

**DETERMINANTS OF INTEGRATED PEST MANAGEMENT ADOPTION
AMONG LARGE-SCALE FARMERS IN UASIN GISHU COUNTY, KENYA**

BY

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**A Research Project Submitted in Partial Fulfillment of the Requirement for the
Award of Degree of Master of Environmental Planning and Management in the
School of Engineering and Architecture of Kenyatta University**

November 2024

DECLARATION

Declaration by Student:

I declare that this research project has not been submitted or presented in any previous award for a degree in any university and that the work herein has been solely done by myself.

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This research project was done and submitted with my approval as the university supervisor.

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DEDICATION

I dedicate this work to my father John Saboke, my mother Sarah Saboke, my siblings, and my uncle Joel Sigei for their advice and financial support in ensuring my education journey was successful.

ACKNOWLEDGMENTS

My sincere gratitude goes to God who has given me a chance to pursue my Masters degree and carry out a successful research project.

I thank my supervisor, Prof. Caleb Mireri for his professional guidance, support, and encouragement throughout the research project. His availability and timely feedback greatly helped in improving my work.

I wish to thank all the staff of the Department of Spatial and Environmental Planning for their academic support and guidance throughout my masters degree journey. I express my gratitude to my classmates for their motivation, and academic class discussions which have contributed to my success.

I wish to thank the Uasin Gishu county commissioner and the county Ministry of Education for allowing me to carry out the research project in Soy sub-county. I also thank the sub-county commissioner, the Assistant County commissioner from the respective sub-county divisions, and chiefs from various locations for organizing Focus Group Discussions and ensuring that all the large-scale farmers were met. I thank all the large-scale farmers, and the extension officers who provided data and in-depth information throughout the research fieldwork.

My sincere gratitude also goes to my parents, my siblings, and my uncle for their support, prayers, and guidance throughout my academic journey. I wish to appreciate all my friends for their encouragement which helped me in my academic journey.

ABSTRACT

Integrated pest management (IPM) is a long-term management practice involving cultural, biological, and physical methods. Chemical control is only applied where other techniques are ineffective and pesticides that only kill the target organisms are selected to minimize environmental pollution. This research examines the different IPM practices adopted, the determinants of IPM adoption, and information dissemination channels for the adoption of these practices among large-scale farmers in Soy sub-county. The study surveyed a total of 155 large-scale farmers from 13 locations in Soy sub-county. The study employed a survey research design and collected data through household questionnaires, interview with the extension officers, and a focus group discussion schedule with the farmers association. Descriptive statistics was used to analyze data where tables, graphs, and pie charts were used in presenting the quantitative data. Data from the focus group discussion schedule and interview schedule were analyzed using qualitative content analysis. The findings showed that natural IPM methods adopted were cultural, physical, and biological practices. The chemical methods adopted were herbicides, insecticides, and fertilizers. Education level, age, main occupation, household income, farmer field day participation, machinery ownership, farm size, and pest and weed resurgence were the main determinants for IPM adoption among the respondents. The respondents obtained information on IPM practices through farmer-to-farmer training, field exhibitions, farmer field days, television, radio, and extension officers. As a result, there was inadequate information on complex practices of natural IPM practices as they required proper training hence the main dependence on chemical control methods due to their quick and guaranteed results in crop yields.

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ACRONYMS AND ABBREVIATIONS

DDT	Dichlorodiphenyltrichloroethane
EA	Environmental Audit
EAC	East African Community
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization
FAO	Food and Agriculture Organization
ICIPE	International Centre of Insect Physiology and Ecology
IPM	Integrated Pest Management
KEPHIS	Kenya Plant Health Inspectorate Service
KOAN	Kenya Organic Agriculture Network
NEMA	National Environment Management Authority
PCPA	Pest Control Products Act
PCPB	Pest Control Products Board
POPs	Persistent Organic Pollutants
SDGs	Sustainable Development Goals
WHO	World Health Organization

DEFINITION OF TERMS

Integrated pest management (IPM): A long-term management practice involving cultural, biological, and physical methods. Chemical control can only be applied when other techniques are ineffective where pesticides that only kill the target organisms are selected to minimize environmental pollution (Mwangi & Kariuki, 2015).

Pesticides: Natural or synthetic chemicals which are commonly used by farmers in controlling harmful insect pests, diseases and weeds in crops (Sharma *et al.*, 2019).

Dissemination: A one-way conveying of knowledge from the expert to the end user groups (Robinson *et al.*, 2020).

