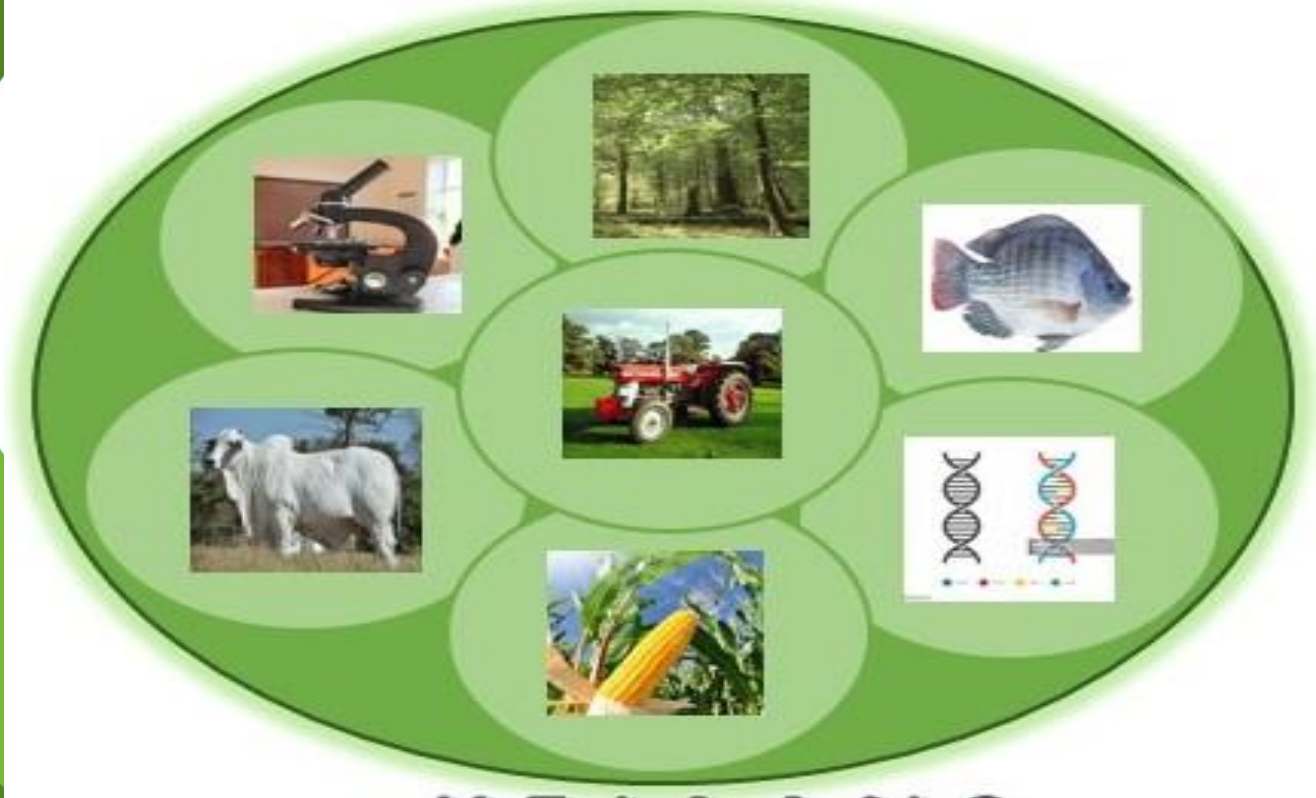
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KEJAANS

TABLE OF CONTENTS

S/N	Article and Author(s)	Page
01	Enhancing Post-Harvest Tomato Value Through Pasteurization: An Action Research Intervention For Smallholder Farmers In Kebbi State, Nigeria **Y. A. Manga and H. A. Bagudo**	1-5
02	Detection Of Pesticide Residues In Some Fruits And Vegetable Crops Consumed In Lapai, Niger State **Mundi, M.M., Danjuma, S., Waziri, A., Sangayama, M.Z., Mbaya, M.H., Jankaro, L.S., and Ibrahim, A.K.**	6-14
03	Trend Analysis On Seasonal Rainfall Onset, Cessation, And Length Using Mann–Kendall And Sen's Slope (1995–2025) In Jos, Nigeria **Kasai, Itse Caleb and Ajik, Izang Dogo**	15-22
04	Identifying The Farm Enterprise Characteristics Of Youth Rice Farmers In Kebbi State, Nigeria **Jibril Muhammad Yelwa, Sa'adu Hamisu, Jamilu Sani Turaki, Sa`adu Umar, Yahaya Kaka, and Garba Aliyu**	23-33
05	Prospective Role Of Indigenous Leafy Vegetables As Functional Food Ingredients Among Households In Zuru Local Government Area Of Kebbi State, Nigeria **Hamisu, Sa'adu**	34-41
06	Effects Of Invasive Fish Species On Native Species And Aquatic Ecosystems **Adeniyi, O. A., Adeoye, O., Faniyi, T. O., and Alabi, A.**	42-57
07	Assessing The Effectiveness Of Integrated Pest Management (Ipm) Strategies On Maize Production In Uhunmwode Local Government, Edo State Nigeria **Osagie Joseph Osarumwense and [2]Taidi Ekrakene**	58-71
08	Occurrence of Soils and Weeds on Toposequences under Sedimentary And Basement Complex Formations In Niger State, Nigeria **Bello, R. M., Mohammed T., Yakubu M., Muhammad A.A**	72-81
09	Market Structure, Performance And Marketing Costs Of Food Grains In South-East, Nigeria **Anorue Paul Chukwuemeka and Njoku Maria-Stella Etomchi**	82-97
10	Determinants Of Marketing Efficiency And The Impact Of Seller Type Among Foodgrains Marketing Households In South-East, Nigeria. **Anorue Paul.Chukwuemeka and Mejeha Remy Onyekachi**	98-113
11	Hubbard Broiler Chickens: A Heat-Resilient And Cheap Alternative Strain For Semi-Arid Environment **Aliyu Sa'adu**	114-123

