

**ASSESSMENT OF FARMERS' KNOWLEDGE AND PERCEPTION ON THE FALL
ARMYWORM PEST INFESTATION ON MAIZE CROP IN NSINZE SUB-COUNTY
NAMUTUMBA DISTRICT, EASTERN UGANDA**

ISIKO ERIC

REG. NO: BU/UP/2020/0577

**A DISSERTATION SUBMITTED TO THE DEPARTMENT OF AGRICULTURE, IN
PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE
BACHELOR'S DEGREE OF SCIENCE EDUCATION OF BUSITEMA UNIVERSITY**

DECEMBER, 2023

DECLARATION

DECLARATION

I ISIKO ERIC strongly declare to the best of my knowledge that this dissertation is my original work and it has never been produced by any another individual or institutions for any academic award. It has been my personal efforts and good will from Almighty God to come up with such material.

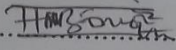
Signed: Isiko Eric

Date: 22/07/2024

APPROVAL

APPROVAL

This dissertation titled "Assessment of Farmer's Knowledge and Perception on the Fall Armyworm Pest Infestation on Maize Crop in Nsinze sub-county Namutumba District, Eastern Uganda", was written by Isiko Eric under our guidance and supervision and meets the requirements set by Busitema University for the award of Bachelor of Science Education. It has been submitted with approval of the University supervisor.

Signature..... 

Date..... 22/01/2024

MR. Otema Patrick Ben Emoi

Supervisor

DEDICATION

This Research Project Report is dedicated to my beloved father Mr Kawanguzi Charles and lovely mum Mrs Namumbya Monica. May the Almighty God bless them abundantly for their support towards my academic journey.

ACKNOWLEDGEMENT

I dearly acknowledge the Almighty God for his great love and grace that enabled me to complete this dissertation successfully. I wish to thank the management and administration of Busitema university Nagongera campus (BUSNC) for giving me a privileged opportunity to pursue excellent in my studies in the university. My great appreciation also goes to my **supervisor Mr. Otema Patrick Ben Emoi** for professional guidance; availability and timely editing of my work which enabled me to complete my work in time. I would like also to thank discussion group members Mr. Liboti Ibrahim, Mr. Ahumuza Derick and Mrs Twanza Asinancy for their encouragement, moral, material and technical support. My appreciation also goes to all those who assisted me in one way or another in gathering data. I would also like to thank Lecturers who took us through the course, the head of department agriculture **Mr Dramadri Afayo Gerald**, for the encouragement and entire staff for their dedication and hard work in their service offered to me during the course.

ACRONYMS

FAW-Fall Army Worm

IPM- Integrated Pest Management

NGO- Non-Government Organization

NARO- National Agriculture Research Organization

FO- Farmers Organization

NAADS- National Agriculture Advisory Services

FAO-Food and Agricultural Organization

IPPC- International Plant Protection Convention

CABI- Centre for Agriculture and Bioscience International

ABSTRACT

This study assessed farmers' knowledge of *Spodoptera frugiperda* (fall armyworm), their perceptions and management practices of the worm in Nsinze Sub- County. Data was collected through a survey of 110 maize farmers. 57.3% of farmers recognized *S. frugiperda* damage, 31.7% of them were able to identify its larvae, and 93.9% of the maize fields were infested. According to farmers, the perceived yield losses amounted to 797.2 kg/ha of maize, representing 49% of the average maize yield commonly obtained by farmers. Most farmers (86.5%) used synthetic pesticides and 9.1% of them used botanical pesticides like Veronia, which they found more effective than synthetic pesticides. More research is required to further understand the effectiveness of botanical pesticides made by farmers against *S. frugiperda* and to refine them for scaling-up.

TABLE OF CONTENTS

DECLARATION	i
APPROVAL	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
ACRONYMS	v
ABSTRACT	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	ix
LIST OF FIGURES	x
1.0 CHAPTER ONE: INTRODUCTION	1
1.1 Background of the study	1
1.2 Statement of the problem	4
1.3 Objectives of the Study	5
1.3.1 General Objective	5
1.3.2 Specific Objectives	5
1.4 Research Questions	6
1.5 Hypothesis of the study	6
1.6 Justification of the study	6
1.7 Significance of the study	7
1.8 Scope of the Study	7
1.9 Conceptual frame work	8
2.0 CHAPTER TWO: LITERATURE REVIEW	9
2.1 Introduction	9
2.2 Farmers Knowledge on Fall Armyworm	9
2.3 Damages caused by fall armyworms	10
2.4 Management practices of fall armyworms	11
3.0 CHAPTER THREE: METHODOLOGY	14
3.1 Introduction	14
3.2 Study area	14
3.3 Research Design	14
3.4 Study Population	14

3.5 Sample Size	15
3.6 Sampling techniques	15
3.7 Data collection.	16
3.7.1 Interview Guide	16
3.7.2 Questionnaire	16
3.7.3 Observation	16
3.8 Procedure of data collection	16
3.9 Data quality control methods	17
3.9.1 Validity	17
3.9.2 Reliability	17
3.10 Data analysis	17
3.11 Ethical considerations	17
3.12 Limitation to the study	18
4.0 CHAPTER FOUR: DATA PRESENTATION	19
4.1 Presentation of the Background information	19
4.2 Farmers' Knowledge and Perceptions of <i>S. frugiperda</i> Attacks	20
4.3. Damage Caused by <i>S. frugiperda</i>	21
4.4 Farmers' Management Practices	22
5.0 CHAPTER FIVE: DISCUSSION OF THE RESULTS	24
5.1. Farmers' Knowledge and Perceptions of <i>S. frugiperda</i> Attacks	24
5.2. Damage Caused by <i>S. frugiperda</i>	24
5.3. Farmers' Management Practices	25
6.0 CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS	27
6.1 CONCLUSION	27
6.2 RECOMMENDATION	27
REFERENCES	28
APPENDICES	32
APPENDIX 1: QUESTIONNAIRE TO FARMERS	32
APPEDIX 2: MAP OF THE AREA OF STUDY	35
APPENDIX 3: BUDGET	35
APPENDIX 4: WORKPLAN	36

LIST OF TABLES

Table 1. Descriptive statistics of the socio-economic profiles of the surveyed farmers	19
Table 2: Farmers' knowledge and perceptions of <i>S. frugiperda</i>.	21
Table 3. Indicators of damage caused by <i>S. frugiperda</i> according to farmers.	22
Table 4. shows the management practices used by farmers.	23

LIST OF FIGURES

Figure 1: Gender of the respondents..... 20

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background of the study

The Fall armyworm (*Spodoptera frugiperda*), an insect pest of more than 353 plant species, affects cultivated crops like maize, rice, sorghum, cotton, and vegetable crops because they are economically significant (Tiwari, 2022). The most popular host is maize (Paulson et al., 2017). The pest has been found in Africa in two strains: the maize strain and the rice strain, with the maize strain being the more prevalent and pervasive of the two (Pardey et al., 2022). The ideal temperature for larval growth is around 28°C for the tropical species *S. frugiperda*, which is acclimated to warm climates (Yan, 2022).