Large- scale farmers: People who practice crop production in large farms of over 50 Ha mainly for commercial purposes (MoALF, 2017).

Extension officers: Resource persons who provide the farmers with information on safe agricultural practices through various advisory channels and also build the farmers' knowledge which is important in developing new methods of agricultural production (Khan, 2020).

Diffusion: A technique of spreading a new technology or innovation through certain means of communication over a period of time (Vargo *et al.*, 2020).

A social system: Groups, individuals, or organizations that come together and participate in problem-solving to achieve a particular objective or common goal and the time taken in deciding to adopt a certain innovation (Vargo, Akaka, *et al.*, 2020).

CHAPTER ONE

INTRODUCTION

1.1 Background information

Pesticide use is of great significance in modern agriculture as it protects crops against pests and diseases and increases agricultural productivity (Hashimi *et al.*, 2020). However, its intense use among farmers contributes to ecosystem contamination due to high toxicity (Balmford *et al.*, 2018). Researchers and policymakers have admitted that the overuse of pesticides is a barrier to meeting sustainable agricultural development (Liu *et al.*, 2023). Many countries have established movements that regulate pesticide usage among farmers (Ciavatta *et al.*, 2012). Organic farming started in the early 1870s when people used organic products which they obtained directly from animal and plant sources. These products would be burnt to produce smoke which was used to kill insect pests and diseases such as mildew and blight in crops (Unsworth *et al.*, 2019).

Integrated Pest Management (IPM) was later developed in the late 1950s as an alternative method to pesticide use although its adoption among farmers is generally low in developing countries (Pretty & Bharucha, 2015). In 1970, there was a move to reduce pesticides reliance due to growing concern about their resultant effect on both the environment and human health which led to the introduction of organic standards by the International Federation of Organic Agriculture Movements (IFOAM) (Seufert *et al.*, 2017). The movement influenced governmental agencies such as EU regulations of organic agriculture and principles by limiting overdependence on agrochemicals and Genetically Modified Organisms (GMOs) and encouraging organic agriculture through the use of traditional and biological methods (Luttikholt, 2020). The movement ensured that knowledge on organic standards was widely spread by providing communication and dissemination channels such as farmer field schools to enhance organic farming and its adoption (Meemken & Qaim, 2018; Seufert *et al.*, 2017).

The first ban on pesticides was dichlorodiphenyltrichloroethane (DDT) in 1972 by the Environmental Protection Agency (EPA) and approved by the Federal Insecticides, Fungicides, and Rodenticide Act (FIFRA) of 1947 and the Federal Environmental

Pesticide Control Act (FEPCA) (Hakeem *et al.*, 2016). This was due to its long accumulation and persistence which caused toxicity to the environment (Hakeem *et al.*, 2016). During this period, the International Organization for Biological and Integrated Control of noxious animals and Plants (IOBC) with the Food and Agricultural Organization (FAO) advocated for IPM adoption. Neonicotinoid pesticides were later banned in 2013 and this led to the introduction of biological methods such as insect growth regulators as an alternative method to synthetic pesticides (Delaplane *et al.*, 2013).

In Kenya, such organizations as the International Centre of Insect Physiology and Ecology (ICIPE), Food and Agricultural Organization (FAO), and the Kenya Agricultural Research Institute (KARI) were established in 1970s to support Integrated Pest Management (IPM) initiatives as an alternative to agrochemicals (KOAN, 2021; Muriithi *et al.*, 2020). ICIPE together with Rothamsted Research later established Push – Pull technology in the 1990s, which dealt with intercropping crops with plants that have insecticidal properties to keep away pests from attacking the crops (Gitahi *et al.*, 2019). The technology has been widely used by many sub-Saharan countries including Kenya. In collaboration with Real IPM Ltd, ICIPE has also developed biopesticides to be used in controlling pests and diseases in crops as an alternative to pesticides. Kenya Plant Health Inspectorate Service (KEPHIS) was established in 1996 to ensure quality crop produce and the safe application of pesticides through inspection services (Gitahi *et al.*, 2019).