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ASSESSING THE EFFECTIVENESS OF INTEGRATED PEST MANAGEMENT (IPM) STRATEGIES ON MAIZE PRODUCTION IN UHUNMWODE LOCAL GOVERNMENT, EDO STATE NIGERIA

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ABSTRACT

Effective pest management strategy is an important aspect of farming that boost production. In farm farming, it is very necessary as several pest and diseases are known to affect maize and reduces yield. Intergrated Pest Management Strategies have been know to be effective on many crops but its effectiveness has not been established in maize producing area of Uhunmwode Local Government area of Edo State, Nigeria. Therefore, this study assessed the effectiveness of Integrated Pest Management (IPM) strategies in maize production among farmers in Edo State, Nigeria. Specifically, it examined farmers' awareness of IPM strategies, their extent of use, and perceived effectiveness in reducing pest incidence and crop damage, and the determinants of IPM effectiveness. The study adopted a descriptive survey research design. A multistage sampling procedure was used to select maize farmers from selected maize-producing communities in Uhunmwode Local Government Area of Edo State. Data were collected using a structured questionnaire and analyzed with frequency counts, percentages, means, standard deviations and binary logistic regression. A decision mean of 2.50 was used to classify IPM use and effectiveness. The findings revealed high awareness of early planting to escape pest infestation (86.7%), judicious use of synthetic pesticides (84.2%), field sanitation/removal of crop residues (81.7%), intercropping (80.0%), crop rotation (75.8%), handpicking of pests (74.2%) and regular field scouting (70.0%). The most highly used and effective IPM strategies included early planting, field sanitation, regular scouting, intercropping, crop rotation, handpicking of pests and judicious pesticide use. However, biological control, pheromone traps and botanical pesticides were poorly used and perceived as less effective, indicating limited exposure to technical and ecological IPM components. Logistic regression showed that educational level, farm size, farming experience, extension contact, access to credit and IPM training significantly influenced IPM effectiveness. The model had a Nagelkerke R^2 of 0.452 and overall classification accuracy of 78.3%. The study concluded that IPM strategies are effective but not fully integrated among farmers. It recommended stronger farmer training, extension support, credit access and provision of IPM-related inputs.

Keywords: Integrated Pest Management, maize production, pest incidence, farmer training, Edo State.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops cultivated in Nigeria and across sub-Saharan Africa. It serves as a major source of food for households, livestock feed and raw material for several agro-allied

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industries, including starch production, brewing, confectionery and poultry-feed manufacturing. The increasing demand for maize has contributed to the expansion of its production in Nigeria, making it an important crop for food security, employment generation and farmers' income. Wossen et al. (2023) observed that the maize sector in Nigeria has experienced considerable growth due to increasing demand for food, feed and industrial processing. Despite its economic and nutritional importance, maize production is constrained by several factors, including poor soil fertility, drought, high cost of farm inputs, limited access to improved varieties, inadequate extension services and pest infestation. Insect pests constitute a major production challenge because they attack maize at different stages of growth and storage. Common pests affecting maize include stem borers, termites, aphids, grasshoppers, maize weevils and fall armyworm (*Spodoptera frugiperda*). Fall armyworm has become particularly important because of its rapid spread, high feeding capacity and ability to cause serious damage to maize leaves, whorls, tassels and cobs. Odeyemi and Ugwu (2021) reported that fall armyworm had spread across Nigeria, creating serious management challenges for maize farmers.

In response to pest infestation, many farmers rely heavily on synthetic pesticides because they provide relatively quick control. However, inappropriate and excessive use of pesticides may result in environmental pollution, destruction of beneficial organisms, pesticide residues in food, health risks to farmers and consumers, pest resurgence and the development of pesticide resistance. Ahissou et al. (2021) noted that the continuous use of chemical pesticides without appropriate management practices may reduce their effectiveness and increase environmental and human-health risks. These limitations have increased the need for pest-management approaches that are effective, economical and environmentally sustainable.