According to Ndiaye et al. (2018), this pest was initially discovered in Benin, Nigeria, Sao Tome & Principe, and Togo in January 2016. According to (De Simone et al., 2021), the pest has already moved to a number of sub-Saharan African nations, including South Africa, Ghana, Kenya, and Uganda. According to (Mack & Lonsdale 2001) predict that the insect will continue to spread to new nations. The African continent's tropical climate and abundance of host plants offer the Fall army worm's optimal circumstances for permanently building up sizable populations (Malo & Hore 2020).

According to Tefera et al. (2023), Fall Army Worm infestation in Africa is thought to result in annual losses of up to 17.7 million tonnes of maize, 40% of the yield losses in maize are related to the FAW; however, several nations report varying numbers. For instance, estimated a 47.3% loss in Kenya, 9.4% in Zimbabwe, and 22-67% in Ghana and Zambia. Although there are no actual yield loss data for Uganda, losses for maize in the various areas are said to be between 15 and 75 percent (Kumar & Kalita, 2017).

Synthetic insecticides and genetically modified crop types are the main management strategies employed in America to combat *S. frugiperda* (Ferré et al., 2008). According to numerous research, *S. frugiperda* is resistant to a number of pesticides, including carbamates, pyrethroids, and organophosphorus. Additionally, recent research has demonstrated *S. frugiperda* resistance to a number of genetically engineered maize cultivars. As a result, alternative approaches that employ natural enemies and botanicals instead of synthetic pesticides are advised for usage in Africa (Van den Berg & du Plessis 2022). To create appropriate management techniques that meet farmers' needs, information on farmers' knowledge and management practices is crucial (Seufert et al., 2012). Farmers acquire knowledge, employ managerial techniques, and come up with their own solutions to a variety of practical issues and cost-effective approaches. The lack of understanding on farmers' knowledge, perceptions, and management practices has been demonstrated to be one of the major obstacles to implementing a pest management programme.

In East Africa and much of Southeast Asia, agriculture remains a major sector supporting the livelihoods of farm households, for example, in SE Asia, it accounted for about 40% of employment according to 1999/2001 and 2009/2011 FAO data (FAO 2019), while in sub-Saharan Africa, agriculture continues to provide more employment than any other sector, with more than 50% according to the 2009/2011 data (FAO 2019) (Kalyebi et al., 2023). But climate change also has a negative impact on agriculture in these two regions, which has an impact on agricultural pest population outbreaks (Skendžić et al., 2021). Furthermore, the Fall armyworm that recently invaded the area has a significant impact on grain production, with maize, rice and wheat being the main crops (Kasoma et al., 2021).

One of the most significant cereal crops in Uganda is maize,(Kaizzi & Byalebeka 2012) which smallholder farmers often cultivate for food, commercial use, and export. Due to a combination of factors including the excellent environment that allows for two farming seasons annually and the growing demand for maize and other maize products, maize output has grown over time, rising from 2.8 million metric tonnes in 2015 to 4 million metric tonnes in 2017 (MAAIF 2018a) (Erenstein et al., 2022). Uganda has expanded its maize production in order to meet the needs of its bordering nations, such as Kenya, Tanzania, Rwanda, South Sudan, and the Democratic Republic of the Congo, where it is a staple crop (Kenya, for example, has an annual demand of 60,000 metric tonnes). Uganda's maize yields (production and productivity, quality) have remained relatively low at 2.2–2.5 metric tonnes/ha (compared to the potential of 8 metric tonnes/ha) as a result of several biotic and abiotic factors that included pests and diseases, declining soil quality, drought stress, and inadequate extension services (MAAIF 2018a). The quality standards are also generally low, with high post-harvest losses during transportation, storage, and processing, while aflatoxin contamination reduces its competitiveness for access to regional markets (Coulibaly et al., 2008).

Throughout the growth cycle, a variety of pests and illnesses target maize. The degree and frequency of infestations rely on a number of factors, including weather, soil conditions, interactions with other arthropod species, and the sensitivity or resistance of the many kinds of maize (Mutymbai et al., 2022). Corn pests include cutworms, termites, maize weevils, the recently discovered FAW, and cereal stem borers/the maize stalk borer *Buseola fusca*, the spotted stem borer *Chilo partellus*, and the African pink borer *Sesamia calamistis*. According to research, *C. partellus* and *B. fusca* were historically Uganda's two primary maize pests. In certain regions of Africa, such *C. partellus* was the predominant lepidopteran pest, and its effects were

controlled by using biological control, to a minimal degree (Mutamiswa et al., 2017). Using samples taken in the field in May and June of 2016, molecular diagnostics was used to confirm the FAW in Uganda (Chidawanyika et al., 2017). Although the percentage of farmers engaged in maize production increased from 85 to 92% between 2014 and 2015, there was a sharp decline in the number of farmers growing maize in 2016 and 2017, amounting to 81.5%. This decline was partially ascribed to both drought (23%) and floods (33%) (NARO-ATAAS 2018). Insecticide use has been the main control strategy promoted in African nations since its arrival.

Governments prioritized the use of pesticides as an expedient reaction due to the disastrous effects of this invasive pest and obtained insecticides for distribution, based on infestation rates (MAAIF 2018a). Governments made people aware of the pest and this helped farmers who had access to chemical pesticides. But in the absence of sufficient understanding of the ecology and biology of the pest as well as sound judgement regarding the best time and rate to apply insecticides, improper use (such as abuse or overreliance) of pesticides may raise production costs and pose a greater risk to consumers, growers, and the environment. Therefore, incorporating other non-chemical methods like mechanical, biological, cultural, and physical control choices is crucial for the long-term management of the FAW.

1.2 Statement of the problem

The effects of new and old illnesses and pests are still being felt in Agri-food systems. For instance, according to estimates from the International Plant Protection Convention (IPPC, 2021), around \$220 billion in crop yield is lost each year owing to diseases, with pests responsible for an additional \$70 billion. If early, cost-effective, and sustainable interventions are not supported, these losses are predicted to increase. This could delay the fulfilment of global development goals like ending hunger (Cardone et al., 2021). The Fall armyworm (*Spodoptera*

frugiperda) is one of the most unsettling pests. According to Montezano, the pest feeds on more than 350 host plants from 76 different plant families. Given that the Fall armyworm is a novel species to Africa, it is crucial to conduct species-targeted research to produce the data required to create management methods that are appropriate for each environment.