The East African Community Customs Management Act of 2004 was amended in 2009 to provide guidelines on products that have been banned and not permitted into the country. Such products include Dichlorodiphenyltrichloroethane (DDT), Hexachlorocyclohexane (HCH), Dieldrin, Fluoroacetamide, Parathion, Aldrin, Chlorobenzilate, and Captafol (Axelsson *et al.*, 2012). This led to the establishment of the Kenya Agricultural and Livestock Research Organization (KALRO) which help in coordinating research and facilitating information based on livestock and heredity in crops (Chepukaka, 2017). It also aimed to strengthen the adoption of IPM and good agronomic practices by providing knowledge and training to farmers (RoK, 2013). National Environment Management Authority (NEMA) was later established in 2002 with an authority over proper pesticide application and ensuring the protection of the

environment through Environmental Impact Assessment and Audits (EIA/EA) (Midingoyi *et al.*, 2019).

Improper application and overuse of pesticides lead to detrimental effects on both flora and fauna species due to their different toxicities. This leads to the death of both aquatic and terrestrial non-target species and exposure to humans especially in workplaces or through food sources which can cause acute and chronic effects (Hakeem *et al.*, 2016). Despite the policies and strategies that have been put in place to support IPM technology, excessive pesticide use among large-scale farmers is evident. In 2018, approximately 803 tons of pesticides were imported into the country due to the high demand and usage which is rapidly increasing (Ottiger *et al.*, 2019).

The banning of DDT led to the introduction of other toxic pesticides such as organophosphates and carbamates as a replacement which include carbofuran and furadan that are highly hazardous and are being traded and made available in the Kenyan market (Oberemok *et al.*, 2015). There seems to be low adoption of IPM technology with the government paying much attention to conventional agriculture compared to organic farming. This study, therefore, sought to investigate IPM adoption among large-scale farmers in Soy sub-county, Uasin Gishu County.

1.2 Problem statement

The IPM practices have low profitability on crop production since the practices take a longer period to show the results (Norton & Ouyang, 2019). Little is known about IPM practices and its adoption particularly among large-scale farmers and how it has contributed to enhancing crop yields as well as the protection of non-target species and biodiversity within the environment. However, many farmers prefer easy ways of controlling pests through the use of pesticides which may make it difficult for them to learn other alternative eco-friendly techniques (Pretty & Bharucha, 2015).

IPM adoption requires resources such as capital and income, which many farmers may not access, making it difficult to implement the practice. Consequently, long droughts and floods lead to low adoption of IPM technology as it encourages pests and diseases resurgence which makes a farmer opt for synthetic pesticides (Dersseh *et al.*, 2016;

Norton & Ouyang, 2019). Pesticide industries providing subsidies, and cheap and available pesticides in the market encourage farmers to rely on synthetic pesticides hence lowering farmers' attitudes towards IPM adoption (Prasanna *et al.*, 2022; Pretty & Bharucha, 2015). Therefore, it was necessary to study these determinants as contributing factors to IPM adoption among large-scale farmers.

The knowledge and information on IPM technology are key to contributing to the awareness of the existence of this technology, its implementation process, and its benefits (Heller *et al.*, 2020; Horgan, 2017; Murray, Jepson, Bouska, Scherr, & Walenta, 2020). Therefore there was a need to investigate the knowledge of IPM practices among farmers as IPM technology requires training on careful, timely, and collaborative practice among the communities which at some point may not be successful due to inadequate dissemination channels to reach out to all the farmers (Mariyono & Kompas, 2018).

IPM is an important means of reducing biodiversity loss and protecting individual well-being against the hitherto toxicants caused by pesticides. In addition, it contributes to good farm management and farm productivity. To further the discourse on the application of IPM among large-scale farmers, this study sought to assess the level of IPM adoption, factors explaining the adoption of IPM, and methods of information channelization on IPM adoption. In particular, the study looked at the social, economic, and environmental factors along with the sources and methods of dissemination of information about IPM to the farmers.

1.3 General Objective

The main objective of the study was to assess the determinants of integrated pest management among large-scale farmers in Soy sub-county, Uasin Gishu County, Kenya.

1.4 Research objectives

1. To assess the Integrated Pest Management practices and their level of adoption among large-scale farmers in Soy sub-county.
2. To assess the determinants of Integrated Pest Management adoption among large-scale farmers in Soy sub-county.
3. To investigate information dissemination channels for Integrated Pest Management adoption in Soy sub-county.

1.5 Research Questions

1. To what extent is IPM technology adopted among large-scale farmers in Soy sub-county?
2. Which determinants influence IPM adoption among large-scale farmers in Soy sub-county?
3. Which channels are being used to disseminate the information on IPM technology and adoption among large-scale farmers in Soy sub-county?