Integrated Pest Management is a knowledge-based and environmentally responsible approach that combines compatible pest-control methods to maintain pest populations below economically damaging levels. It incorporates cultural, mechanical, biological, botanical and chemical-control measures. Such practices include early planting, crop rotation, intercropping, field sanitation, regular field scouting, handpicking of pests, use of resistant maize varieties, conservation of natural enemies, botanical pesticides, pheromone traps and the judicious use of synthetic pesticides. Under IPM, chemical pesticides are applied only when necessary and at the recommended dosage and time. The Food and Agriculture Organization (2018) emphasized that effective management of fall armyworm requires regular field monitoring, accurate pest identification, timely intervention and the integration of several control practices rather than dependence on chemical pesticides alone. Similarly, the International Institute of Tropical Agriculture (2021) stressed the importance of training farmers and extension agents in pest identification, field scouting, treatment timing, pesticide application, sprayer calibration and safety measures.

Although IPM is recognised as a sustainable approach to pest control, its use among maize farmers remains uneven. Some farmers are familiar with cultural practices such as early planting, intercropping, crop rotation and field sanitation but have limited knowledge of biological control, botanical pesticides, resistant varieties and pheromone traps. The effectiveness of IPM may also be influenced by farmers' educational level, farming experience, farm size, access to extension services, access to credit and participation in IPM training. Ojumoola, Omoloye and Thomas (2022) reported that farmers' knowledge and pest-management practices are

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important factors in the effective control of fall armyworm in maize production.

In Uhunmwode Local Government Area of Edo State, maize production is an important livelihood activity among rural households. However, farmers continue to experience pest infestation and crop damage, while their level of awareness, use and perceived effectiveness of different IPM strategies has not been adequately documented. There is therefore a need to assess the IPM practices known and used by maize farmers and determine how effective these practices are in reducing pest incidence and crop damage. Therefore, the main objective of the study was to assess the effectiveness of Integrated Pest Management strategies in maize production among farmers in Uhunmwode Local Government Area of Edo State, Nigeria. Specifically, the study:

1. ascertained maize farmers' level of awareness of Integrated Pest Management strategies;
2. determined the extent to which maize farmers used Integrated Pest Management strategies; and
3. assessed the effectiveness of Integrated Pest Management strategies in reducing pest incidence and crop damage.

Materials and Methods

Study Approach

The study adopted a descriptive survey research design. This design was considered appropriate because the study sought to obtain information from maize farmers on their awareness, use and perceived effectiveness of Integrated Pest Management (IPM) strategies in maize production. The design also enabled the collection of quantitative data on farmers' socioeconomic characteristics, major pest problems, IPM practices used, perceived effectiveness of the strategies, yield-related outcomes and constraints to IPM adoption.

Study Area

The study was carried out in Nigeria, with emphasis on maize-producing communities where maize is cultivated as a major food and income-generating crop. Nigeria is located in West Africa and has diverse agro-ecological zones suitable for maize production, including the derived savanna, southern Guinea savanna, northern Guinea savanna and rainforest transition zones. Maize is widely grown by smallholder farmers for household consumption, livestock feed and commercial purposes. However, maize production in the country is affected by several pest problems, including fall armyworm, stem borers, termites, aphids and storage pests, making the area suitable for a study on the effectiveness of IPM strategies.

Population of the study

The population of the study comprised all registered and active maize farmers in the selected maize-producing communities in Edo State, Nigeria. These included male and female farmers who had cultivated maize for at least one production season and had experience with pest management practices. Farmers who cultivated maize either as sole crop or in mixed cropping systems were included in the study.

Sampling Procedure and Sample Size

A multistage sampling procedure was used for the study. In the first stage, maize-producing communitie (Ora, Oke, Irhue,Ekpan, Umokpe, Orhua, Irhua) all in Uhunmwode local government area of Edo State were purposively selected based on the intensity of maize production and prevalence of pest infestation. In the second stage, maize-producing communities were randomly selected from the list of communities in the Local Government Area. In the final stage, maize farmers were selected using simple random sampling from available lists of maize farmers obtained from agricultural extension offices, farmers' associations or community leaders.

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The sample size for the study may be determined using Taro Yamane's formula where the population of maize farmers is known:

$$n = N / [1 + N(e)^2]$$

Where n = sample size; N = population size; and e = level of precision, usually 0.05. Where the exact population is not known, a reasonable sample of maize farmers may be selected from the sampled communities to ensure adequate representation. The final sample size should be large enough to allow meaningful statistical analysis of IPM awareness, use, effectiveness and constraints.

Method of Data Collection

Data for the study were collected using a structured questionnaire. The questionnaire was divided into sections based on the objectives of the study.

Section A contained questions on the socioeconomic characteristics of respondents, including age, sex, marital status, educational level, household size, farming experience, farm size, income, membership of farmers' association, access to extension services and access to credit.Section B focused on the major pests affecting maize production. Respondents were asked to identify common pests such as fall armyworm, stem borers, termites, aphids, grasshoppers, maize weevils and other field or storage pests.

Section C measured farmers' awareness of IPM strategies, including early planting, crop rotation, intercropping, resistant varieties, field sanitation, regular scouting, handpicking of pests, botanical pesticides, biological control, pheromone traps and judicious use of synthetic pesticides.

Section D examined the extent of use of IPM strategies. Farmers were asked to indicate how frequently they used selected IPM practices in maize production. This may be measured on a four-point scale of: Very often = 4, Often = 3, Rarely = 2 and Never = 1.