The majority of farmers in Namutumba area plant maize, which is the main staple that FAW eats from a wide range of cereal crops. Due to higher production costs and barriers to inter-personal commerce, the FAW continues to pose a danger to food security, incomes, and the livelihoods of a large number of people. Due to the FAW's almost complete consumption of the plant, maize is particularly severely damaged, leading to crop loss (Sharon et al., 2020). Even though there has been some research conducted nationwide regarding the Fall Army Worm infestation, there is still a gap in our understanding, particularly with regard to farmers' perceptions and knowledge of the infestation. This study aims to fill that knowledge gap in Nsinze Sub- County, Namutumba District.

1.3 Objectives of the Study

1.3.1 General Objective

To examine farmers' knowledge on the fall armyworm pest infestation on maize crop in Nsinze sub-county, Namutumba district

1.3.2 Specific Objectives

- i) To find out the farmers' knowledge on fall armyworm attacks on maize in Nsinze sub-county, Namutumba district.
- ii) To find out the farmers' knowledge on damages caused on maize by fall armyworms in Nsinze sub-county, Namutumba District.

ii) To determine the management practices used by farmers in controlling fall armyworms on maize in Nsinze sub-county, Namutumba district.

1.4 Research Questions

1. What do farmers know about the fall armyworm?
2. What could be the damages caused by the fall armyworm?
3. What management practices do farmers in Nsinze sub-county, Namutumba district use in the event of fall armyworm attack?

1.5 Hypothesis of the study

1. Null hypothesis: There is no significant difference in the level of knowledge about the fall armyworm infestation among farmers in different areas of the district.
2. Alternative hypothesis: Significant relationships exist between farmers' management practices, their knowledge, organization membership, and contact with research and extension services.

1.6 Justification of the study

Crop losses due to insect pests may be prevented, or reduced, by deploying effective crop protection measures, which to a large extent depends on farmers' knowledge and behavior towards pest management, and the availability and effectiveness of crop protection methods. Farmers' knowledge and management strategies for *S. frugiperda* have been poorly documented since its appearance in Uganda. Specific information regarding farmer's knowledge, perception and management practices especially with use of natural botanicals, host, and plants known by farmers

has not been reported in Namutumba district, though these are important for developing sustainable pest management methods.

1.7 Significance of the study.

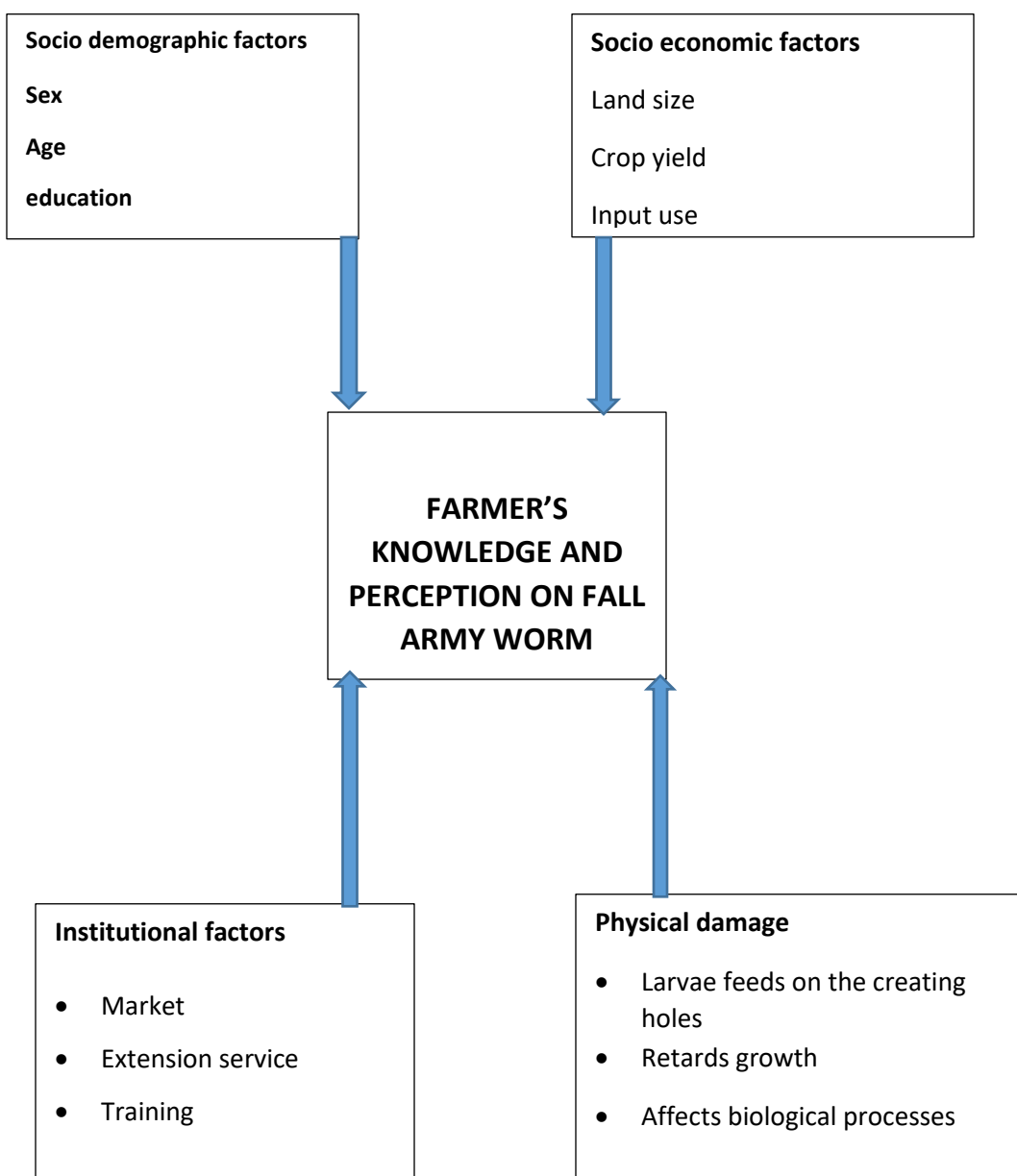
The Fall Armyworm (FAW) is a destructive agricultural pest with a wide host range and adaptability to different climates. It has spread to over 70 countries, including Uganda, posing a significant threat to maize production. The pest can cause yield losses of maize ranging from 15-73%, leading to substantial economic losses. FAW infestations can lead to substantial economic losses for farmers, especially in countries like Uganda where maize is the most widely grown cereal crop. Assessing farmers' knowledge and perception of FAW infestation can help to understand their current pest management practices and identify areas for improvement. Understanding farmers' perceptions and management practices can inform the development of sustainable and effective control strategies. This could include targeted spraying, use of biocontrol agents, and deployment of resistant maize varieties. In conclusion, the proposed research topic is significant as it addresses a pressing issue affecting the agricultural sector. The findings could inform the development of effective pest management strategies, promoting economic stability, food security, and environmental sustainability

1.8 Scope of the Study

This study was conducted in Nsinze sub-county, Namutumba District. This study ran between the months of November and December, 2023 and it was completed by the end of December 2023. Special focus was given to the knowledge of farmers on fall armyworm, the damages they thought these worms cause as well as the management practices used to control the fall armyworms.

