

An Assessment of Farmers' Awareness of the Effects of Fall Armyworm Larvae (*Spodoptera frugiperda*) on Maize Yield and Control Strategies in Rural Kenya: A Case Study of Bondo Sub-County

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ABSTRACT

Kenyan Agriculture has faced a lot of challenges caused by various invasive insect crop pest. This has threatened the efforts of the Kenyan government in actualizing Sustainable Developments Goals (SDGs) towards agriculture. Invasion of insect pest in sub-Saharan Africa, particularly on the cereals crops is one of the major threat to their effective utilization. Although several methods have been utilized towards the control of these pests, optimum utilization is still a challenge. This is because Integrated Pest Management (IPM) strategies have been underexplored by the farmers. A survey was conducted in Bondo Sub-County, Siaya county, Kenya, among the maize farmers using questionnaire to assess farmers' awareness of the effects of Fall Armyworm (FAW), control strategies practiced in its management on maize yield. Among 62 respondents spread across the entire Sub-County, 9.7% of the respondents first learnt about FAW in the media (Radio, TV, internet and newspapers) and 56.5% learnt about FAW when their farms got invaded. 37.1% of respondents use insecticides in controlling FAW in their farms, 12% apply biological control strategies while 21 % use both chemical insecticides and biological control methods. However, approximately 29% of farmers are not sure of effective control strategies of FAW in farms. From the survey, it was established that the average bags of maize (50kg) produced per acre in Bondo sub-county when there is no invasion of fall army worm is 40 bags. However, when farms are invaded the average bags that can be produced in a single planting season is 17 bags. A paired t test statistical analysis was used to establish if there was a significant difference in the average no of bags of maize produced before and after FAW invasions. At $\alpha = 0.05$, t score was found to be 9.604 with a corresponding p-value < 0.001 . The result was found to be significant at $p < 0.05$. From this study, it was established that there is need to sensitize farmers about FAW management since it has adverse effect overall crop yield. It is therefore imperative for the Kenya Government and the development partners to prioritize farmer sensitization about FAW management strategies and best farming practices which are eco-friendly.

Key words: IPM, FAW, SDGs

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I. INTRODUCTION

A healthy, inclusive and sustainable food systems are key to achieving the world's development goals. Development in agriculture is a powerful tool that will end extreme poverty, increase shared prosperity and feed the rapidly increasing world's population projected at 10 billion by 2050 [World bank]. Humans, livestock and poultry use maize for food and other applications include bread making, corn syrups, corn flakes and corn oil [Khan et al, 2022].

Food and Agriculture Organization statistics (FAOSTAT) data shows that in the last decade the world produced approximately 1,036 billion tonnes of maize [Dragomir et al, 2022]. In Eastern and Southern Africa, maize is considered staple food to millions of people. However, the yield level is lowest in global ranking and the major setback behind this low production record are the insect pests [Ampofo, 1988].

Several insects have been reported to cause major losses in maize yield including the Fall Armyworm (FAW)- which is currently a major challenge in maize production. The estimated FAW infestation rate in Kenya is 47% translating to 1381kg/Ha maize yield loss. Due to high potential losses caused by FAW, a range of control methods have been proposed for practice by farmers [De Groote, et al, 2020]. However, the effect of FAW still remains a major challenge to maize farmers.

FAW is a native of Western Hemisphere and due to its broad host range and long-distance migration capability, FAW spread to Eastern Hemisphere over a remarkably short period of time initially in West Africa and later to Eastern and Southern Africa [Nagoshi et al, 2020].

In North Sumatra, FAW increase production cost by 4.2 % and reducing production cost by 26.6% wherein labour records the highest cost of production and rainfall and wind speed factors positively and negatively influence development of FAW [Girsang et al, 2020].

FAW is considered a serious polyphagous and destructive pest of maize, therefore, global maize production is still at risk [Bakry and Abdel, 2023]. Invasion of FAW in the Old World has potentially threatened food security and incomes of millions of small holder farmers [Chisonga et al, 2023]. FAW larvae feed on all developmental stages of maize growth; ears, tassels, silks and young leaf whorls leading to massive losses in grain yields [Omar, H. 2023].

FAW belong to class *Insecta* in the the genus *Spodoptera* now classified as *Spodoptera frugiperda*. The genus *Spodoptera* comprises of close to 31 species distributed in six continents. About 15 of these species are pests of numerous cultivated plants. FAW undergo four stages of life cycle consisting of eggs, larva, pupa and moth (adult). The life cycle is completed within 4 weeks [Kenis et al, 2022]. Crop development and abiotic factors such temperature and relative humidity also affects the development of FAW [Ahmad and Ibrahim, 2021].

