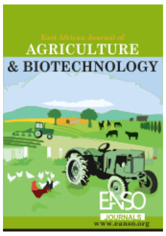

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Original Article

Contribution of Indigenous Innovations for Mitigating Fall Armyworm (*Spodoptera frugiperda* J. E. Smith) among Maize Farmers for Improved Food Security

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ABSTRACT

Fall armyworm (FAW) is a new invasive pest that causes economic damage to a wide variety of crops. This pest is estimated to reduce maize yields by about 60%. FAW could cause crop losses of up to US$13 billion annually across sub-Saharan Africa, threatening the livelihoods of millions of resource-poor farmers worldwide. Governments have warned against the indiscriminate use of chemical pesticides that could undermine pest control strategies for smallholder farmers who rely heavily on natural enemies. Since the invasion of this pest in Kenya, there had been limited studies conducted on indigenous innovations to tackle the challenges of FAW infestation. There has also been limited knowledge on the effects of the indigenous innovations adopted by smallholder farmers on crop production. A total of 150 farmers from Busia, Siaya, and Vihiga counties were purposely sampled and appropriately informed about the indigenous innovations they developed to address and leverage FAW challenges with the help of well-structured questionnaires. The impact of the indigenous innovations on crop production were evaluated. Analysis of quantitative data was performed using the Statistical Package for Social Sciences (SPSS) version 20. Results showed that households affected by FAW without indigenous methods in place were 11% more likely to experience food shortage, and their members had a 13% higher probability of going to bed hungry or going a whole day without eating, compared to households affected but with indigenous methods in place. Conversely, households that reported severe level of FAW infestation due to lack of indigenous methods in place, observed a 44% significant decrease in per capita household income and their members were about 17% more likely to go hungry relative to their unaffected counterparts. Finally, food security implications, we find that the affected households without control action had nearly a 15% higher likelihood of experiencing hunger, while their counterparts that applied control measures were 10% more likely to experience hunger, compared with households unaffected by FAW. Thus, while FAW infestations contribute significantly to hunger, the likelihood of hunger is lesser when a control measure is applied.

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INTRODUCTION

Sub-Saharan Africa (SSA) counts maize as the stable food, covering 36 million hectares and providing food and livelihoods for about 208 million people in the region (Macauley, 2015; FAOSTAT, 2018). Unfortunately, since 2016, the maize invasion by fall armyworm (FAW), *Spodoptera frugiperda*, has exacerbated an already fragile food system and food security in the region (De Groote et al., 2020; Hruska, 2019; Otim et al., 2021), as a result threatening the livelihoods of many farmers who depend on maize production for their income and food security (Goergen et al., 2016; Abrahams et al., 2017). Farm-level estimates in some SSA countries show that FAW causes maize yield losses ranging from 11% and 67% (Baudron et al., 2019; Abrahams et al., 2017; De Groote et al., 2020; Kassie et al., 2020; Kumela et al., 2019; Rwomushana et al., 2018; Overton et al., 2021). FAW prevalence also brings additional costs to the use of pesticides and the labour required to control pests (Kassie et al., 2020; Tambo et al., 2019; Yang et al., 2021).

Maize is Kenya's most important staple food crop contributing significantly to food, nutrition, and economic security (Macauley, 2015; FAOSTAT, 2018). In Kenya, more than 10 million people suffer from chronic food insecurity and malnutrition, about 7.5 million live in extreme poverty and four million require emergency food assistance (ASCU, 2011). FAW can cause yield losses of 21-53% of annual maize production (Abrahams *et al*., 2017). Therefore, there is a need to improve and secure Kenya's food sector.

SSA countries use insecticides as the primary FAW control strategy (Harrison et al., 2019). This necessarily means more than reducing corn production losses. Pesticide pollution can have adverse effects on the environment, biodiversity, and health of producers and consumers (Gautam et al., 2017; Lai, 2017). Chemical pesticides are expensive for smallholder farmers and most of them are hesitant to invest in pest control tactics (Morris & Thomson, 2014). This strategy becomes increasingly ineffective and fails to adequately control *S. frugiperda.* (Hardke *et al*., 2015). Further research is therefore needed to identify other affordable, environmentally friendly, on-farm available, and effective indigenous innovations that Kenyan farmers have employed to combat this pest. Physical crushing of larvae, moths, and egg masses and use of ash and liquid detergents to control FAW have been used in various other African countries (Rwomushana et al., 2019). However, no systematic studies

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have been documented to assess their impact and contribution to food security. Despite the importance of FAW, studies on the economic impact of FAW on production, management costs, including the cost of pesticides and the perceived impact of these indigenous innovations on crop yields are limited. Thus, this study, assessed the effect of those indigenous innovations on crop production and to assess the contribution of indigenous innovations to food/nutritional security.