1.9 Conceptual frame work

A conceptual framework builds a structure or “concept” of what has been learned in a particular area of study. It’s a hypothesized model identifying the concepts under study and their relationship. The conceptual models derived from variables are put to test in order to establish the significance of the proposed relationship. The variables considered in this research are independent variables like institutional, economic, social variables and dependent variable like physical variables.



2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter embodies previous works by other scholars in line with the objectives of the study. These works have been extracted from secondary sources which include; articles, journals, reports and other relevant sources as herein cited.

2.2 Farmers Knowledge on Fall Armyworm.

The Fall armyworm (*Spodoptera frugiperda*) and farm-level management practices in Zambia were examined by Harrison et al. (2022). While participating in the study, farmers were shown images of the Fall armyworm in various phases and its symptoms without the researcher identifying it as such. 91% of farmers could identify Fall armyworm with certainty, and 97% (88% of all respondents) had seen it in person on their farms during the 2016–2017 cropping season. In addition to other well-known pests including aphids, stalk borers, and cutworms, farmers described it as the most troublesome insect during the cropping season. Farmers usually noticed the pest on maize during its larval stages (caterpillar), with a smaller number also noticing the adult moth and its eggs. Improved kinds of maize were compared to local types, is thought to be more vulnerable to the Fall armyworm, with the vegetative stage of the crop being the most vulnerable.

Houngbo et al. (2020) examined farmers' knowledge of and management techniques for the Fall Armyworm, *Spodoptera frugiperda*, in Benin, West Africa. The majority of farmers (91.8%), it was shown, were aware of *S. frugiperda's* impacts on the maize harvest. The majority of them (78.9%) could spot the bug while it was still a larva. In their maize harvests, 88.6% of farmers said *S. frugiperda* was active. They recorded the initial attacks of *S. frugiperda* in 2015 and 2016. They considered *S. frugiperda* to be a recent pest. *S. frugiperda* is not now referred to

by any particular name in the local tongues. Between the first and fourth weeks after planting, when the majority of farmers cultivate maize, attacks were more common.

Most farmers noticed that *S. frugiperda* attacks were more widespread in 2018 than they were in 2017. About 32% of the farmers said that *S. frugiperda* caused more harm to their fields than any other maize pests they had come across.

2.3 Damages caused by fall armyworms

Despite the contrasting geo-climates, *S. frugiperda* was found throughout Benin. The ideal temperatures for adults and larvae are 25 °C and 30 °C, respectively. (Cairns et al., 2012). Researchers found that 97.1% of farmers experienced *S. frugiperda* infestations in 2018. 93.9% of the maize fields were infested, which confirms *S. frugiperda's* existence throughout Benin despite the geoclimatic variations. According to estimates, there are 58.9% more injured maize plants and 50.4% more damaged maize ears per field of maize.

The average amount of maize crop losses anticipated by farmers in 2018 was 797.2 kg/ha. Prior to the introduction of *S. frugiperda*, the farmers stated that their average maize yield was 1626 kg/ha. As a result, the yield losses caused by *S. frugiperda* equaled 49% of the average before it invaded, when farmers produced a given amount of maize (Chisonga et al., 2023). (Hruska and Gould) showed a correlation between yield losses and *S. frugiperda* infection levels in Nicaragua. For them, yield losses ranging from 15 to 73% could result from infestations of 55 to 100% of maize plants. The greatest yield losses were in Kenya and Ethiopia. 0.8 to 1 tonnes of maize per hectare were typical. The degrees of infestation which may explain the variations in crop losses between nations depend on weather conditions, farming techniques, and insecticide availability.

The most vulnerable crops, according to farmers in the Chiro and Darolebu districts, were maize (76% and 72.88%), sorghum (13% and 18.56%), and millet (11% and 8.56%). The early discovery and assessment of numerous morphological characteristics and damaging symptoms of insect pests was based on information acquired from adjacent farmers who were producing maize. In both districts, the FAW was referred to as Geri America, and at the damaging symptoms primarily consume the leaf's emerging tip and widow its margin in fields where maize is cultivated. The larvae stage has a morphological aspect that is coloured differently; the colours are green and grey with varied stripes.

2.4 Management practices of fall armyworms

According to, Kasoma et al., (2021) investigated the Fall armyworm (*Spodoptera frugiperda*) and farm-level management techniques in Zambia. The majority of farmers (62%) adopted at least one strategy to control the Fall armyworm during the 2016–2017 cropping season, according to their research. Fall armyworm management methods can be broadly categorized into three groups: pesticide, cultural/physical, and biological. Pesticide application was the most common strategy, used by 60% of the farmers (Bengtsson 2019). The most frequent physical/cultural practices were hand picking and crushing egg masses (36%), covering the larvae with ash, sand, or liquid detergent (19%), and early planting (7%). It is less frequent to utilize biologicals because only 5% of farmers do so. Biologicals comprised farm-produced plant extracts including tobacco, chilli pepper, plus neem. Few farmers specifically used the biopesticides Azadirachtin and Spear (GS-omega/kappa-Hv1a). Numerous methods were widely used, and the majority of farmers (72%) combined the use of pesticides with behavioral and cultural norms.

Houngbo et al. (2020) examined farmers' knowledge of and management techniques for the Fall Armyworm, *Spodoptera frugiperda*, in Benin, West Africa. 38% of the farmers questioned were found to apply at least one control strategy. Farmers used synthetic pesticides as their primary management tool the most. 1.9% of farms used botanical pesticides, 91.4% of farmers used synthetic pesticides, and 6.6% of farmers utilized other management techniques. At least one management strategy was applied by these farmers. To control *S. frugiperda*, the majority of farmers in Benin utilized synthetic pesticides. very same was seen in nations throughout Africa, including Ghana, Zambia, Nigeria, Kenya, and Ethiopia. Farmers may certainly easily get synthetic insecticides. Low usage of synthetic pesticides is encouraged by institutions such as USAID and other organizations like the FAO(Bista et al., 2020) . However, there is little proof that farmers abide by these organizations' recommendations, which support the prudent and minimal use of synthetic pesticides. This suggests that the extension services must still make an effort to prevent the use of synthetic pesticides against *S. frugiperda*.