Sustainable Agriculture is one of the developmental agenda of the Kenyan government as documented in its key Strategic Plans; vision 2030 and Sustainable Development Goals (SDGs). However, this premier national dream cannot be fully realized if farmers are not empowered with adequate information pertaining the global threats of invasive crop pests.

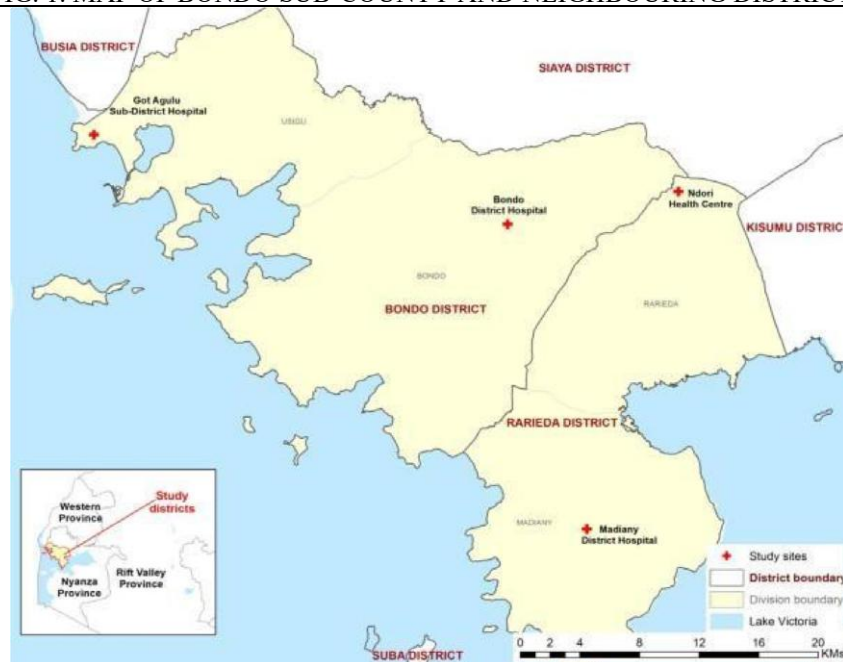
Despite the national and global concerns to contain the spread of FAW infestation and improve food production and security, control methods are limited to regular weeding, intercropping and chemical application [Ansa et al, 2021]. The use of chemicals in farms has been associated with poisoning cases that affects the environment [Rijal, S., 2019]. Adoption of Integrated Pest Management strategies (IPM) incorporating the use of biological control, host plant resistance, cultural control and safe pesticides has not been fully applied in Bondo Sub-county.

II. MATERIALS AND METHODS

Study site

This study was conducted in Bondo Sub-county, Kenya. Bondo sub-county has a total coverage of 1328 km². 577.2 km² is land surface and 751 km² is covered with water of Lake Victoria. The sub-county lies between latitude 0°26' and 0°90' South of the equator and from longitude 33°58'E and 34°35'W.

FIG. 1. MAP OF BONDO SUB-COUNTY AND NEIGHBOURING DISTRICTS



<https://www.researchgate.net/profile/Gabriel-Otieno/publication/260089122/figure/fig1/AS:202628148535297@1425321723150/The-map-of-Bondo-and-Rarieda-districts-with-study-health-facilities.png>

Study design

A cross-sectional study was conducted on maize growing farmers within Bondo Sub-county that were considered the study population.

Sampling and data collection

Based on the pilot study that was conducted in Usigu, Nyong'oma and Maranda villages, approximately 74 farmers could turn up for awareness outreach about FAW. From this data, it was concluded that there are approximately 74 active maize farmers in Bondo sub-county.

To calculate the sample size, **Slovin's formula** was used:

$$n = \frac{N}{1 + Ne^2}$$

Where:

- $N = 74$
- $e = 0.05$ (margin of error for 95% confidence level)

The sample size (n) was calculated to be 62 farmers.

A total of 62 farmers were randomly sampled across the three administrative divisions of Bondo sub-county; Usigu division, Maranda division and Nyang'oma division. A structured questionnaire, observation and interviews were used to gather data from the farmers.