Section E assessed the perceived effectiveness of IPM strategies in reducing pest infestation, minimizing crop damage, improving yield, reducing pesticide use, lowering cost of production and improving farm income. This may be measured on a four-point scale of: Highly effective = 4, Effective = 3, Slightly effective = 2 and Not effective = 1.

Section F identified the constraints limiting the adoption and effective use of IPM strategies. Possible constraints include inadequate knowledge of IPM, high cost of inputs, poor extension contact, lack of training, poor access to resistant maize varieties, limited availability of biological-control agents, labour demand, poor access to credit, inadequate pest-monitoring information and farmers' preference for chemical pesticides.

The questionnaire was subjected to face and content validity by experts in Agricultural Extension, Crop Protection and Rural Development. The experts examined the instrument to ensure that the questions were clear, relevant and adequate for addressing the objectives of the study. Their comments, corrections and suggestions were incorporated into the final version of the questionnaire before field administration.

The reliability of the instrument was established through a pilot test conducted among maize farmers outside the selected study communities but with similar characteristics to the actual respondents. Data obtained from the pilot test were analyzed using Cronbach's alpha to determine the internal consistency of the questionnaire items, especially those relating to awareness, extent of use, perceived effectiveness and constraints. A Cronbach's alpha coefficient of 0.70 and above was considered acceptable for the study.Sources of Data

Primary data were collected from maize farmers with the aid of the structured questionnaire. Trained enumerators were used

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to assist in administering the questionnaire, especially where respondents have limited literacy. The questionnaire was administered through personal interview and direct contact with respondents in their farms, homes, community meeting points or farmers' group meetings. This method was adopted to ensure a high response rate and to assist respondents in understanding the questions.

Measurement of Variables

The dependent variable of the study was the effectiveness of IPM strategies in maize production. This was measured using farmers' perceived effectiveness of IPM practices in reducing pest infestation, reducing crop damage, improving maize yield, reducing pesticide dependence and lowering production risk.

The independent variables included the different IPM strategies used by maize farmers. These included early planting, crop rotation, intercropping, use of resistant varieties, field sanitation, regular scouting, handpicking of pests, use of botanical pesticides, biological control, pheromone traps and judicious application of synthetic pesticides.

Socioeconomic and institutional variables included age, sex, educational level, household size, farm size, farming experience, income, access to extension services, access to credit, membership of farmers' association, training on IPM and access to pest-management information.

The extent of use of IPM strategies was measured on a four-point scale as follows: Very often = 4, Often = 3, rarely = 2 and Never = 1. The decision mean was calculated as:

(4 + 3 + 2 + 1) / 4 = 2.50.

Therefore, any IPM strategy with a mean score of 2.50 and above was regarded as highly used, while any strategy with a mean score below 2.50 was regarded as poorly used.

The perceived effectiveness of IPM strategies was measured using the following scale: Highly effective = 4, Effective = 3, Slightly effective = 2 and Not effective = 1. Using the same decision mean of 2.50, any IPM strategy with a mean score of 2.50 and above was considered effective, while any strategy with a mean score below 2.50 was considered not effective.

Constraints to IPM adoption may also be measured on a four-point scale: Very serious constraint = 4, Serious constraint = 3, Less serious constraint = 2 and Not a constraint = 1. A mean score of 2.50 and above indicated a serious constraint, while a mean score below 2.50 indicated a less serious constraint.

Methods of Data Analysis

Data collected from the field were coded and analyzed using descriptive and inferential statistics. Descriptive statistics such as frequency counts, percentages, means and standard deviations were used to describe respondents' socioeconomic characteristics, identify major pests, assess awareness of IPM strategies, determine extent of use and identify constraints.

Mean scores and standard deviations were used to rank the IPM strategies based on level of use and perceived effectiveness. This helped to identify the most commonly used and most effective IPM practices among maize farmers.

To analyse the determinants of IPM effectiveness, a logistic regression model was used as effectiveness pf IPM was measured as a binary variable, where effective was coded as 1 and non-effective was coded as 0. The model is specified as:

$$\text{Logit}(P) = \ln[P / (1 - P)] = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + e$$

Where P = probability that IPM strategies was effective; 1 - P = probability that IPM strategies are not effective; X_1-X_6 = explanatory variables such as education, farm size, experience, extension contact, credit access and IPM training; and e = error term.

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Respondents' consent was obtained before data collection. They were informed about the purpose of the study and assured that their responses would be used only for academic and research purposes. Participation was voluntary, and respondents were free to withdraw at any stage. Confidentiality and anonymity of responses were maintained throughout the study.