Farmers in Benin discovered that chemical control was largely effective. They used a range of synthetic pesticides, including Cypermethrin (472) and Lambda super 2.5 EC (lambda-cyhalothrin), Pyro FTE and Thalix 112 EC (emamectin benzoate and acetamiprid), and Emacot 019 EC (emamectin benzoate). and chlorpyrifos-ethyl), and Pacha 25 EC (acetamiprid and lambda-cyhalothrin) (Chisonga et al., 2023). Different countries have different views on how successful chemical control is according to farmers. For instance, in Kenya, 60% of farmers believed synthetic pesticides to be ineffective, whereas Ethiopian farmers insisted chemical control of *S. frugiperda* was efficient.

Dougoud et al., (2019) examined that these natural pesticides were hardly ever utilized, though. This might be accounted for by ignorance of the production process and raw ingredients.

Farmers typically created their natural pesticides against *S. frugiperda* from neem leaves or seeds, vernonia leaves, pepper, and ash. Some of the farmers additionally mixed petroleum, soap, or detergent with natural insecticides. Vernonia is among the pesticides from Africa that were chosen to enhance botanically-based pest control in smallholder farming in Africa. However, no research has been done on how effective it is against *S. frugiperda*. The same holds true for pepper, ashes, soaps, detergents and petrol. Farmers' homemade botanical pesticides must be improved and standardized by agricultural research organizations and scientists before being scaled up.

3.0 CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter presents the background of the study area, research design, study sample size, sample selection procedures and data management that was used in this study.

3.2 Study area

Nsinze sub-county, is approximately 5km north of Namutumba town, the nearest large town on an all-weather dry road. The sub-county has five parishes and seventeen villages. The coordinates of the town are 0°53'42.0N, 33°36'15.0 E (Latitude: 0.81056, Longitude: 33.60417). This research will take a period of two months (November to December). This will enable the researcher to concentrate and come up with practical and beneficial findings and recommendations.

3.3 Research Design

The research was carried out using a descriptive cross-sectional survey. The researcher employed both quantitative and qualitative analysis approaches in order to get the attention of a bigger number of respondents and data to be collected.

Quantitative design aided in the collection of information from variables that involve measurements, whereas qualitative design aided in the collection of ideas, perceptions, and explanations.

3.4 Study Population

A target population refers to the entire group of people or objects to which the researcher wishes to generalize the study findings. This study purposely targeted Maize farmers in Nsinze sub-county, Namutumba district.

3.5 Sample Size

According to (Omair 2014), a sample size is the selection from the population from which information will be obtained. The research population composed of a sample size of 110 respondents, consisting of 80 men and 30 women. The sample size was determined using Yamane formula (Yamane, 1997).

This formula is as below. Due to financial constraints, the researcher used a sample size of 110

$$n = \frac{N}{1 + N(e)^2}$$

Where,

n= sample size

N= population that can easily be accessible

e= level of precision

3.6 Sampling techniques

The researcher adopted two sampling techniques: purposive sampling and simple random sampling techniques. According to Tongco, (2007), purposive sampling is a sampling technique in which the researcher chooses individuals who are knowledgeable about a certain aspect to participate in the study. The researcher employed the purposive sampling technique to select top officials from a sub-county of the study because this will give much more detailed information than can be obtained from the farmers. On the other hand, the researcher adopted the snowball sampling technique to select the farmers in a way that is non-biased while at the same time offering equal opportunity for an individual to participate in the study.

3.7 Data collection.

Data collection proceeded and was aided by use of the following tools;

3.7.1 Interview Guide

A semi structured interview guide is a tool which doesn't hold the interviewer to strictly follow a formalized list of questions. Interviews helped the researcher interact with respondents who would not be in position to effectively layout their responses through questionnaires which may require them to read and write. This also helped in probing especially where specific answers were needed.

3.7.2 Questionnaire

A questionnaire is a research instrument consisting of a series of questions for the purpose of gathering information from respondents. The researcher designed a questionnaire that consisted of both open-ended and closed-ended questions. The open-ended questions required detailed explanation's while the closed-ended questions restricted the views of the respondents.

3.7.3 Observation

Observation was carried out by the researcher by travelling across the parishes. The intension was to access the farmers who cultivate maize crops in each parish.

3.8 Procedure of data collection

The researcher got approval from the university research supervisor where the researcher upon approval obtained an introductory letter which helped introduce the researcher to the management of Nsinze sub-county, Namutumba district. After this, the researcher made appointments with the respondents to establish the most convenient time for data collection.

3.9 Data quality control methods

3.9.1 Validity

Data validity is the accuracy and meaningfulness of influences which are based on the research result. The researcher ensured validity by computing the data obtained from the field. This aimed at ensuring that the information got corresponds with the theoretical and conceptual values thus ensuring validity.

3.9.2 Reliability

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. The researcher designed data collection tools that is to say a questionnaire and an interview guide and later on submit it to the supervisor for approval to ensure reliability.

3.10 Data analysis

Data analysis is defined as the process of evaluating data using analytical and statistical tools to discover useful information as these aids in decision making as regards the data provided. The collected data was edited and coded while being captured in the computer. Editing allowed the researcher to identify and remove errors during the collection process. The cleaned data was then analyzed using the SPSS software (Statistical package for social scientists, 16th Edition).

3.11 Ethical considerations

The researcher presented a letter of introduction from Busitema University to officials of Nsinze sub-county, Namutumba district and most importantly inform them on the purpose of the study. Before engaging the respondents, they were briefed about the relevance of the study. The researcher also guaranteed confidentiality and anonymity where their personal information was not to get disclosed. Respondents were given the freedom to withdraw from the study if they wish to do so.

3.12 Limitation to the study

The researcher would have loved to carry out the investigation in all seven parishes of the subcounty, but because of the large area and long distances apart from one another, the research was carried out in only five neighboring parishes.

4.0 CHAPTER FOUR: DATA PRESENTATION

4.1 Presentation of the Background information

Information was sought on demographic factors and these included age, gender, education level, farming experience, main occupation among others. The details of these are presented in the table below.