MATERIALS AND METHODS

Study Area

The study was conducted in western Kenya; Busia, Siaya, and Vihiga Counties, representing different agro-ecological characteristics. These regions consisted of small-scale farmers who actively practiced maize farming. Additionally, these counties were invaded by Fall Armyworms, according to (KALRO, 2017). Siaya County had a total population of 841,682 people (KPHC, 2009), annual rainfall of 1500-1900 mm, and annual mean temperatures of 21.8 °C - 20.9 °C. The County had an altitude of 1300-1500 m above sea level. The second area of study was Busia County which has a population of 743,946, with an area of 1,694.5 square kilometres (km^2). It lies between 0° and 0°45° north latitude and 34°25° east longitude. The elevation is undulating, rising from about 1,130 meters (m) above sea level to a maximum of about 1,500 meters (m). The annual rainfall in Busia County ranges from 760 millimetres (mm) to 2000 mm. Temperatures throughout the county are fairly uniform. The third study area was Vihiga County, located between 34°30'E and 35°0'E, and between 0°N and 0°15'N. Have a population of 554,622 with an altitude range of 1300 m to 1800 m above sea level. Temperatures range from 14 °C to 32 °C with an average temperature of 23 °C.

Research Design

The study adopted cross-sectional survey using a mixed-method research design involving collecting data using both quantitative and qualitative approaches. A cross-sectional study was used for its economic advantage in quantitative data collection. This was also in support of the Sedgwick (2014) study, which revealed that cross-sectional studies are quick, easy, and cheap to perform as they are often based on questionnaire surveys. There is no loss of time in follow-up since respondents are interviewed only once.

Sampling Procedure and Sample Size

Sampling Procedure

The three counties were selected for the study based on the farming activities undertaken in cluster wards of Busia, Siaya, and Vihiga. Due to the diverse geographical area of the study area, sampling was done in three stages, with the first phase being multi-stage, dividing smallholder farmers into Counties. This was consistence with Dhanai et al. (2019) study, which used multistage and random sampling methods to arrive at the respondents. The second phase consisted of stratified sampling which divided counties into strata, with each sub-county forming a stratum; hence three strata were formed. The third phase used simple random sampling to select households, where each smallholder maize farmer had an equal chance of being selected for the interviews from the three targeted sub-counties. Purposive sampling was employed to decrease the amount of data to a manageable number.

Sample Size Determination

The study employed Cochran (1977) sample size calculation formula because it allows a sample size to be obtained from a finite or known population to arrive at a representative number of respondents, as shown below:

$$n = \frac{z^2 N p(1-p)}{(e^2 N) + (Z^2 p[1-p])} \quad (1)$$

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Where: n = Sample Population, N = Population (170), Z = 1.96 (95% confidence level), P = Population sample proportion of 0.5 (50%) to provide maximum sample size, e = 5% (0.05) acceptable error margin

Data Collection

Quantitative data was collected using a questionnaire placed on the KoBo-Collect digitized platform software app that was uploaded on an android phone and used to examine the indigenous innovations for mitigating the fall Armyworm menace among smallholder farmers. The questionnaire was structured into different section: Household characteristics and demography, knowledge about Fall Armyworms, and the indigenous innovations that they have come up with for tackling the challenges of Fall Armyworms in their farms. The effects of the local innovations adopted by farmers on crop production, the economic effects of FAW invasion, and their contribution to food security.

Data Analysis and Interpretation

Data was analysed using quantitative analysis techniques and summarized using percentages, frequency distributions, means, tables, and models. The first objective sought the identification indigenous innovations and data analysed using descriptively. The researcher determined the variables' degree of association and cause-effect relationship using probit regression model for objective 2 and 3 by coded data from the Likert scaled questions and other questions within the questionnaire. Data was analysed using the Statistical Package for Social Sciences (SPSS) version 20. This tool enabled the researcher to determine the correlation coefficient between the independent and dependent variables. We also showed that a relationship exists and the strength of the relationship between each independent and dependent variable.

Statistical Model and Analysis for the FAW effects on economy and food security.