Results and Discussion

Table 1 presents the awareness of Integrated Pest Management (IPM) strategies among maize farmers in Edo State, Nigeria. The result shows that farmers had high awareness of early planting to escape pest infestation (86.7%), judicious use of synthetic pesticides (84.2%), field sanitation/removal of crop residues (81.7%), intercropping maize with other crops (80.0%), crop rotation for pest reduction (75.8%), handpicking and destruction of visible pests (74.2%), and regular field scouting/monitoring of pests (70.0%). This implies that most maize farmers were aware of basic and commonly practised IPM strategies, especially those that are simple, low-cost and already embedded in traditional maize production systems. The high awareness of early planting, intercropping, field sanitation and crop rotation suggests that farmers are more familiar with cultural and agronomic pest-management practices than highly technical pest-control methods. This finding is justified because maize is a major food-security and commercial crop in Nigeria, and pest infestation has increasingly forced farmers to seek practical ways of reducing crop damage and yield loss. Wossen *et al*. (2023) observed that maize has become a dominant staple and commercial crop in Nigeria, while FAO (2018) emphasized that sustainable management of fall armyworm and other maize pests requires farmer education on integrated, field-based and preventive pest-management practices.

The table further reveals moderate awareness of the use of resistant/tolerant maize varieties (60.0%), botanical pesticides such as neem extract (55.0%), and recommended dosage and timing of pesticide application (65.0%). This indicates that although farmers were aware of some improved and semi-technical IPM practices, their awareness was not as strong as their awareness of traditional cultural practices and chemical pesticide use. The moderate awareness of resistant/tolerant maize varieties may be due to limited access to improved seeds, inadequate extension demonstrations and weak dissemination of information on varietal resistance as a pest-management option. Similarly, the moderate awareness of botanical pesticides may suggest that farmers know some local plant-based pest-control materials but may not fully understand their preparation, standard dosage, timing and effectiveness. The moderate awareness of recommended pesticide dosage and timing is particularly important because wrong dosage, poor timing and repeated pesticide application can reduce control effectiveness and increase production risks. This agrees with Ojumoola *et al*. (2022), who reported that maize farmers' knowledge and management practices are central to effective control of fall armyworm in southwest Nigeria. Therefore, the result shows that awareness alone is not enough; farmers require deeper technical understanding of how, when and under what pest conditions each IPM component should be applied.

However, the result shows low awareness of biological control/conservation of natural enemies (34.2%) and use of pheromone traps (26.7%). This finding indicates that farmers' awareness of IPM is still incomplete and largely concentrated on familiar cultural practices and pesticide-related options, while ecological and surveillance-based pest-management techniques remain poorly understood. Biological control and pheromone traps usually require more technical knowledge, availability of inputs, extension support and practical training before farmers can adopt them effectively. The low awareness

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of these strategies is therefore justified by the likelihood of weak extension contact, limited farmer training and poor access to specialized pest-management technologies in many rural farming communities. FAO (2018), recommended Farmer Field Schools and learning-by-doing approaches as important pathways for strengthening farmers' capacity to identify pests, monitor pest populations and use integrated control options. Similarly, studies on fall armyworm management have shown that dependence on synthetic pesticides alone is not sustainable because of risks such as pesticide resistance, environmental contamination and destruction of beneficial organisms (Carvalho *et al*., 2013; Ngegba *et al*., 2025). The overall implication of Table 1is that maize farmers have a useful foundation of awareness for IPM, but extension programmes must place greater emphasis on the technical and ecological components of IPM, especially biological control, pheromone traps, correct pesticide-use practices and resistant maize varieties.

Table 1: Awareness of IPM Integrated Pest Management

IPM Strategies	Freq.	%	Remark
Early planting to escape pest infestation	104	86.7	High
Crop rotation for pest reduction	91	75.8	High
Intercropping maize with other crops	96	80	High
Use of resistant/tolerant maize varieties	72	60	Moderate
Field sanitation/removal of crop residues	98	81.7	High
Regular field scouting/monitoring of pests	84	70	High
Handpicking and destruction of visible pests	89	74.2	High
Use of botanical pesticides, e.g., neem extract	66	55	Moderate
Biological control/conservation of natural enemies	41	34.2	Low
Use of pheromone traps	32	26.7	Low
Judicious use of synthetic pesticides	101	84.2	High
Recommended dosage and timing of pesticide application	78	65	Moderate

Source: Field Survey, 2025.

Extent of Use of Integrated Pest Management Strategies

Table 2 presents the extent of use of Integrated Pest Management (IPM) strategies among maize farmers in Edo State, Nigeria. The result shows that early planting to escape pest infestation ranked first with a mean score of 3.10, followed by judicious use of synthetic pesticides with a mean score of 3.05, field sanitation/removal of crop residues with a mean score of 2.98, intercropping maize with other crops with a mean score of 2.91, regular field scouting/monitoring of pests with a mean score of 2.83, crop rotation for pest reduction with a mean score of 2.73, handpicking and destruction of visible pests with a mean score of 2.66, and use of recommended dosage and timing of pesticide application with a mean score of 2.61. Since all these mean scores are above the decision mean of 2.50, they were regarded as highly used IPM strategies. This implies that farmers were more likely to adopt IPM practices that are practical, affordable, familiar and easy to integrate into existing maize production systems. The high use of early planting may be because farmers consider planting time an important way of escaping severe pest pressure, especially during periods when pests such as fall armyworm, stem borers and other maize pests are more destructive. This finding agrees with FAO (2018), which emphasized that effective maize pest management requires preventive and field-based practices such as timely

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planting, scouting, sanitation and appropriate intervention. It also supports Wossen *et al*. (2023), who noted that maize production in Nigeria has expanded significantly, making practical pest-management strategies necessary for sustaining productivity and reducing crop losses.