Quantitative Variables		Means	Standard Deviations
Age		41.9	12.3
Farm experience (year)		19.5	11.8
Household size		9.2	6.7
Qualitative Variables		Numbers	Frequency (%)
Gender	Male	65	72.7
	Female	23	27.3
	None	65	59
Education levels	Primary	23	20.9
	Secondary	20	18.1
	Tertiary	2	1.8

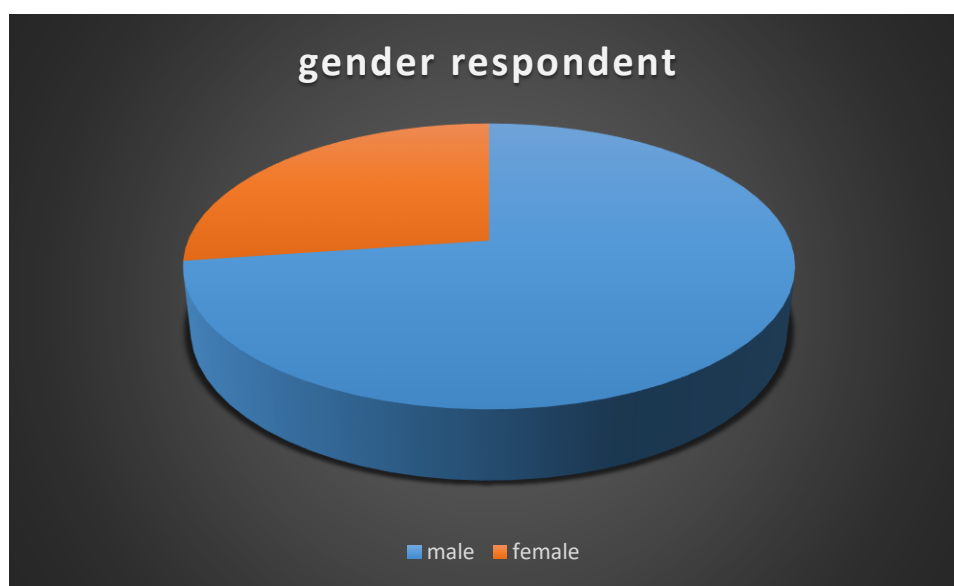
Table 1. Descriptive statistics of the socio-economic profiles of the surveyed farmers

The surveyed farmers were mostly men (72.7%), and their household had an average of nine people. The number of years of experience in maize production averaged 19.5 years. About 59% of farmers were illiterate. They practiced agriculture as their main activity (92.6%). Livestock

production (e.g., poultry, goat, sheep, cattle, or pigs), food processing, and trade were their secondary activities

Figure 1: Gender of the respondents

The results were also further represented on a pie chart as shown below for better understanding and interpretation.



4.2 Farmers' Knowledge and Perceptions of *S. frugiperda* Attacks

Farmers have different perceptions and knowledge about the infestation of Fall Armyworm on maize which have been summarized in the table below.

Variables	Numbers	Frequency (%)
Knowledge of <i>S. frugiperda</i> damage (Yes)	63	57.3
Egg (yes)	5	4.5

Knowledge of <i>S. frugiperda</i> development stages	Larva (yes)	15	13.6
	Pupa (yes)	7	6.3
	Adult (yes)	20	18.2
Farmer information sources on <i>S. frugiperda</i>	Extension agents (yes)	5	4.5
	Medias (radio/television) (yes)	69	62.7
	Residents of neighboring localities (yes)	36	32.7

Table 2: Farmers' knowledge and perceptions of *S. frugiperda*.

Most farmers (57.3%) recognized the damage of *S. frugiperda* on maize crop. The majority (18.2%) of them were able to identify the pest during its adult stage. Farmers observed the activities of *S. frugiperda* in their maize fields. They recorded the first attacks of *S. frugiperda* in 2017 and 2018. They perceived *S. frugiperda* as a new pest. Currently, there is no name in local languages to specifically refer to *S. frugiperda*.

4.3. Damage Caused by *S. frugiperda*

The damages which are caused by FAW on the maize plant have been summarized in the table 3 below;

Incidence and Maize Yield Losses	Percentage(%)	SD
Incidence of infested maize fields	93.9	18.1
Incidence of damaged plants per infested field	58.9	22.6

Incidence of damaged ears		50.4	20.7
Maize yield losses (kg/ha)		797.2	613.6
Damage severity for farmers who suffered from <i>S. frugiperda</i> attacks (n = 1198)		Numbers	Frequency (%)
Severity of <i>S. frugiperda</i> attack on maize leaves	Low	130	10.6
	Medium	1003	81.7
	High	95	7.7

Table 3. Indicators of damage caused by *S. frugiperda* according to farmers.

The results showed that around 97.1% of farmers suffered from *S. frugiperda* attacks in 2018. About 93.9% of the maize fields were infested. The incidence of damaged maize plants per field was estimated to 58.9%, and the incidence of damaged maize ears was estimated at 50.4%. The estimated yield losses by farmers averaged 797.2 kg/ha of maize in 2018. The farmers revealed that before the invasion of *S. frugiperda*, they obtained an average maize yield of 1626 kg/ha. Thus, the yield losses caused by *S. frugiperda* represented 49% of the average maize yield that farmers obtained before the invasion of *S. frugiperda*.

4.4 Farmers' Management Practices

Results on the management practices used by farmers are presented in the table below

Management practices used	Numbers	Frequency	Average effectiveness Score
Synthetic pesticides	95	86.5	5
Botanical pesticides	10	9.1	6
Other practices used	5	4.5	3

Source:(primary data from the survey)

Table 4. shows the management practices used by farmers.

The most common management method used by farmers was synthetic pesticides. Among farmers using at least one management method, 86.5% used synthetic pesticides, 9.1% used botanical pesticides, and 4.5% used other management practices. The wide range of synthetic pesticides used by farmers included Thalis 112 EC (emamectin benzoate and acetamiprid), Pyro FTE 472 (cypermethrin and chlorpyrifos-ethyl).

The average effectiveness score for all of these synthetic pesticides is 5 out of 7. Thus, farmers believed that synthetic pesticides were relatively effective against *S. frugiperda*. Among the synthetic pesticides, Emacot 019 EC is the one for which the average effectiveness score is 6 followed by Thalis 112 EC whose score is 5.

5.0 CHAPTER FIVE: DISCUSSION OF THE RESULTS

5.1. Farmers' Knowledge and Perceptions of *S. frugiperda* Attacks

In this study, the majority of maize farmers were able to identify *S. frugiperda* at its larval stage and recognized the damage it causes. A small percentage of farmers (6.3 to 57.3%) were able to recognize *S. frugiperda* eggs, pupae, and adults, among other developmental stages. A deeper understanding of the biology of the pest is necessary to identify these developmental stages.