The main objective of this paper was to estimate the effect of FAW on household income and food security. This can be expressed as:

$$\mathbf{Y_i = \alpha + \beta + \Phi FAW_i + €_I \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)}$$

where y_i represents the indicators of income and food security of household i; x_i is a vector of control variables, with the associated parameters β; FAW_i is a dummy variable equal to one if household crop production was affected by FAW and zero otherwise; and €i is a random error term. We are particularly interested in the coefficient Ψ, which measures the effect of FAW on the household income and food security. We hypothesise that FAW infestation is significantly associated with lower household income and food security, but the adoption of control strategies can reduce these negative outcomes.

To assess food security, we used items from the household hunger scale (HHS). The HHS is a simple perception-based measure of the access dimension of food security. It is a subset of the household food insecurity access scale (HFIAS) and has been validated for cross-cultural use (Ballard et al.,2011). It is based on three questions that reflect severe food insecurity experiences. The questions include whether or not in the past 30 days: (1) there was no food of any kind in the house; (2) a household member went to sleep hungry; and (3) a household member went a whole day without eating, due to lack of resources. Our main food security indicator (hunger) is a binary variable that is equal to one if a household responded ‘yes’ to any of these three HHS questions and zero otherwise. In addition, we separately examined responses to the three questions.

The control variables (xi) include household characteristics (e.g., age, gender, and education of the house hold head and household size); maize plot area; wealth and institutional-related factors (e.g., wealth index, access to credit and off-farm activities, group membership and proximity to inputs and extension information. The choice of

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these control variables was motivated by previous literature on the economic impact and management of FAW (e.g., Kassie et al., 2020).

In equation 1 above, all FAW-affected households were lumped together (regardless of whether or not they implemented a control strategy) and compared with unaffected households. To analyze the potential mitigating effect of the adoption of control practices, we re-express equation 1 as:

$$Y_i = \alpha i + \beta xi + \Phi FAW1i + \Phi FAW0i + €_I \text{ ………………………………………………..(2)}$$

where FAW1 and FAW0 represent FAW-affected households who did or did not implement a control strategy, respectively. The coefficients ϑ and δ compare the income and food security levels of these two groups of FAW-affected households with those of households unaffected by the pest. While FAW shock is reasonably exogenous, a household's decision to implement a control strategy is potentially endogenous. For instance, it is possible that some unobservable factors influence both the decision to implement a FAW control strategy and our outcome variables; hence, using OLS or probit regression models may yield biased estimates. Consequently, to address the potential endogeneity problem in equation 2, we employed the control function approach (Wooldridge, 2015). The control function approach involves two steps. First, a reduced-form probity model for the adoption of a FAW control strategy was estimated to obtain the generalized residual. The control variables are similar to those included in xi in equation 2, but we also require at least one instrumental variable that affects households’ decisions to adopt a FAW control strategy but is not directly correlated with our outcome variables.

Ethical Approval

This study was ethically reviewed and permitted by the Ethical Review Committee and Board of Postgraduate Studies of Jaramogi Oginga Odinga University of Science and Technology (JOOUST). Permission to collect data from the study county was obtained from Board of Graduate Studies. Consumers who took part in the study completed consent forms and were assured of anonymity.

RESULTS

4.2 Statistics of surveyed small-scale farmers

Descriptive statistics Table 4.2 below shows that 53% of the households reported experiencing FAW attack on their crops during the 2021/2022 cropping season. While maize was the most affected crop, about 7% of the FAW-affected households also mentioned sorghum, and other crops infested by the pest. The average age of the farm household heads in our sample was about 49 years. Nearly two-thirds of the households were headed by male who had attained at least secondary level of education. The average maize farm size was roughly two hectares, reflecting a sample of smallholder maize-growing households. Maize was generally grown as a sole crop, with only 5% of the sampled households intercropping it with other crops (mostly groundnut, common bean or cowpea).

Data also suggest limited access to institutional support services in the study area. For instance, only 20% and 39% of the households had access to credit and off-farm income-generating activities, respectively. Moreover, only about one-sixth of the households had participated in farmer-based groups. One-third of the households relied on extension workers for information on FAW, while only 7% obtained similar information from neighboring farmers.

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Table 4.1 Summary statistics of surveyed households.