The result also shows that farmers highly used cultural practices such as field sanitation, intercropping, crop rotation and regular field scouting. This suggests that maize farmers in the study area did not depend entirely on chemical pesticides but combined some agronomic and preventive practices in managing pest infestation. Field sanitation helps to reduce pest breeding sites and carry-over of pests from one season to another, while intercropping and crop rotation can interrupt pest life cycles and reduce the continuous availability of host plants. Regular scouting is also important because it enables farmers to detect pest infestation early and apply appropriate control measures before serious crop damage occurs. The high use of these strategies is justified because they require relatively low financial investment and can be implemented with farmers' existing labour and local knowledge. Ojumoola *et al*. (2022), reported that farmers' knowledge and management practices are central to effective fall armyworm control, especially where early detection and correct response are needed. Similarly, the International Institute of Tropical Agriculture (2021), emphasized that farmer training on pest identification, field scouting, treatment windows, sprayer calibration and pesticide safety is essential for effective maize pest management. Therefore, the high use of these strategies indicates that farmers are applying IPM mostly through familiar cultural and management-based practices rather than through more specialized technologies.

However, Table 2 further reveals that some IPM strategies were poorly used. These include the use of resistant/tolerant maize varieties with a mean score of 2.47, botanical pesticides such as neem extract with a mean score of 2.35, biological control/conservation of natural enemies with a mean score of 1.98, and use of pheromone traps with a mean score of 1.76. Since these mean scores are below the decision mean of 2.50, they were considered poorly used. This implies that the use of IPM among maize farmers is still partial and uneven, with farmers relying more on practices that are familiar and less dependent on external inputs, while underutilizing strategies that require improved technologies, technical knowledge, institutional support or market availability. The poor use of resistant maize varieties may be linked to limited access to improved seed, high seed cost or inadequate awareness of varietal resistance. Similarly, low use of botanical pesticides, biological control and pheromone traps may be due to inadequate training, poor availability of inputs and weak extension support. This finding is consistent with the view that IPM adoption is not only a technical issue but also an institutional and behavioural issue influenced by farmers' access to information, training, and extension contact and pest-management resources (FAO, 2018; Ojumoola *et al*., 2022). The implication is that extension agencies and agricultural development programmes should intensify farmer training on underutilized IPM components, especially biological control, botanical pesticides, resistant varieties and pheromone-based monitoring, so that farmers can move from partial IPM use to a more complete and sustainable pest-management system.

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Table 2: Extent of Use of Integrated Pest Management Strategies

IPM Strategies	Mean	SD	Rank	Remark
Early planting to escape pest infestation	3.1	0.95	1st	Highly used
Judicious use of synthetic pesticides	3.05	0.94	2nd	Highly used
Field sanitation/removal of crop residues	2.98	0.95	3rd	Highly used
Intercropping maize with other crops	2.91	0.96	4th	Highly used
Regular field scouting/monitoring of pests	2.83	0.97	5th	Highly used
Crop rotation for pest reduction	2.73	1	6th	Highly used
Handpicking and destruction of visible pests	2.66	1.01	7th	Highly used
Use of recommended dosage and timing of pesticide application	2.61	0.98	8th	Highly used
Use of resistant/tolerant maize varieties	2.47	0.99	9th	Poorly used
Use of botanical pesticides, e.g., neem extract	2.35	0.99	10th	Poorly used
Biological control/conservation of natural enemies	1.98	0.94	11th	Poorly used
Use of pheromone traps	1.76	0.89	12th	Poorly used

Source: Field Survey, 2025.

Perceived Effectiveness of IPM Strategies in Reducing Pest Incidence and Crop Damage

Table 3 presents the perceived effectiveness of Integrated Pest Management (IPM) strategies in reducing pest incidence and crop damage among maize farmers in Edo State, Nigeria. The result shows that early planting to escape pest infestation recorded the highest mean score of 3.18, followed by field sanitation/removal of crop residues with a mean score of 3.11, regular field scouting/monitoring of pests with a mean score of 3.08, judicious use of synthetic pesticides with a mean score of 3.05, intercropping maize with other crops with a mean score of 2.92, crop rotation for pest reduction with a mean score of 2.83, use of resistant/tolerant maize varieties with a mean score of 2.73, recommended dosage and timing of pesticide application with a mean score of 2.69, and handpicking/destruction of visible pests with a mean score of 2.59. Since these mean scores are above the decision mean of 2.50, the strategies were regarded as effective in reducing pest incidence and crop damage. This implies that farmers perceived the most effective IPM practices to be those that either prevent pest build-up, support early detection or provide timely control of infestation. The strong effectiveness rating for early planting is justified because timely planting can help maize crops escape peak pest pressure and establish better crop vigour before severe infestation occurs. This agrees with FAO (2018), which emphasized that sustainable management of fall armyworm and other maize pests requires timely field operations, regular monitoring, farmer education and the combination of compatible control measures rather than dependence on one method alone.