1.6 Justification of the Study

Uasin Gishu County is the leading producer of maize in the country. The maize production is mainly practiced in large-scale farms of 50 Ha and above and pesticide use by farmers in this county is therefore critical in crop production. Soy sub-county was chosen as the area of study as it is the largest sub-county with a higher concentration of large-scale farmers who practice maize farming (MoALF, 2017). IPM is a lasting approach that controls and prevents crop pests with little negative impacts on the environment, and biodiversity and ensures safe and healthy food for human consumption (Khanal *et al.*, 2020). Through this strategy, farmers can improve the quality and quantity of crop production with less dependence on synthetic pesticides (Kabir & Rainis, 2015).

1.7 Significance of the Study

This research study is of great importance as it brings to understanding the adoption of IPM technology among large-scale farmers. The information will also guide the policy-makers and the decision-makers in finding better ways of strengthening IPM adoption as an alternative to over-reliance on pesticides in the county. The research study is also the forth level of IPM practices in large-scale farming thus literature for academic use.

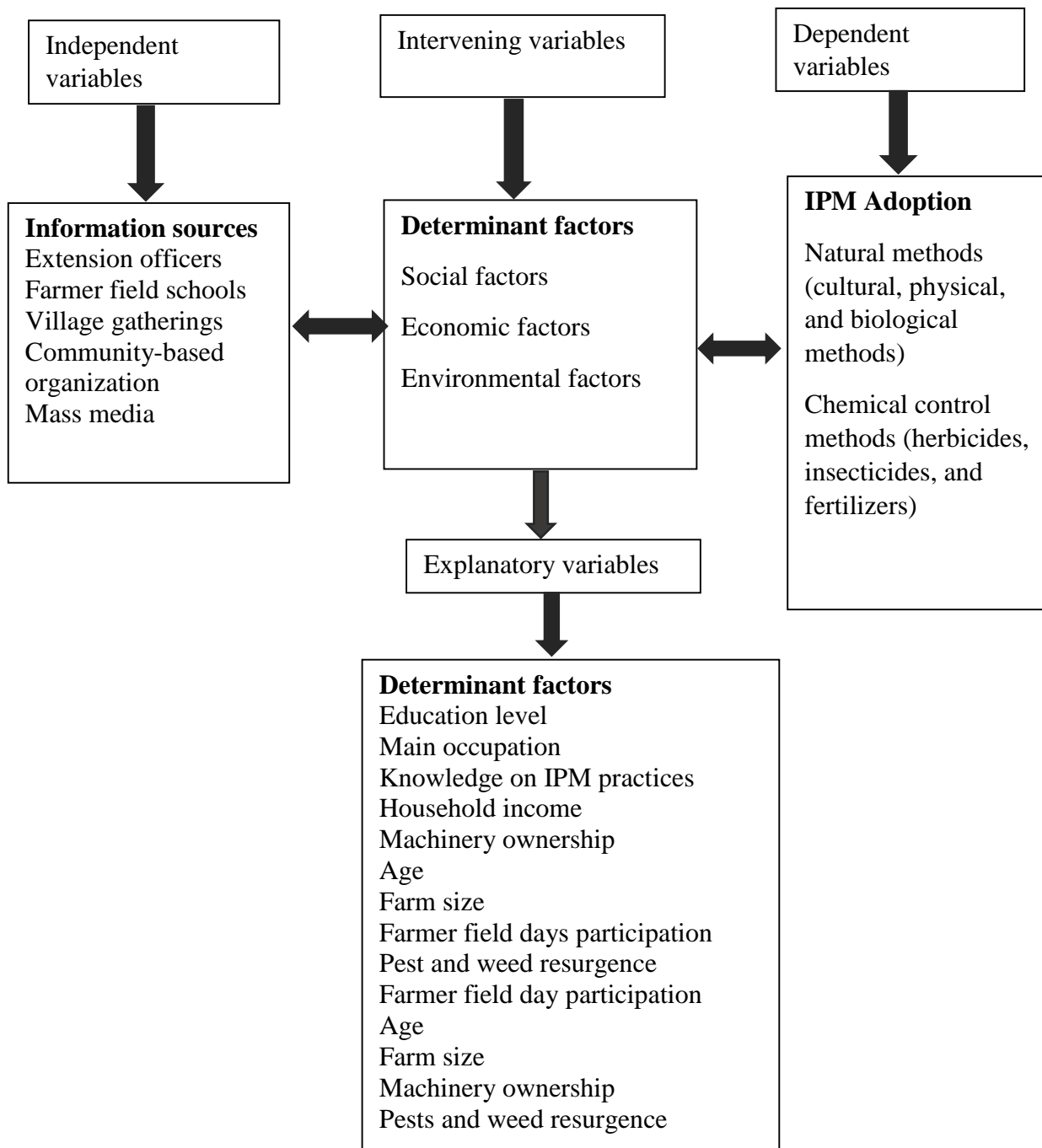
1.8 The scope of the study

The study was conducted in Soy sub-county in Uasin Gishu county where maize production is mainly practiced in large farms of over 50 ha. The study sought to assess the level of IPM adoption and practices, the determinants of IPM adoption, and IPM information channelization among large-scale farmers. The target population was the large-scale farmers within the area of study and the extension officers in the Ministry of Agriculture.

1.9 Conceptual framework

The conceptual framework gives a relationship between different variables under the study. The information sources are the driving forces (independent variables) that influence IPM adoption. The intervening variables are social, economic, and environmental factors. The explanatory variables explains the intervening variables in detail which include; include education level, household income, machinery ownership, age, farm size, farmer field day participation, and pests and weed resurgence. It also links the independent variables with dependent variables.

IPM adoption is the dependent variable that is influenced by the availability of information sources. In this case, IPM adoption includes; natural methods (cultural, physical, and biological practices) and chemical control methods (fertilizers, insecticides, and herbicides).



Source: Author, 2024

Figure 1: Conceptual framework on IPM adoption by large-scale farmers in Uasin Gishu county