Variables	Description	Mean	SD
Fall armyworm	Household experienced fall army worm attack on crops (1/0)	0.53	0.50
Age	Age of household head (yrs)	48.65	17.06
Gender	Gender of household head (1=male)	0.66	0.47
Education	Household head has secondary education (1/0)	0.64	0.48
Household size	Number of household members	6.51	5.19
Maize area	Total area planted with maize (hectares)	2.22	5.83
Off – farm activity	Household member has off-farm activity (1/0)	0.39	0.49
Credit access	Household has access to credit (1/0)	0.20	0.40
Wealth index Di	Household wealth index	-0.01	1.52
Farmer group	Household member belongs to a farmer group (1/0)	0.17	0.37
FAW info from extension	Household received info on FAW from an extension agent (1/0)	0.33	0.47
Faw info from neighbors	Household received info on FAW from neighbors (1/0)	0.07	0.25
Siaya	Household located in Siaya	0.15	0.35
Busia	Household located in Busia	0.15	0.35
Vihiga	Household located in Vihiga	0.19	0.40

**The wealth index was computed based on household ownership of 10 durable assets using principal component analysis (Filmer & Pritchett, 2001).*

Indigenous Methods for Tackling the Challenges of Fall Armyworms (FAW)

From *Table 1*, it can be seen that there are different types of indigenous innovations; these are biological methods, physical methods, chemical methods, and other indigenous methods. It can be concluded that a majority of the respondents (70, 56%) utilize the other local indigenous innovations, which include handpicking, wood ash, aloe Vera paste, and cow's urine. Physical methods of indigenous innovation followed with 30 respondents utilizing it; this accounts for (24%) of the respondents. Biological methods were the least utilized, with only 25 respondents, who accounted for (20%). Throughout the research, no respondent used the chemical methods.

Table 1: Indigenous methods used

	Frequency	Percent
Biological methods	25	20.0
Other indigenous innovation	70	56.0
Physical methods	30	24.0
Total	**125**	**100.0**

Economic losses associated with Fall armyworms in the study

The examination on the economic loss was determined by the differential effects of the pest disaggregating the affected households into two groups based on self-reported severity of FAW infestation. A household was considered to have experienced minor FAW infestation if it reported the use of any indigenous innovation and the cultivated area was quarterly affected with FAW

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during the season under study, while severe infestation denotes that at least half of the farm area was attacked by the. According to the data, about 24% and 29% of the households suffered from FAW infestation, respectively, and these were compared with the farmer who applied indigenous innovations (47%) in the disaggregated analysis below. **Table 4.2** below, presents the estimation results of the impact of FAW, disaggregated by the level of infestation. The coefficients on the minor infestation variable have the expected signs but are statistically insignificant, suggesting that households that observed minor FAW infestations due to indigenous methods did not suffer significant reductions in incomes and economic resource compared to households that were unaffected by the pest. On the other hand, households that reported severe infestation were significantly worse-off in terms of all our outcome indicators. In particular, households that experienced severe FAW attack achieved 64% and 44% significant declines in per capita maize and household income, respectively.

Table 4.2 FAW food security damage through maize and hunger parameters.

	Ln (Maize income/capita)		**Ln (HH income/capita)**		**Hunger (1/0)**	
	Coefficient	Percentage effect[c]	coefficient	Percentage effect[c]	Coefficient	Marginal effect (%)
Minor FAW infestation[a]	-0.210(0.363)	-24.07	-0.007(0.226)	-3.24	0.321(0.230)	7.10
Severe FAW infestation[a]	-0.920**(0.432)	-63.69	-0.531*(0.309)	-43.92	0.687***(0.212)	16.61
Control variables included[b]	yes		Yes		yes	
No. of observations	150		150		150	
Estimation method	OLS		OLS		Probit	

*Note: Robust standard errors in parenthesis*minor infestations due to indigenous innovations *severe infestations due to no indigenous innovations.*

Maize Yield Before the Invasion

From *Table 2* below, it can be seen that before the adoption of indigenous methods of preventing Fall armyworms or before the invasion, a majority of the respondents (105, 84%) harvested between 2 to 5 bags of maize; the respondents who harvested bags less than one were 14 (11.2%). Six respondents harvested more than five bags of maize, they accounted for 4.8% of the sample under study.