Data management and analysis

Raw data from individual farmers collected through questionnaire were entered into Microsoft excel spreadsheet program to create a database. The data were then transferred to SPSS version 20 for subsequent analysis. The data were summarized using the descriptive statistics.

A paired t-test was used to analyze the comparison between the average bags of maize produced before and after FAW invasion. In all the cases, a 95% confidence interval (CI) and $p > 0.05$ were set for significance.

III. RESULTS

a) Farmers awareness

The findings show that farmers' awareness of Fall Armyworm (FAW) was largely influenced by direct experience with the pest. The majority of respondents, 56.5% (35 respondents), reported becoming aware of FAW when it invaded their farms. This was followed by respondents who obtained awareness from all three sources—fellow farmers, media channels, and personal experience—at 27.4% (17 respondents). Media channels accounted for 9.7% (6 respondents), while fellow farmers accounted for only 6.5% (4 respondents). These findings suggest that direct exposure to FAW was the major driver of awareness, indicating that many farmers may have had limited prior awareness before experiencing the invasion. This highlights the importance of strengthening proactive awareness and extension programmes so that farmers receive information on FAW identification, prevention, and management before outbreaks occur.

Table 1: Farmers awareness about FAW

Sources of awareness	Frequency	Percent	Valid Percent	Cumulative Percent
Fellow Farmer	4	6.5	6.5	6.5
Media Channels	6	9.7	9.7	16.1
When FAW invaded my farm	35	56.5	56.5	72.6
From all the three Sources	17	27.4	27.4	100.0
Total	62	100.0	100.0	

b) FAW Control Strategies Practiced by farmers

The findings indicate that insecticides were the most commonly reported strategy for controlling Fall Armyworm (FAW), accounting for 37.1% (23 respondents). Biological control was reported by 12.9% (8 respondents), while 21.0% (13 respondents) reported using both insecticides and biological control. Notably, 29.0% (18 respondents) were not sure about the appropriate control strategy. These findings suggest that chemical control remains the predominant approach to FAW management, while the relatively high proportion of respondents who were uncertain about control strategies indicates a need for increased farmer training and awareness on effective and integrated FAW management practices.

Table 2. FAW Control Strategies Practiced by farmers

Control Strategies	Frequency	Percent	Valid Percent	Cumulative Percent
Insecticides	23	37.1	37.1	37.1
Biological Control	8	12.9	12.9	50.0
Not Sure	18	29.0	29.0	79.0
Both Insecticides & Biological Control	13	21.0	21.0	100.0
Total	62	100.0	100.0	

c) Effects of FAW invasion on maize yield.

A paired-samples t-test was conducted to determine whether there was a significant difference in the average number of bags before and after FAW invasion. The results showed a statistically significant difference between the two periods, $t(61) = 9.738$, $p < 0.001$. The mean difference was 7.968 bags (95% CI: 6.332–9.604), indicating that the average number of bags was approximately 8 bags higher before FAW invasion than after the invasion. Therefore, FAW invasion was associated with a significant reduction in the average number of bags produced/harvested. Since $p < 0.001$, the null hypothesis was rejected.

Table 3. Paired Samples Test

Pair 1	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2tailed)
				Lower	Upper			
Average Bags before and after FAW invasion	7.968	6.443	.818	6.332	9.604	9.738	61	<.001

IV. DISCUSSION

Farmers awareness

The study established that 100% of farmers in Bondo sub-county are aware of FAW. In a study conducted in Zambia, 91% of farmers correctly identified fall armyworm, and reported it as the most important maize pest during 2016/2017 cropping season, affecting nearly half of cultivated area (Kansiime *et al*, 2019). Equally, in a separate study performed in Uganda, FAW was ranked as the most important insect pest by the majority of farmers from all the agro-ecologies (Odong *et al*, 2024). Farmers obtain relevant information about FAW from sources like training workshops and agricultural retail stores (Zhang and Peng, 2024).

This survey found out that 9.7% of the farmers received information about FAW invasion and management from different media that is, television adverts, newspapers, and social media such as Facebook. However, 27.4% received information from all the three sources.

In a separate study in Rwanda, the results indicate that exposure to the campaign channels (whether singly or in combination) is significantly correlated with improved knowledge of using cultural methods (rather than pesticides) as the first resort for managing FAW (Tambo *et al*, 2023). Further studies suggest that increasing

public awareness among the farmers facilitates timely management of FAW with focus on Integrated Pest Management (IPM) strategies like the combined use of chemical pesticides, biopesticides, biological control, cultural and physical methods [Rijal S. 2019].

