumed directly by households. Economic value - in Nigeria, maize production contributes significantly to the country's economy, generating income for farmers and employment opportunities in the agricultural sector (Adebayo *et al*., 2018). A study in Kaduna State, Nigeria, evaluated the economics of maize production, highlighting its potential for economic growth (Olukosi *et al*., 2017).

Industrial applications - maize is used in various industries, including biofuel - maize is used to produce bioethanol, providing a sustainable alternative energy source (Hill *et al*., 2006). Animal Feed - maize is a key ingredient in livestock feed, supporting the poultry and livestock industries (Larbier & Leclercq, 2005). Commercial uses - maize is used in the production of various products, such as starch, oil, and biodegradable plastics (Johnson *et al*., 2013).

Key factors influencing maize production including climate and soil - maize production is influenced by climate, soil type, and farming practices (Lobell & Burke, 2010). Conservation agriculture practices, such as mulching and crop rotation, can improve maize yields and reduce soil erosion (Giller *et al*., 2009). Technology and research - advances in technology, such as genetic modification and marker-assisted breeding, have improved maize yields and nutritional content (Prasanna *et al*., 2020). Global demand - rising demand for maize has driven production growth, with countries like the US, China, and

Brazil leading global production (FAO, 2020).

Benefits of maize production including food security - maize production helps ensure food security, particularly in developing countries (Shiferaw *et al*., 2011). Economic growth - maize production contributes to economic growth, generating income for farmers and employment opportunities (Adebayo *et al*., 2018). Sustainable development - maize production can support sustainable development, providing a source of renewable energy and reducing reliance on non-renewable resources (Hill *et al*., 2006).

Maize (*Zea mays L*.) is susceptible to various pests that can significantly impact crop yields and quality. Some of the most common pests found in maize farms and stores include: Insect pests such as seedcorn maggot - the maggot bores into seeds and seedlings, potentially causing seedling death (Pedigo, 2002). Seedcorn beetle - adult beetles attack germinating seeds and seedlings, leading to stunted growth (Hill, 2008). Wireworms - wireworms feed at the base of young plants, causing stunted growth and death (Metcalf & Luckmann, 1994). Black cutworm - cutworms feed at the base of young plants, cutting them off soon after emergence (Capinera, 2001). Maize stalk borer - stalk borers create holes in young unfurled upper leaves and bore into the stalk, potentially causing plant death (Kfir *et al*., 2002). Corn earworm - earworms cause damage to leaves, tassels, and especially silks and ears, reducing pollination and grain-set (Storer *et al*., 2010). Fall armyworm - fall armyworms can cause significant damage and crop yield losses if not managed properly (Abrahams *et al*., 2017). Corn aphids - aphids pierce plant roots and leaves, causing retarded growth and reduced yields (Dixon, 1998). Maize thrips - thrips can decrease maize plant productivity and cause remarkable damage (Lewis, 1997). White grubs - white grubs can cause significant problems and losses in maize during plant growth stages (Hill, 2008). Black field earwigs - earwigs can cause damage to maize, particularly in Africa and China (Hill, 2008). Migratory locusts - locusts can cause significant damage to maize crops (Latchininsky *et al*., 2016).

Effective pest control methods are essential to minimize losses and ensure food security. Here are several methods of pest control for maize production: Cultural control methods includes rotating maize with other crops can help break the life cycle of pests (Kiptoo *et al*., 2018). Removing weeds and debris can reduce pest habitats (Midega *et al*., 2018). Adjusting planting dates can avoid peak pest periods (Badu-Apraku et al., 201 6).Biological control methods involves introducing beneficial insects, such as parasitoids and predators, can control pest populations (Kenis *et al*., 2017). Using microorganisms, such as bacteria and fungi, can control pests (Lacey *et al*., 2015). Chemical control methods which involves using chemical insecticides can control pest populations, but their use should be judicious to avoid environmental pollution and resistance development (Williamson *et al*., 2018). Using fungicides can control fungal diseases in maize (Munkvold, 2017). Developing maize varieties with built-in resistance to pests can reduce pest damage (Prasanna *et al*., 2020). Genetic modification can introduce pest-resistant genes into maize (Babu *et al*., 2017). Integrated pest management (IPM) involves combining cultural, biological, chemical, and host plant resistance methods to manage pests sustainably (Shiferaw *et al*., 2011).