Table 2: Bags of maize harvested before the invasion

Bags of maize	**Frequency**	**Percent**	**Cumulative Percent**
<1	14	11.2	11.2
>5	6	4.8	16.0
2—5	105	84.0	100.0
Total	125	100.0	

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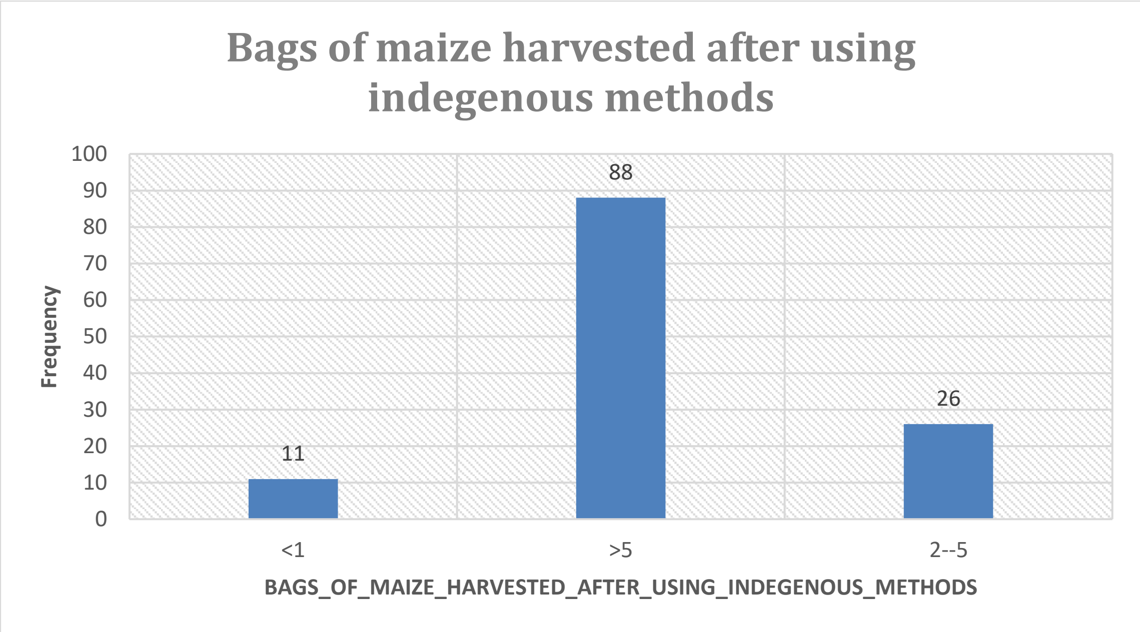
Maize Yield After Invasion

From *Figure 1* below, it can be seen that after the adoption of indigenous methods of preventing Fall armyworms or before the invasion, a majority of the respondents (88, 70.4%) harvested above five bags of maize; the respondents who harvested bags between 2 and 5 were 26 (20.8%) of the sample, a total of 11 (8.8%) of the respondents harvested less than one bag of maize.

Figure 1: Bags of maize harvested after using indigenous methods



Contribution to Food Security among Farmers

Table 4.5. Effects of no Indigenous innovation towards food security

	Run out of food		Went to bed hungry		Whole day without eating	
	Marginal effect	Robust SE	Marginal Effect	Robust SE	Marginal Effect	Robust SE
Fall armyworm	0.113***		0.129***	0.039	0.130***	0.038
Age	0.003***	0.041	0.002	0.001	-0.003**	0.001
Gender	-0.010	0.001	-0.018	0.043	-0.036	0.042
Education	-0.052	0.046	-0.015	0.042	0.017	0.040
Household size	0.004	0.043	0.004	0.004	0.005	0.003
Maize area	-0.064***	0.004	-0.052**	0.022	-0.037**	0.017
Wealth index	-0.067***	0.023	-0.068***	0.020	-0.075***	0.018
Off-arm activity	0.022	0.020	-0.026	0.040	-0.022	0.039
Credit access	-0.081	0.043	-0.073	0.057	-0.075	0.056
Farmer group	0.079	0.060	0.017	0.055	0.010	0.054

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Distance to agro-dealer	0.000	0.057	0.000	0.002	0.000	0.002
Distance to extension	-0.004	0.002	-0.004	0.003	-0.005	0.003
Siaya	0.153*	0.002	0.154*	0.081	0.059	0.077
Busia	0.027	0.084	0.028	0.072	0.044	0.073
Vihiga	-0.120	0.080	-0.059	0.071	-0.060	0.072
No. of observation	150	0.076	150		150	

Contribution of indigenous innovations

The results for the heterogeneous welfare effects according to whether the FAW-affected households implemented control practices are presented in **Table 4.7** We observe that FAW-affected households that did not put in place any control intervention obtained about 65% and 51% lower per capita maize and household income, respectively, compared to households that were not affected by the pest. These effect sizes are statistically significant. On the contrary, the unaffected households did not achieve significant income gains relative to the FAW affected households that implemented control measures. In terms of food security implications, we find that the affected households without control action had nearly a 15% higher likelihood of experiencing hunger, while their counterparts that applied control measures were 10% more likely to experience hunger, compared with households unaffected by FAW. Thus, while FAW infestations contribute significantly to hunger, the likelihood of hunger is lesser when a control measure is applied.