The finding also shows that regular field scouting, field sanitation, intercropping, crop rotation and judicious use of synthetic pesticides were perceived as effective strategies. This suggests that farmers recognized the value of both preventive and responsive pest-management practices. Field sanitation reduces crop residues that may serve as pest shelters or breeding sites, while crop rotation and intercropping help to disrupt pest life cycles and reduce continuous pest pressure on maize fields. Regular scouting enables farmers to identify pest problems early and respond before infestation reaches damaging levels. The effectiveness of judicious pesticide use also shows that farmers still consider

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chemical control useful when applied correctly, especially under severe pest pressure. However, IPM does not reject pesticide use; rather, it promotes careful and need-based application in combination with cultural, mechanical, biological and ecological methods. Ojumoola *et al*. (2022) similarly reported that farmers' knowledge and management practices are central to effective fall armyworm control in maize production, while the International Institute of Tropical Agriculture (2021) emphasized that effective management requires training on pest identification, field scouting, treatment windows, correct pesticide use, sprayer calibration and pesticide safety. Therefore, the result confirms that IPM effectiveness depends on how well farmers combine knowledge, monitoring and appropriate control decisions.

However, Table 3 further reveals that botanical pesticides such as neem extract with a mean score of 2.44, biological control/conservation of natural enemies with a mean score of 2.18, and use of pheromone traps with a mean score of 1.94 were perceived as not effective because their mean scores were below the decision mean of 2.50. This does not necessarily mean that these strategies are scientifically ineffective; rather, it may indicate poor farmer knowledge, limited use, poor access to inputs, inadequate training or incorrect application in the study area. For instance, botanical pesticides require proper preparation, concentration and timing before they can produce meaningful pest-control effects, while biological control and pheromone traps require technical support and availability of reliable inputs. The low effectiveness rating may therefore reflect weak exposure and poor practical application rather than the actual potential of these technologies. This finding is consistent with FAO's (2018) recommendation that Farmer Field Schools and learning-by-doing approaches are necessary for improving farmers' capacity to understand and apply technical IPM components. It also supports the argument that reliance on synthetic pesticides alone is not sustainable because pesticide misuse can cause resistance, environmental pollution and destruction of beneficial insects (Carvalho *et al*., 2013). The implication is that extension programmes should not only create awareness of IPM but also provide hands-on demonstrations on botanical pesticides, biological control, pheromone traps and correct pesticide-use practices so that farmers can experience their effectiveness under field conditions.

Determinants of IPM Effectiveness among Maize Farmers

Table 4 presents the binary logistic regression result on the determinants of IPM effectiveness among maize farmers in Edo State, Nigeria. The model was statistically significant, with a Chi-square value of 44.627 and a significance level of 0.000, indicating that the explanatory variables jointly influenced the effectiveness of IPM strategies among the respondents. The Cox and Snell R^2 value of 0.318 and Nagelkerke R^2 value of 0.452 show that the model explained a reasonable proportion of the variation in IPM effectiveness, while the overall classification accuracy of 78.3% indicates that the model had good predictive capacity. The negative constant value of -2.148 was significant at 5%, suggesting that in the absence of the selected explanatory factors, the likelihood of IPM strategies being effective would be low. This confirms that IPM effectiveness is not automatic; it depends on farmers' socioeconomic characteristics, institutional support and access to relevant pest-management resources. This finding is consistent with the view that IPM is knowledge-intensive and requires farmer education, technical guidance and access to appropriate technologies for effective implementation (Food and Agriculture Organization [FAO], 2018). The result also supports the study's methodological position

that IPM effectiveness is influenced by variables such as education, farm size, farming experience, extension contact, access to credit and IPM training. s

Table 3: Perceived Effectiveness of IPM Strategies in Reducing Pest Incidence and Crop Damage

IPM Strategies	Mean	SD	Rank	Remark
Early planting to escape pest infestation	3.18	0.91	1st	Effective
Regular field scouting/monitoring of pests	3.08	0.94	2nd	Effective
Judicious use of synthetic pesticides	3.05	0.94	3rd	Effective
Field sanitation/removal of crop residues	3.11	0.96	4th	Effective
Intercropping maize with other crops	2.92	0.97	5th	Effective
Crop rotation for pest reduction	2.83	0.99	6th	Effective
Use of resistant/tolerant maize varieties	2.73	1.03	7th	Effective
Use of recommended dosage and timing of pesticide application	2.69	0.16	8th	Effective
Handpicking and destruction of visible pests	2.59	1.01	9th	Effective
Use of botanical pesticides, e.g., neem extract	2.44	0.82	10th	Not effective
Biological control/conservation of natural enemies	2.18	0.99	11th	Not effective
Use of pheromone traps	1.94	0.96	12th	Not effective

Source: Field Survey, 2025.