Promoting effective pest control methods among maize production farmers is crucial to ensure food security, reduce crop losses, and improve farmers' livelihoods. Here are various ways to promote effective pest control methods: Training and capacity building by providing farmers with hands-on training and practical experience in pest management (Davis *et al*., 2010). Organizing workshops and seminars to educate farmers on pest control methods and best practices (Midega *et al*., 2018). Information dissemination by providing farmers with access to extension services, including pest management advice and support (Anderson & Feder, 2007). Using mobile phones to disseminate pest management information and advice to farmers (Aker & Mbiti, 2010). Training lead farmers to promote pest control methods to other farmers in their communities (Franzel *et al*., 2014). Encouraging farmer groups to share knowledge and experiences on pest management (Kiptoo *et al*., 2018). Use of technology by using precision agriculture technologies, such as drones and satellite imaging, to monitor and manage pests (Gebbers & Adamchuk, 2010). Developing decision support systems to help farmers make informed decisions on pest management (Rossi *et al*., 2017). Policy support by developing policy frameworks that support integrated pest management (IPM) and sustainable agriculture practices (Pretty, 2008). Providing incentives to farmers who adopt IPM practices, such as subsidies for biological control agents (Bale *et al*., 2008).

II. MATERIALS AND METHODS

2.1 Study Design

This study employed a cross-sectional survey design to assess pest control methods among maize (*Zea mays L*.) farmers in Keffi Metropolis, Nasarawa State, Nigeria.

2.2 Study Area

Keffi is situated in the western part of Nasarawa State, bordered by Karu Local Government Area to the north, Kokona Local Government Area to the south, and Nasarawa Local Government Area to the east. Keffi lies between latitudes 8.83°N and 8.85°N, and longitudes 7.87°E and 7.89°E. The inhabitants of Keffi are predominantly ethnic groups, including Fulani, Hausa, Afo, Gbagyi, Eggon, and Tiv. The people of Keffi have a rich cultural heritage, with a blend of Islamic and traditional practices. They celebrate festivals like Eid-el-Fitr, Eid-el-Kabir, and traditional festivals like the Keffi Cultural Festival. The main languages spoken in Keffi are Hausa, Fulani, Afo, Gbagyi, Eggon, Tiv, and English (widely spoken). The economy of Keffi is driven by agriculture (mainly maize, yam, and cassava), trade (local markets), small-scale industries (food processing, crafts), and services (education, healthcare, government).