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Table 4.7. Overall contribution of indigenous innovations to food security.

	Ln (Maize income/capita)		**Ln (HH income/capita)**		**Hunger (1/0)**	
	coefficient	Percentage effect[c]	Coefficient	Percentage effects[c]	Coefficient	Marginal effect (%)
Affected by FAW but did not apply a control measure[a]	-0.955**(0.486)	-65.36	-0.630*(0.353)	-50.78	0.621**(0.281)	14.44
Affected by FAW but applied a control measure[a]	-0.091(0.562)	-20.41	0.419(0.344)	42.78	0.428**(0.296)	9.94
Control variables included[b]	yes		yes		yes	
No. of observations	150		150		150	
Estimation method	Control function		Control function		Control function	

Note: Bootstrapped standard errors in parentheses

** and ** represent 10% and 5% significance level, respectively*

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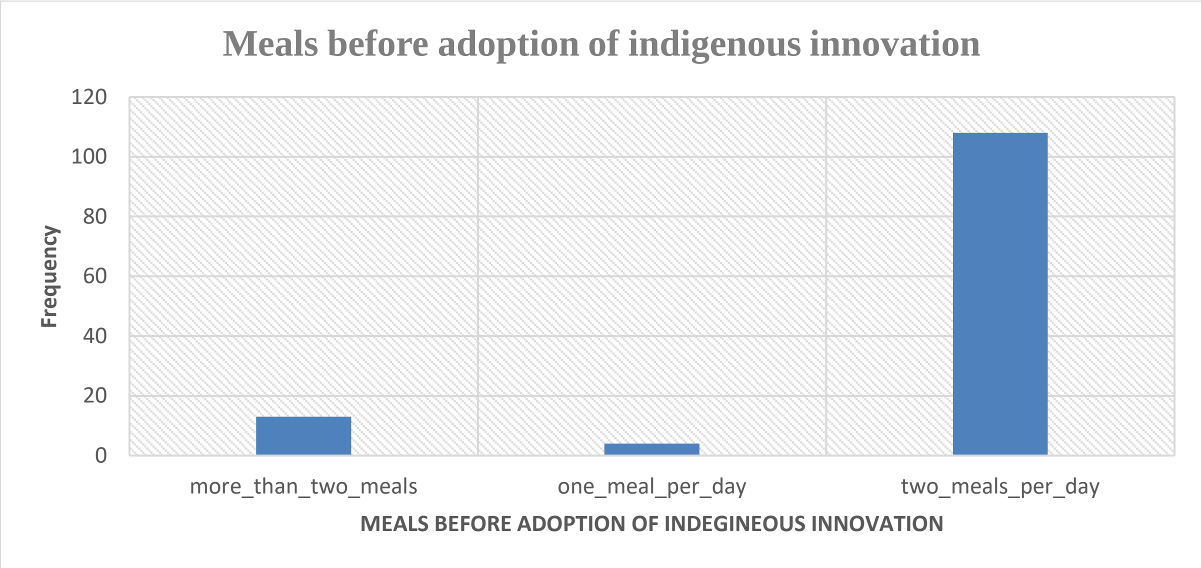
Meals Before Adoption of Indigenous Innovation

Figure 2 below, it can be seen that before the adoption of indigenous innovation, a majority of the farmers (108, 86.4%) took two meals per day. The respondents who took more than two meals per day were 13 (10.4%). Farmers or respondents who took one meal per day were the least (4, 3.2%).

Figure 2: Meals before adoption of indigenous methods



Meals After Invasion (After Adoption of Indigenous Methods)

From *Table 3* below, it can be seen that before the adoption of indigenous innovation, a majority of the farmers (104, 83.2%) took three meals per day. The respondents who took two meals per day were 20 (16%). Farmers or respondents who took one meal per day were the least (1, 0.8%).