Some farmers reported the first *S. frugiperda* attack in 2017. The assaults by *S. frugiperda* were first documented in Namutumba in early 2017. Farmers' perceptions suggest that *S. frugiperda* was present in Namutumba before 2017, but its impact only became noticeable after that year

5.2. Damage Caused by *S. frugiperda*

Yield losses caused by *S. frugiperda* averaged 797 kg of maize per hectare, or 49% of the average maize yield obtained by farmers before the invasion of *S. frugiperda*. This result corroborates forecasts by the Centre for Agriculture and Bioscience International (CABI), indicating that *S. frugiperda* could cause a loss of 40% of the average annual Namutumba

Furthermore, some farmers demonstrated that frequent weeding and no-till sowing reduced the damage of *S. frugiperda*. As well, yield losses due to *S. frugiperda* attacks have been shown to vary with planting dates. Some farmers in Nsinze reported significant yield losses on late-planted maize plots compared to plots planted earlier. She expressed as follows

*“When you delay to plant, there are higher chances of the maize to be attacked by the fall
army worm”*

Furthermore, the kinds of planted maize varieties were linked to the intensity of the *S. frugiperda* attack. Compared to traditional kinds, contemporary varieties experienced more severe

attacks. This indicates that *S. frugiperda* attacks were not repelled by the contemporary types utilized in Namutumba. According to certain studies, current cultivars' yield loss from *S. frugiperda* was negligible when they were planted in rich soils or with proper fertilizer. Farmers in this study undoubtedly did not provide enough fertilizers to strengthen contemporary varieties' defence against *S. frugiperda*.

5.3. Farmers' Management Practices

Most farmers in Namutumba used synthetic pesticides to manage *S. frugiperda*. Synthetic pesticides are indeed easily accessible for farmers. Institutions like National Agricultural Advisory Services (NAADS), National Agricultural Research Organization (NARO) and other organizations such as Food and Agricultural Organization (FAO) advocate low use of synthetic pesticides. However, there is no evidence that farmers comply with the recommendations of these organizations which advocate the rational and threshold use of synthetic pesticides. This implies that an effort remains to be deployed by the extension services concerning the use of synthetic pesticides against *S. frugiperda*.

Farmers in Namutumba discovered that chemical control worked really well. The efficiency of chemical control is perceived differently by farmers depending on the location. For instance, in Kivule parish, farmers asserted that chemical control was successful against *S. frugiperda*, but in the Isegero parish, almost 60% of farmers felt that synthetic pesticides were unsuccessful.

When it came to controlling *S. frugiperda*, some farmers believed that using botanical pesticides was more effective than using synthetic ones. These plant-based insecticides weren't very effective, though. This could be explained by ignorance of the manufacturing process and raw materials. Farmers typically employed ash, pepper, vernonia leaves, neem leaves or seeds, and other botanical insecticides to control *S. frugiperda*. In addition, some farmers mixed botanical

pesticides with soaps, detergents, or petroleum. Among the locals, pesticide plants chosen to enhance botanically based pest management in smallholder farming in Namutumba is *Vernonia*. Its efficacy against *S. frugiperda* hasn't been investigated yet, though. Pepper, ashes, soaps, detergents, and petroleum all work in the same way. It is up to universities engaged in agricultural research and scientists to refine and standardize botanical pesticides made by farmers for their scaling up.

6.0 CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSION

This paper reported on farmers' knowledge, their perceptions, and management practices they use against *Spodoptera frugiperda*. Most farmers handle *S. frugiperda* with synthetic pesticides, which don't always work for them. A minority use traditional methods that, in their opinion, are more successful. These mostly ecological local practices merit further investigation and larger implementation. The results of the study demonstrated a connection between management practice use and *S. frugiperda* knowledge. Additionally, there was a connection between the different kinds of management techniques and pest knowledge. As a result, the study affirms that farmers' decision to manage the pest is significantly influenced by their level of pest knowledge. More investigation is needed to improve and standardize management

6.2 RECOMMENDATION

Farmer organizations and extension services possess the capability to enhance farmers' understanding and bring about behavioral modifications in their pest control approaches, thereby impacting their pest management choices. Given that over 50% of the farmers questioned lacked formal education, extension agencies ought to think about providing pertinent material in the local tongue and holding on-site demonstrations to enhance farmers' understanding of pest management techniques.

More research should be done on;

1. More research is required to further understand the effectiveness of botanical pesticides made by farmers against *S. frugiperda* and to refine them for scaling-up.
2. Impact of Fall Armyworm on Small-scale Maize Farmers.
3. Impact of Climate Variability on Fall Armyworm Infestation.

REFERENCES

- Bengtsson, B. M. (2019). *Agricultural research at the crossroads: revisited resource-poor farmers and the millennium development goals*, CRC Press.
- Bista, S., et al. (2020). "Fall armyworm: Menace to Nepalese farming and the integrated management approaches." *International Journal of Environment, Agriculture and Biotechnology* **5**(4): 1011-1018.
- Brévault, T., et al. (2018). "First records of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), in Senegal." *Entomologia generalis* **37**(2).
- Cairns, J. E., et al. (2012). "Maize production in a changing climate: impacts, adaptation, and mitigation strategies." *Advances in agronomy* **114**: 1-58.
- Cardone, G., et al. (2021). "Potential socio-economic impact of *Xylella fastidiosa* in the Near East and North Africa (NENA): Risk of introduction and spread, risk perception and socio-economic effects." *New Medit: Mediterranean Journal of Economics, Agriculture and Environment= Revue Méditerranéenne d'Economie Agriculture et Environment* **20**(2)
- Chisonga, C., et al. (2023). "Understanding the impact of fall armyworm (*Spodoptera frugiperda* JE Smith) leaf damage on maize yields." *Plos one* **18**(6): e0279138.
- Coulibaly, O., et al. (2008). *Economic impact of aflatoxin contamination in sub-Saharan Africa. Mycotoxins: Detection methods, management, public health and agricultural trade*, CABI Wallingford UK: 67-76.
- Dougoud, J., et al. (2019). "Efficacy of homemade botanical insecticides based on traditional knowledge. A review." *Agronomy for sustainable development* **39**: 1-22.

Erenstein, O., et al. (2022). "Global maize production, consumption and trade: Trends and R&D implications." *Food Security* **14**(5): 1295-1319

Ferré, J., et al. (2008). *Insecticidal genetically modified crops and insect resistance management (IRM)*. Integration of insect-resistant genetically modified crops within IPM programs, Springer: 41-85.

Harrison, R., et al. (2022). "Low Impact of Fall Armyworm (*Spodoptera frugiperda* Smith)(Lepidoptera: Noctuidae) Across Smallholder Fields in Malawi and Zambia." *Journal of Economic Entomology* **115**(6): 1783-1789.

Houngbo, S., et al. (2020). "Farmers' knowledge and management practices of fall armyworm, *Spodoptera frugiperda* (JE Smith) in Benin, West Africa." *Agriculture* **10**(10): 430.

Iannella, M., et al. (2021). "A Continental-Scale Connectivity Analysis to Predict Current and Future Colonization Trends of Biofuel Plant's Pests for Sub-Saharan African Countries." *Land* **10**(11): 1276.

Kaizzi, K. C., et al. (2012). "Maize response to fertilizer and nitrogen use efficiency in Uganda." *Agronomy journal* **104**(1): 73-82.