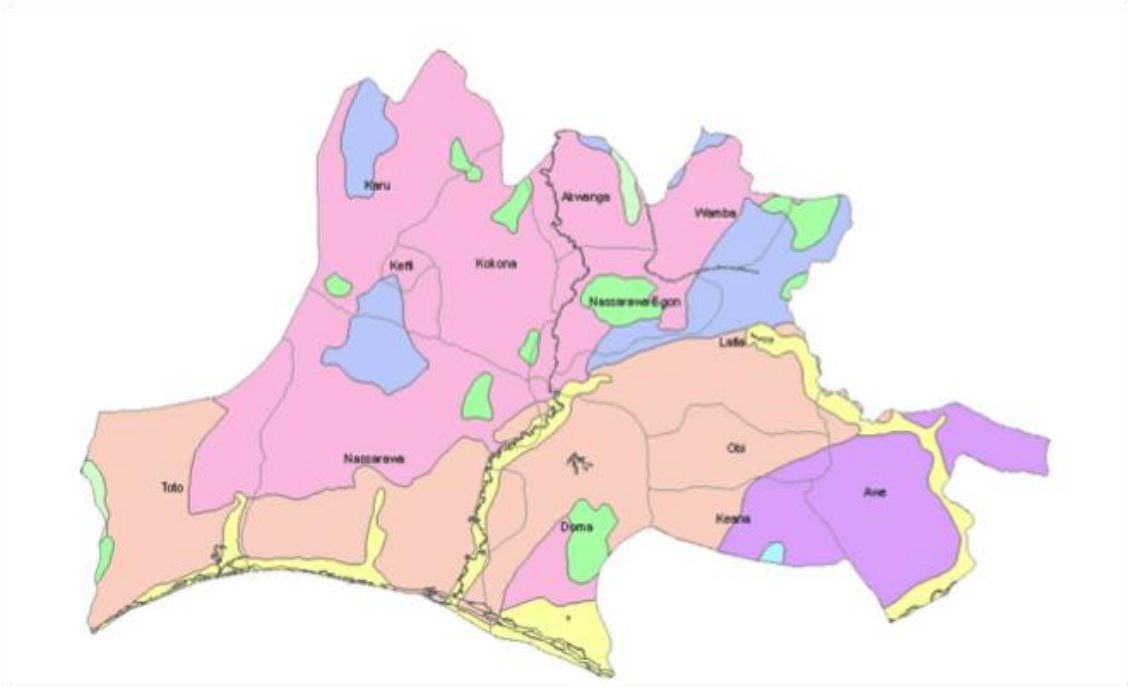

Fig. 1: Map of Nasarawa State showing Keffi LGA (Catholic Relief Services, 2023)

2.3 Sample Size and Sampling Technique

A sample size of 150 maize farmers was selected using a simple random sampling technique.

2.4 Instrumental Design

A structured questionnaire was designed to collect data on socio-demographic characteristics, maize production practices, pest control methods, and challenges faced by farmers.

2.5 Method of Data Collection

Data were collected through face-to-face interviews with farmers using the structured questionnaire.

2.6 Method of Data Analysis

Descriptive statistics (frequencies, percentages, etc) and inferential statistics (regression analysis) were used to analyze the data.

2.7 Limitation of the Study

The study's limitations include potential biases in self-reported data and the cross-sectional design, which may not capture seasonal variations in pest control practices.

III. RESULTS

Presentation of frequency distribution tables

Table 1: Types of Pests Affecting Maize (*Maize mays L*) Production

Pest	Frequency	Percentage (%)
Stem-borers	90	60
Aphids	30	20
Earworms	20	13
Other pests	10	7
Total	**150**	**100**

Table 1 shows that stem-borers are the most common pest (60%), followed by aphids (20%) and earworms (13%) and other pests (7%) were identified by the respondents.

Table 2: Pest Control Methods Used by Maize (*Maize mays L.*) Production Farmers

Method	Frequency	Percentage (%)
Chemical control (pesticides)	80	53
Cultural control	40	27
Biological control	20	13
Integrated Pest Management (IPM)	10	7
Total	**150**	**100**

The table 2 shows that chemical pesticides are the most commonly used method (53%), followed by cultural control (27%), biological control (13%) and IPM (7%) as the least in the pest control methods used by maize (*maize mays l.*) production farmers.

Table 3: Effectiveness of Pest Control Methods

Method	Effective	Not Effective	Total
Chemical control (Pesticides)	60	20	80
Cultural control	38	5	43
Biological control	12	5	17
IPM	8	2	10
Total	**118**	**32**	**150**

The table 3 shows that chemical control (pesticides) are perceived as effective by 51% of respondents, while cultural control and biological control are perceived as effective by 32% and 10% of respondents, and the least is IPM with 7%, respectively.

Table 4: Constraints Faced by Maize (*Maize mays L*) Production Farmers in Controlling Pests

Constraint	Frequency	Percentage (%)
Lack of knowledge	70	47
High cost of pesticides	50	33
Inadequate extension services	20	13
Limited access to resources	10	7
Total	**150**	**100**

The table 4 shows that lack of knowledge (47%) and high cost of pesticides (33%) are the major constraints faced by respondents. Inadequate extension services (13%) and limited access to resources (7%) were the least in the constraints faced by maize (*Maize mays l*) production farmers in controlling pests.

IV. DISCUSSION AND CONCLUSION

Stem-borers (60%) are the most common pest affecting maize (*Maize mays L.*) production in Keffi Metropolis. This finding is consistent with previous studies that have identified stem-borers as a major pest of maize in Nigeria (Ogah, 2015). Stem-borers are known to cause significant yield losses in maize, and their control is crucial for ensuring food security. A study by (Akinfenwa, 2017), found that stem-borers caused an average yield loss of 30% in maize fields in Nigeria. Our finding highlights the need for effective management strategies to control stem borers and minimize yield losses.