Table 3: Meals After Adoption of Indigenous Methods

Meals taken	Frequency	Percent	Cumulative Percent
One	1	.8	.8
Three	104	83.2	84.0
Two	20	16.0	100.0
Total	125	100.0	

DISCUSSIONS

From the binomial logistic regression model, it was found that 66.4% of the variation in the awareness of Fall armyworms pests can be explained using the independent variables which were Age, Gender, Level of education, Farm size, Employment status, and income.

The indigenous methods used in managing FAW have also been identified and grouped as biological, physical, chemical, and other local methods like hand picking, wood ash and aloe vera paste. As for the methods, the research observed that most of the farmers use other indigenous methods which were cheaper, followed by the physical methods then the biological methods. Chemical methods have not been used according to the research because it is very expensive and not friendly to the environment. Accordingly, (Mwiinga et al., 2022), suggested that public be aware of insects' role in food security instead of labelling all insects as pests and exacerbate synthesised chemical-usage in the environment.

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In this connection, many alternative control methods to pesticides have been tried and tested. For example, the push-pull method intercrops maize with repellent plants surrounded by attractants. This technique is particularly effective against the FAW in a study conducted in Kenya (Midega et al., 2018). Furthermore, efforts have been made to generate resistant plants, but with conflicting results (Davis et al., 1995). Another established method is the use of pheromone traps, which have been tested in many locations in the Americas. However, its effectiveness is a controversial issue.

There is also evidence that the Fall Army worms have brought about losses economically and also in the crop output. This can be seen by the difference in the bags of maize harvested before adoption of indigenous methods and after the adoption of the indigenous methods. The bags or maize harvested have greatly increased after farmers adopted the indigenous methods of managing the Fall Army worm pests from the period before the methods were adopted. Food and nutritional security have also been increased and guaranteed after the adoption of indigenous methods to manage the fall army worms. This can be clearly explained by the increase number of meals per day by the farmer after adoption of the indigenous methods compared to the period before the adoption of the method. Interest by researchers have increased to investigate farmers perceptions of FAW and management practices (Midega et al., 2018). For example, using survey data conducted in Ethiopia and Kenya, Kumela et al. (2019) found that nearly every farmer experienced FAW attack on their farms and had subsequently adopted control practices such as the use of synthetic pesticides and plant extracts, handpicking of larvae, and applying soil to maize whorls. The present study contributes to the existing literature in the following ways: (1) identifying other indigenous innovations for tackling the challenges of fall armyworm; (2) assessing the effects of indigenous innovations on crop production (3) analysing the economic losses associated with fall armyworms and (4) assessing the contribution of indigenous innovations to food/nutritional security.

CONCLUSION

Farmers in the study area were aware of fall armyworm and were able to correctly identify them based on their morphology and feeding behaviour. Farmers identified the larval stage more than other stages of FAW as it was the damaging stage. Management of this pest has been primarily through the use of chemical pesticides. This was partially motivated by the government's initial free supply to respond to the outbreak. These chemical pesticides were expensive but not very effective. As such, farmers have adopted a number of indigenous innovations, such as pouring ash and sand into swirls of plants and soaking them in tobacco, neem, and soap detergents, some of which have had considerable success. Farmers believed that the expected decline in maize yields was primarily due to the fall armyworm invasion. The majority of farmers had access to external sources of information, such as advisors, radio/television, and informed neighbours and family members.

The researcher also found out that Age positively affects and is associated with the likelihood of a farmer’s awareness of the Fall army worm. Gender had a negative effect to the FAW awareness, level of education had a positive relationship and hence a more learned a farmer is, the more likely he is aware of the Fall army worm pests. The size of the land owned by a farmer had negative relationship to his awareness and therefore the larger the land, the less likely he is aware of the Fall armyworm pests. Income also had a positive effect to the farmers awareness of Fall army worm pests and thus, the more money he or she had, the more likely he or she is aware of the fall army worm pests. Farmers deployed a variety of indigenous innovations to control FAW, some of which have met with some degree of success. Most of these options are inexpensive, easily accessible, and user-friendly. The researchers should test and validate these options and package these technologies as one of the management options for FAW and be

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disseminated to other farmers who may not be aware and be encouraged to use them to reduce the cost on FAW management. The government through with the ministry of Agriculture, should partner with other private agricultural research institution and come up with programs that will create awareness on the Fall army worm pests and proper ways to manage them.

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