Kalyebi, A., et al. (2023). "Farmer perception of impacts of fall armyworm (*Spodoptera frugiperda* JE Smith) and transferability of its management practices in Uganda." *CABI Agriculture and Bioscience* **4**(1): 1-14.

Kasoma, C., et al. (2021). "Outbreaks of the fall armyworm (*Spodoptera frugiperda*), and maize production constraints in Zambia with special emphasis on coping strategies." *Sustainability* **13**(19): 10771.

Kasoma, C., et al. (2021). "Fall armyworm invasion in Africa: implications for maize production and breeding." *Journal of Crop Improvement* **35**(1): 111-146.

Kumar, D. and P. Kalita (2017). "Reducing postharvest losses during storage of grain crops to strengthen food security in developing countries." *Foods* **6**(1): 8.

Mack, R. N. and W. M. Lonsdale (2001). "Humans as global plant dispersers: getting more than we bargained for: current introductions of species for aesthetic purposes present the largest single challenge for predicting which plant immigrants will become future pests." *BioScience* **51**(2): 95-102.

Malo, M. and J. Hore (2020). "The emerging menace of fall armyworm (*Spodoptera frugiperda* JE Smith) in maize: A call for attention and action." *J. Entomol. Zool. Stud* **8**: 455-465.

Mendesil, E., et al. (2023). "The invasive fall armyworm, *Spodoptera frugiperda*, in Africa and Asia: responding to the food security challenge, with priorities for integrated pest management research." *Journal of Plant Diseases and Protection*: 1-32.

Mutamiswa, R., et al. (2017). "Dominance of spotted stemborer *C. hilo partellus* S. winhoe (Lepidoptera: Crambidae) over indigenous stemborer species in Africa's changing climates: ecological and thermal biology perspectives." *Agricultural and Forest Entomology* **19**(4): 344-356.

Mutyambai, D. M., et al. (2022). "Agronomic factors influencing fall armyworm (*Spodoptera frugiperda*) infestation and damage and its co-occurrence with stemborers in maize cropping systems in Kenya." *Insects* **13**(3): 266.

Niu, B., et al. (2017). "Simplified and representative bacterial community of maize roots." *Proceedings of the National Academy of Sciences* **114**(12): E2450-E2459.

Omar, A. (2014). "Sample size estimation and sampling techniques for selecting a representative sample." *Journal of Health specialties* **2**(4): 142.

Senay, S. D., et al. (2022). "Fall armyworm from a maize multi-peril pest risk perspective." *Frontiers in Insect Science* **2**.

Seufert, V., et al. (2012). "Comparing the yields of organic and conventional agriculture." *Nature* **485**(7397): 229-232.

Sharon, B., et al. (2020). "Severity and prevalence of the destructive fall armyworm on maize in Uganda: A case of Bulambuli District." *African Journal of Agricultural Research* **16**(6): 777-784.

Skendžić, S., et al. (2021). "The impact of climate change on agricultural insect pests." *Insects* **12**(5): 440.

Tiwari, S. (2022). "Research article host plant preference by the fall armyworm, *Spodoptera frugiperda* (je smith)(Lepidoptera: Noctuidae) on the range of potential host plant species." *Journal of Agriculture and Forestry University* **5**: 25.

Tongco, M. D. C. (2007). "Purposive sampling as a tool for informant selection."

Van den Berg, J. and H. du Plessis (2022). "Chemical control and insecticide resistance in *Spodoptera frugiperda* (Lepidoptera: Noctuidae)." *Journal of Economic Entomology* **115**(6): 1761-1771.

Yan, X.-R., et al. (2022). "Impact of Temperature Change on the Fall Armyworm, *Spodoptera frugiperda* under Global Climate Change." *Insects* **13**(11): 981.

APPENDICES

APPENDIX 1: QUESTIONNAIRE TO FARMERS

Dear Respondent,

The purpose of this questionnaire is to assess your opinion and attitude towards farmers' knowledge and perception on the fall armyworm pest infestation. Kindly read and answer all the statements as precisely and frankly as you can.

Tick against the alternative you think is suitable.

Name of the Parish.....

Section A: Demographic characteristics

1. Age

21-30 years 31-40 years 41-50 years
51 and above

2. Sex

a) Male b) Female

3. Level of education

Primary Secondary uneducated
Tertiary University

4: Farming experience

(a) 1-2 years (b) 3-5years (c) 7-10years (d) 11years and above

5. Main Occupation

(1) Subsistence farming (2) commercial farming (3) civil servant

Section B: Farmer's knowledge on fall armyworm in Nsinze Sub County.

6. Do you grow maize? (1) Growers (2) Non growers

7. If YES, which variety of maize is grown? (1) Longe 5 (2) Longe 10

(3) Bazooka (4) others (specify)

8. How long have you been producing maize (in years)? (1) Below 5 (2) 6-10 (3) 11-15 (4) 16-20 (5) above 21

9. Have you ever recognized the attack of maize by fall armyworm in your garden?

1) Yes 2) NO

10. If YES, which season of the year is faced by fall armyworm

(1) All year Round (2) Rainy season (3) Dry season

(4) Others (if others specify)

11. At what stage of maize growth is the pest more serious

a) 1-2 weeks b) 2-4 weeks c) 4-6 weeks others specify.....

Section C: damages caused by the fall armyworm

12. Which parts of the Maize does fall armyworm pest attack?

(1) Leaves (2) roots (3) stem (4) the whole plant

13. To what extent is the damage to the maize plants

1) Severe 2) Moderate 3) low

14. How does fall armyworm bring about yield losses to a maize plant?

(a) Lower quality of the crop (b) Reduce the crop yield (c) inhibit the growth of the plant (d) if others specify.....

15. Which stage of the pest pose a serious threat to the maize plant?

a) larval stage b) Pupa c) Adult

Section D: Management practices used by farmers in Nsinze sub-county, Namutumba district in the event of fall armyworm attack

16. Which method is mostly used to manage Fall armyworm in the maize farm in Nsinze Sub county?

a) chemical management (b) cultural management
c) biological management (d) integrated pest management

17. Do you have some knowledge about natural enemies and Host Plants of *S. frugiperda*

(a) Yes (b) No

18. If yes, briefly express your knowledge about natural enemies and host plants during the management of *S. frugiperda*

.....
.....
.....
.....

..... **Thank u for participating**.....

APPEDIX 2: MAP OF THE AREA OF STUDY

Location of Nsinze sub-county on the map of Uganda



APPENDIX 3: BUDGET

S/N	ITEM	QTY	UNIT PRICE	TOTAL COST
1	Questionnaire printing	110	200	22000
2	Food			50000
3	Transport			55000
4	Report writing	47 pages	200	9200
5	Pens	3	500	1500
6	Data	5GB	5000	25000
7	Gum boots	1 pair	15000	15000
TOTAL				Shs177700