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Environmental pollution, the risk to human health, food contamination, and loss of biodiversity are associated with the overuse of pesticides (Biswas *et al.*, 2014; Nicolopoulou-stamati, 2016). Organophosphate pesticides have been reported to cause several health effects and diseases in humans, including thrombosis, diabetes, cardiovascular disease, manic disorder, nephrosis, and cancer (Hashimi *et al.*, 2020). Organochlorine pesticides such as DDT, Dieldrin, endosulfan, heptachlor, dicofol, and methoxychlor cause hormonal disorders and affect early embryo growth in animals (Nicolopoulou-stamati, 2016). Studies show that carbamate pesticides such as carbofuran and ziram cause neurobehavioral perniciousness, mental illness, and non-Hodgkin's malignancy (Hashimi *et al.*, 2020).

Neonicotinoid pesticides have been reported to cause cerebrospinal nervous system illnesses such as paralysis agitans, hallucinosis, brain damage, depression, and reproduction in animals (Hashimi *et al.*, 2020). Unregistered and prohibited pesticides are extensively made available in the East African market. Concerns on food security together with the growing environmental perception, have initiated a necessity for promoting sustainable agriculture in crop production through reducing overdependence on agrochemical inputs (Kughur *et al.*, 2020). To minimize these negative impacts caused by excessive pesticide application, registration of pesticides that are less harmful and advocating for natural methods of Integrated Pest Management (IPM) is vital for green cultivation and Sustainable Development Goals (SDGs).

2.2 Integrated Pest Management Practices and the level of adoption

Integrated pest management began in the early 19th century where crops were protected from pests and diseases in every aspect of production. As the years passed by, the increase in human population led to high demand for food which encouraged invention of synthetic pesticides. Crop yields began to increase since 1940's to 1970's through technology advancement and development of pesticides in different varieties. Many

African countries began to improve crop quality and quantity through educating farmers and providing extension services which boosted crop production. Subsidies on pesticides encouraged many farmers to depend on pesticides which later turned to over-use since they lacked knowledge on proper application (Khanal *et al.*, 2021).

From then on, the pesticides were found to cause environmental pollution and ecosystem imbalance due to its toxicity. It led to an invention of IPM which was environmentally friendly approach and appropriate for crop production and protection. Integrated pest management (IPM) is a long-term management practice involving cultural, biological, and physical methods (Khanal *et al.*, 2021). Chemical control can only be applied when other techniques are ineffective and pesticides that only kill the target organisms are selected to minimize environmental pollution (Samiee *et al.*, 2014). It is a long-term approach that helps in safeguarding the biodiversity through prevention and control of pests and diseases (Khanal *et al.*, 2021).