Chemical control (pesticides) (53%) are the most commonly used pest control method. This finding is consistent with previous studies that have reported the widespread use of

chemical pesticides in maize production in Nigeria (Ajayi, 2018). However, the over-reliance on chemical pesticides has been linked to environmental pollution, health risks, and the development of pesticide-resistant pest populations. A study by (Oyedele, 2019), found that the use of chemical pesticides in maize production in Nigeria was associated with environmental contamination and health risks to farmers. Our finding highlights the need for sustainable pest management practices that minimize the use of chemical pesticides.

Lack of knowledge (47%) is a major constraint faced by maize (*Maize mays L.*) production farmers in controlling pests. This finding is consistent with previous studies that have identified lack of knowledge as a major constraint to effective pest management in maize production (Adebayo, 2016). Farmers' knowledge and skills are critical for effective pest management, and lack of knowledge can lead to poor pest management practices. A study by (Akinbode, 2017), found that farmers' knowledge of pest management practices was a significant factor influencing their adoption of integrated pest management (IPM) practices. Our finding highlights the need for extension services and training programs to enhance farmers' knowledge and skills in pest management.

High cost of pesticides (33%) is a major constraint faced by maize (*Maize mays L.*) production farmers in controlling pests. This finding is consistent with previous studies that have identified high cost of pesticides as a major constraint to effective pest management in maize production (Ogunyemi, 2018). The high cost of pesticides can limit farmers' access to effective pest control measures, leading to poor pest management practices. A study by (Afolabi, 2019), found that the cost of pesticides was a significant factor influencing farmers' adoption of IPM practices. Our finding highlights the need for affordable and sustainable pest management practices that minimize the use of costly chemical pesticides.

In conclusion, the findings of this study highlight the importance of effective pest management practices in maize (*Maize mays L.*) production in Keffi Metropolis, Nasarawa State, Nigeria. The study identified stem borers as the most common pest affecting maize (*Maize mays L.*) production, and chemical pesticides as the most commonly used pest control method. However, the over-reliance on chemical pesticides was found to be associated with environmental pollution, health risks, and the development of pesticide-resistant pest populations. The study also identified lack of knowledge and high cost of pesticides as major constraints faced by maize (*Maize mays L.*) production farmers in controlling pests. These findings suggest that there is a need for sustainable pest management practices that minimize the use of chemical pesticides, and for extension services and training programs to enhance farmers' knowledge and skills in pest management. Furthermore, the study highlights the importance of integrated pest management (IPM) practices in maize (*Maize mays L.*) production. IPM practices were found to be effective in controlling pests and reducing the use of chemical pesticides. However, the adoption of IPM practices was found to be low among maize production farmers in Keffi Metropolis.

Overall, the findings of this study suggest that there is a need for a holistic approach to pest management in maize (*Maize mays L.*) production in Keffi Metropolis, one that takes into account the social, economic, and environmental factors that influence pest management practices. This approach should involves the development of sustainable pest management practices, the provision of extension services and training programs, and the promotion of IPM practices among maize (*Maize mays L.*) production farmers.

Therefore, the researchers are hereby recommend that there is a need for farmers to develop a sustainable pest management practice that minimize the use of chemical pesticides; there is need for government to make provision of extension services and training programs to enhance farmers' knowledge and skills in pest management; there is a need for promotion of IPM practices among maize (*Maize mays L.*) production farmers; government should develop policies and regulations that would support the adoption of sustainable pest management practices; and further research on the effectiveness of IPM practices in maize (*Maize mays L.*) production in Keffi Metropolis.

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Disclosure of Conflict of interest

The authors declared that they have no conflict of interest.

Authors' Contributions

OMU, AED, and AAD conceptualized the study. OMU designed the study. OMU, AED, and HFA participated in framework and data collection. OMU, HFA, and AAD performed data analysis. OMU, AED, and HFA prepared the first draft of the manuscript and reviewed by AAD. All authors contributed to the development of the final manuscript and approved its submission.

Ethical Approval and Informed Consent

Ethical approval for this study was granted by the ethical review committee of the Ministries of Health and that of Agriculture, Lafia, Nasarawa state. Also, a letter of approval to get access to Maize Production Farmers in Keffi was granted by the Ethical Committee of Agric. Unit, Keffi Local Government Area of Nasarawa State. The informed consent of each Farmer that participated in the study was also obtained.

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