The result further shows that all the explanatory variables included in the model had positive and significant effects on IPM effectiveness. Educational level had a positive coefficient of 0.421 and was significant at 5%, with an odds ratio of 1.523. This implies that an increase in farmers' educational level increased the likelihood of IPM strategies being effective by about 52.3%. Education improves farmers' ability to understand pest identification, read pesticide instructions, interpret extension messages and make informed decisions on pest-management practices. Farm size was also positive and significant, with a coefficient of 0.386 and an odds ratio of 1.471, meaning that farmers with larger farm sizes were more likely to experience effective IPM outcomes. This may be because larger-scale farmers are more commercially oriented and may have stronger incentives to protect their crops from pest damage. Farming experience was significant with a coefficient of 0.294 and an odds ratio of 1.342, indicating that experienced farmers were more likely to apply IPM strategies effectively because of their accumulated practical knowledge of pest occurrence, crop seasons and control responses. This agrees with Ojumoola *et al*. (2022), who reported that maize farmers' knowledge and management practices are central to effective fall armyworm control. Similarly, Wossen *et al*. (2023) observed that productivity improvement in Nigeria's maize sector is strongly linked to farmers' capacity to adopt improved practices and respond to production constraints.

Extension contact, access to credit and IPM training were also positive and significant determinants of IPM effectiveness. Extension contact had a coefficient of 0.768 and an odds ratio of 2.155, meaning that farmers who had contact with extension agents were more than twice as likely to achieve effective IPM

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outcomes as those without extension contact. Access to credit had a coefficient of 0.512 and an odds ratio of 1.669, suggesting that credit access increased farmers' likelihood of purchasing improved seed, pesticides, sprayers and other pest-management inputs needed for effective IPM implementation. IPM training had the strongest effect, with a coefficient of 0.893 and an odds ratio of 2.442, indicating that farmers who received IPM training were about 2.4 times more likely to use IPM strategies effectively. This is justified because IPM requires practical skills in pest identification, field scouting, threshold-based decision-making, correct pesticide application, biological control and environmental safety. FAO (2018) emphasized that Farmer Field Schools and learning-by-doing approaches are essential for improving farmers' ability to identify pests, monitor pest populations and select appropriate control measures. The International Institute of Tropical Agriculture (2021) also stressed the importance of training farmers and extension agents on fall armyworm identification, scouting, action thresholds, treatment windows, sprayer calibration and safe pesticide use. Therefore, Table 4 clearly shows that strengthening education, extension contact, credit access and IPM-specific training would improve the effectiveness of IPM strategies and promote more sustainable maize pest management among farmers in Edo State.

Table 4: Determinants of IPM Effectiveness among Maize Farmers

Variables	B	S.E.	Wald	df	Sig.	Exp(B)	Remark
Constant	-2.148	0.912	5.547	1	0.019	0.117	Significant
Educational level	0.421	0.176	5.721	1	0.017	1.523	Significant
Farm size	0.386	0.158	5.967	1	0.015	1.471	Significant
Farming experience	0.294	0.139	4.477	1	0.034	1.342	Significant
Extension contact	0.768	0.241	10.155	1	0.001	2.155	Significant
Access to credit	0.512	0.226	5.134	1	0.023	1.669	Significant
IPM training	0.893	0.267	11.187	1	0.001	2.442	Significant

Source: Field Survey, 2025.

2 Log Likelihood = 96.314; Cox & Snell R^2 = 0.318; Nagelkerke R^2 = 0.452; Chi-square = 44.627; df = 6; Sig. = 0.000; Overall classification accuracy = 78.3%

Conclusion

The study concluded that Integrated Pest Management (IPM) strategies are relevant and effective in improving maize pest management among farmers in Edo State, Nigeria. The findings showed that farmers had high awareness of several IPM practices such as early planting, intercropping, field sanitation, crop rotation, handpicking of pests, regular field scouting and judicious use of synthetic pesticides. These practices were also among the most frequently used and perceived as effective in reducing pest incidence and crop damage. This implies that maize farmers in the study area already possess a useful foundation for IPM adoption, particularly in relation to cultural, preventive and familiar pest-management practices. The effectiveness of these practices further confirms that IPM can contribute meaningfully to reducing pest pressure, minimizing crop damage and improving maize production outcomes when farmers apply the strategies correctly.

However, the study also revealed that the use and perceived effectiveness of some technical and ecological IPM components, such as biological control, pheromone traps, botanical pesticides and resistant/tolerant maize varieties, were relatively low. This suggests that IPM use among the farmers is still partial

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rather than fully integrated. The logistic regression result further confirmed that educational level, farm size, farming experience, extension contact, access to credit and IPM training significantly influenced the effectiveness of IPM strategies among maize farmers. Therefore, the study concludes that IPM effectiveness depends not only on farmers' awareness but also on their access to training, extension services, credit facilities, improved technologies and practical knowledge of pest-management decision-making. Overall, strengthening farmer education and institutional support will enhance sustainable maize pest management and reduce overdependence on synthetic pesticides. Therefore, the following recommendations are put forward: Agricultural extension agencies should intensify practical farmer training and field demonstrations on the less-used IPM components, especially biological control, pheromone traps, botanical pesticides, resistant maize varieties, field scouting and correct pesticide application. Government and agricultural development institutions should improve farmers' access to credit, improved maize seeds, pest-monitoring tools and IPM-related inputs so that farmers can apply integrated pest-management practices more effectively and sustainably.

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