Cultural methods are reported to interrupt insect pests' life cycle by providing hostile environmental conditions that prevent them from spreading for example through pruning away the infected crop parts, disinfecting farm tools, and proper plowing to expose any breeding larvae in the soil (Dara, 2019). Crop rotation and intercropping are proven to minimize reliance on synthetic pesticides and encourage successful control and management of insect pests such as Western corn rootworm as well as various harmful weeds (Barzman *et al.*, 2015). Crop rotation promotes the reduction of soil nematodes and other disease-causing mechanisms as well as adjusting planting seasons and dates and destroying their breeding habitats to reduce pest infestations (Dara, 2019). A study in Pakistan found that push–pull method through intercropping different crop species has helped in luring harmful pests particularly stemborers from damaging crops and eliminating weeds as well as improving soil texture and fertility (Khan *et al.*, 2021).

Physical and mechanical methods are treatments, barriers, equipment, or high temperatures used to control weeds and insect pests in which physical methods involve manual removal of pests through hand picking, weeding, and trapping insect pests to prevent them from attacking the crops (Khan *et al.*, 2021). Mechanical methods use hot

water for steaming and sterilization to destroy and kill weeds as well as use of nets as a barrier to prevent insect pests (Dara, 2019; Humayun & Ruslan, 2014).

Biological methods involve the introduction of natural enemies such as predators and parasites to attack or suppress the insect pests affecting the crops (Khan *et al.*, 2021). It is a natural and target-specific way of controlling pests and weeds in a crop farm in which plant extracts containing insecticidal properties (botanicals) are used to destroy or repel insect pests and prevent disease infections in crops (Dara, 2019; Mwangi & Kariuki, 2015). Reports have shown that biological methods have been effectively achieved to control pests both in greenhouses and in open fields through the introduction of natural enemies to feed on harmful insect pests (Dara, 2019).

In Kenya, the biological control methods are available such as use of natural enemies in crop protection. However, suppliers mainly put their main focus on farmers doing crop production for export as many farmers on the other hand lack technical knowledge in breeding these natural enemies. This makes it difficult for its widespread adoption as there is no support for the registration and adoption of non-exotic biological methods. Behavioral control methods confuse insects during their mating seasons through the use of insect pheromones and poisonous attractants to trap or attract them into toxic baits (Dara, 2019; Karamidehkordi, 2014; Kughur, 2020). Infertile male insects can also be released to reduce the insect population by preventing them from reproducing (Khan *et al.*, 2021).

Chemical control methods are only applied when needed and not for preventive measures where selective and non-persistent pesticides are preferred since they only act on target organisms or species and remain active in the environment for a short period (Karamidehkordi, 2014). Farmers mainly rely on pesticides because they are easy to use, effective, saves on time, and guarantee high crop production hence encouraging farmers to abandon other IPM practices (Deguine *et al.*, 2021). Reports have explained how pesticide application in crop production has been increasing due to phytosanitary education on farming, and monitoring programs being ventured mainly by agrochemical organizations (Deguine *et al.*, 2021). It is reported that control and management of crop pests and diseases in Africa is mainly through use of pesticides where majority of farmers

tend to excessively apply these pesticides more frequently by blending different pesticide products and brands to enhance their effectiveness (Dorothy *et al.*, 2019).

2.3 Determinants of Integrated Pest Management Adoption

The decision of farmers to adopt an IPM technology depends on social, economic, and environmental factors. The adoption of IPM technology among farmers is based on the choices they make. Farmers often make decisions based on certain background conditions affecting crop production (Maguza-Tembo *et al.*, 2017). The diffusion of innovation results from farmers' enthusiasm and readiness to adopt the new technology in relation to its importance and the cost of implementing it (Mwangi & Kariuki, 2015). A farmer's level of education greatly influences the adoption of IPM technology by increasing the capacity to acquire relevant information on how to implement the technology (Thomas Bilalib Udimal & Owusu Samuel Mensah, 2017). Studies have shown that knowledge has a positive impact on adoption since farmers can understand and make decisions based on the importance of the technology (Ndimbwa, 2021).

Age is found to have influenced the adoption of new technology. Previous studies show that older farmers understand and make better decisions on the adoption of technology because of the great experience acquired in their farming than young farmers (Mwangi & Kariuki, 2015). Additionally, other reports have described young farmers to have a greater potential for adopting the new technology compared to older farmers as they are more interested in valuable and longer investments (Kughur, 2020). Different farm sizes and machinery ownership also influence IPM adoption as farmers with machinery such as tractors and large farms have more potential to adopt the technology since many of them can allocate part of the farm for technology trial (Emerick *et al.*, 2016; Udimal *et al.*, 2017).