This study established that information about FAW invasion and management obtained from peers during the meetings and agricultural workshops accounted for 6.5% of the sample size. Our results corroborate with the findings of a study which was carried out in Kakamega County, revealing how interpersonal communication channels like peers and agro dealers play a very crucial role in disseminating information about FAW management strategies [Chipango L. 2022].

It is believed that public education has a big effect on the effective management of FAW (Zhang and Peng, 2024). However, this survey brought to our understanding the divide in the association between social media and farmers' knowledge of invasive agricultural pests in Bondo Sub-County since 29% of respondents recorded lack of knowledge of appropriate methods of FAW management in farms. This has also been demonstrated by 56.5% of farmers who got to learn more about FAW when their farms got invaded by FAW.

Control Strategies

The study found that majority of the farmers use pesticides in FAW management practices (37.1%) while a few apply biological and other methods. This conforms with the studies of Makale et al, 2022, which reported predominant use of pesticides in FAW eradication in the regions of Botswana. The frequent use of chemical insecticides are associated with significant risks in human health, animal health, and environmental safety (Bezuidenhout and Nunkumar, 2017).

These synthetic chemicals used as crop protection mechanism has been associated with life threatening acute and chronic toxicities that can most probably result in significant mortality cases (Christensen et al., 2009; Kamrin, 1997). The adoption of eco-friendly methods of pest control in Bondo Sub-county is still low referenced to our survey that recorded low numbers of farmers practicing biological control strategies.

Effects of FAW on maize yield and economy

According to the study, the results showed a statistically significant difference between the two periods, $t(61) = 9.738$, $p < 0.001$. This outcome proved that 7.968 bags (17.5 %) of maize lost per ha during FAW invasion was significant. Relative to this study, All participants (100 %) perceived it as the most destructive insect pest affecting maize production at irrigation schemes in Limpopo province, South Africa (Pophi et al, 2026).

The infestation of FAW in maize is becoming a dangerous problem at present, and it may pose a threat to the future maize crop worldwide as yield loss is due to massive damages in young leaves, whorls, maize cobs or kernels that deprives maize of sufficient nutrition (Bakry and Abdel, 2023). Faw causes more damages to crops during the larval stages and they are actively feeding during the night hours and spread rapidly during the period of low humidity. [Ahmad and Ibrahim, 2021, Rijal S. 2019]. Regrettably, concerns are raised about little information in the literature about the assessment of the fall armyworm, *S. frugiperda*, damage on maize plant characteristics (growth characteristics and yield loss) in Egypt (Bakry and Abdel, 2023).

Study results published by EIAR, 2010 and EARO, 2001, revealed that infestation of maize by FAW lead to complete losses of products that affected both crops producers and consumers rendering them to serious food security problems in Ethiopia. Comparatively, our results (17.5 % yield loss per ha) reveals serious damages caused by FAW that threatens food security in Bondo sub-county.

V. CONCLUSION

We established that FAW invasion was significantly associated with reduction in maize production even though all the sampled farmers were aware of the presence of FAW. However, awareness was largely reactive rather than preventive, since a significant majority of the farmers reported that they became aware of FAW when their farms were invaded. This suggests that although general awareness of FAW exists among farmers, access to timely and reliable information on identification, prevention and management remains inadequate. The findings of this study implicated insecticides as the most commonly used method of FAW management among farmers, suggesting that chemical control remains dominant, while adoption and knowledge of integrated and environmentally friendly approaches are still limited.

VI. RECOMMENDATIONS

Specific interventions targeting farmer sensitization and extension services are therefore necessary for identification, prevention and management of FAW before outbreaks occur. Greater emphasis should be placed on biological control and other sustainable management approaches which are eco-friendly because their current adoption among farmers is relatively low.

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Contributions

Ouko Emanuel, Gabriel O. Ng'ong'a, Violet Atieno, Maricus Ahomo, Mary Mercy Ochieng' conceptualized the study, participated in its design and implementation, and wrote and reviewed the manuscript.

Ouko Emanuel and Gabriel O. Ng'ong'a took part in statistical analyses. All authors read and approved the final draft of the manuscript.

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Consent of publication

The authors affirm that participants provided informed consent for the publication regarding their data.

Competing interests

The authors declare that they have no competing interest.

Data Availability

Data for this study will be made available upon request.

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