Information sources help in the adoption of IPM technology as farmers are aware of or have heard about it. Uncertainty of IPM can lead to the incurrence of many losses in their crop production through pest management exposing them to many risks, and they may also lack adequate information on how to face these risks such as pest infestation and market risks due to low output on the crop produce (Alwang *et al.*, 2019). Insufficient training and technical support to farmers may limit farmers' knowledge required for

understanding IPM and its constituent process as many farmers are unaware of complex practices such as biological control methods. The different techniques of passing the information may not reach many farmers because of few extension officers and inadequate funds to aid field demonstrations (Murray *et al.*, 2020).

Household income greatly influences IPM adoption it provides farmers with adequate capital for trial and implementation process. Farmer's occupation greatly determines IPM adoption as it is the source of income for crop production. The diverse sources of income are important among many farmers as they limit fluctuations and ensure sustainable livelihoods (Strzelecka & Zawadzka, 2021). The diversification of farmers' occupations reduces risk exposure caused by agricultural produce losses. Farmers with higher income are able to purchase farm inputs such as fertilizers, herbicides, and insecticides. This encourages dependence on pesticides compared to farmers with lower income as they may not afford to purchase all the farm inputs. They therefore integrate synthetic pesticides with natural IPM methods (Mwangi & Kariuki, 2015).

Climate change and variabilities such as long droughts and floods have led to reduced soil fertility, general degradation of the environment and landscapes, and pest resurgence which have made many farmers opt for synthetic pesticides because they find it easy to provide solutions and meet the demand for food from the growing population (Munyuli *et al.*, 2017). Agriculture at large mainly faces new threats which are a result of changes in climate leading to outbreaks of pests and diseases hence altering crops and their normal abiotic environment (Karlsson Green *et al.*, 2020). Pesticide use in large-scale farming does not require intense effort due to mechanization compared to cultural methods such as manual weeding, preparing compost manure, and timely planting which may not be effective as it is tiresome, time-consuming, and require a long time to plan (Akenga *et al.*, 2017).

The lack of favorable government policies and support makes it challenging to train farmers in crop protection through IPM policy implementation (Pretty & Bharucha, 2015). This is because of challenges to food security which encourage farmers to rely on synthetic pesticides (Wyckhuys *et al.*, 2019). The powerful influence of the pesticide industry leads to the availability of cheap pesticides in the markets which has contributed

to the low adoption of IPM technology. Farmers often depend on pesticides because of their immediate effectiveness, ease of use, cost-effectiveness, and also a guarantee of high crop yields (Heller *et al.*, 2020; Pretty & Bharucha, 2015).

2.4 Information dissemination channels for integrated pest management adoption.

The information dissemination is greatly influenced by the availability of advisory channels such as extension officers which bring a good collaboration with the farmers hence fostering the adoption of good agricultural techniques (Malekani & Mubofu, 2020). These communication channels can be used to convey both natural and chemical IPM information (Deguine *et al.*, 2021). To achieve this, the IPM strategy requires an adequate understanding of farmers' knowledge of agricultural production and practices in managing and controlling pests and diseases. This information will help to incorporate a strategy that helps farmers successfully adopt IPM practices (Dara, 2019).

Dissemination methods through field exhibitions, agricultural extension officers, Farmer Field Schools, electronic media, and village gatherings spread information on farming innovations (Nyagwansa *et al.*, 2021). A recent study from Punjab, Pakistan, pointed out that the accessibility of knowledge has promoted farmers' synthetic pesticide hazard awareness and encouraged the implementation of IPM, especially through Farmer Field Schools where the educated farmers adopted the organic methods of pest control (Khan *et al.*, 2021).

Studies have shown that mass media and farmer field days are cheaper methods of information dissemination as they enhance the adoption of simpler practices compared to farmer field schools which are expensive and require more time to learn complex practices such as biological methods in detail and put them into practice (Dorothy *et al.*, 2019; Kughur, 2020; Pretty & Bharucha, 2015). However, the farmer field schools have achieved results by training farmers intensively (Alwang *et al.*, 2019). A small group of farmers trained on complex practices through learning every IPM practice and putting them into practice repeatedly has been shown as an effective way to IPM adoption (Alwang *et al.*, 2019; Dara, 2019; Deguine *et al.*, 2021).

Agricultural extension services provide the farmers with information on safe agricultural practices and also build the farmers' knowledge which is important in developing new

methods of agricultural production. The education level of farmers influences information dissemination through various advisory channels (Khan, 2020). The effectiveness of the information channels is subject to the farmers reached and their readiness to adopt new technology. The advisory channel is considered as effectual when the information is relayed in the preferred language that suits the needs of the user (Nyagwansa *et al.*, 2021).

Several farmers rely on other farmers as their first-hand origin of information on agricultural practices which has been considered a common and effective dissemination channel. Therefore, a farmer with practical knowledge can organize field exhibitions and educate other farmers on good agricultural practices (Deguine *et al.*, 2021). Agroveterinarians and suppliers also play a significant task in providing instruction to farmers on pesticides handling hence a quick advisory channel which disseminates knowledge because of their closeness to farmers (Parsa *et al.*, 2014).

According to a recent study to identify the advisory channels used for safe agrochemical use in Kisii County, the agricultural extension officers were most useful to farmers in channeling the information (Ndimbwa, 2021). Farmers relied on effective pesticide sellers and farmer trainers which were most effective as it would reach a large and wide area of targeted farmers (Nyagwansa *et al.*, 2021).

2.5 Theoretical framework

2.5.1 Diffusion of Innovation Theory

The theory was originated by E.M Rogers in 1962 which describes human behavior and their choices in adopting or rejecting a new technology depending on the experience and the individual's level of education. Extension planners and researchers have widely used it to understand why extension programs encourage the spread of organic farming (Wyckhuys *et al.*, 2019). According to Vargo *et al.* (2020), diffusion is a technique of spreading a new technology or innovation through certain means of communication over a period of time. Modern farming technologies aim to minimize pesticide use through information communication technologies to reach farmers or growers (Jørs *et al.*, 2017).

According to Emerick *et al.* (2016), dissemination approaches could be village meetings where farmers choose the best person to spread the information to their fellow farmers in

the village. Farmer field schools and field exhibitions through training and demonstrations provide detailed information to the adopters (Vargo *et al.*, 2020). An individual attempts to discover the invention, how it works, and ways to ensure the information is spread to the individuals (Roobroeck & Lee, 2019). Diffusion of innovation theory can be applied in the context of IPM practices to understand the rate of adoption or rejection and how the new technology innovation spreads among large-scale farmers. Certain factors attributed to this innovation including socio-economic and environmental factors greatly influence farmers' adoption (Rahman, 2017).

2.5.2 The Prospect Theory

The theory was developed in 1979 by Daniel Kahneman and Amos Tversky where human attitudes affect decision-making depending on the consequences (Mitkov, 2022). IPM adoption rate may be slower or faster depending on the choice of method and its application time (Wyckhuys *et al.*, 2019). Because of the uncertainty of IPM practices, farmers compare between making losses and profits in crop production and therefore decide on the best option for them due to loss aversion (Alwang *et al.*, 2019). Over-confidence may lead to farmers' making wrong decisions in crop production such as frequent monocropping, and over-dependence on synthetic pesticides (Pretty & Bharucha, 2015).

Farmers with limited attention are not fully informed of the consequences and therefore, end up making wrong decisions from the available options (Alwang *et al.*, 2019; Tudi *et al.*, 2021). Menu effects consisting of several crop production methods may sometimes overwhelm the farmer since he/she has to choose between many options, leading to a decision to take simple methods for crop production regardless of any consequences. Many farmers prefer pesticides because of their immediate solution and find other practices difficult to adopt while others find pesticides too expensive to purchase and prefer cultural, physical, and biological methods (Roobroeck & Lee, 2019).

2.6 Institutional Arrangements on Integrated Pest Management Adoption

Agriculture has been put to emphasis by the Kenyan government to ensure farmers utilize farm inputs in increasing crop production to meet food demand by the growing population. Integrated pest management plan ensures safe application of pesticides to

reduce environmental pollution and climate change (RoK, 2013). In 2006, a conference was held in Dubai on the management of chemicals through implementing the Strategic Approach to International Chemicals Management (SAICM). Implementation of this approach requires the development of strong accountability regime. Management of pesticides in Kenya has been lacking regulations and is therefore at risk of chemical hazards. Kenya has high exposure to improper disposal of banned and toxic pesticide products. The government has collaborated with international bodies in developing national policies which help in curbing hazardous pesticide products and disposal mechanisms to safeguard human health and the environment (RoK, 2012).

2.6.1 The National Agricultural Research Systems Policy

The policy gives the basis for agricultural research in various sectors as it focuses on supporting and enhancing the development and growth of innovation, commercial stability, and modernized agriculture. The Policy also ensures that goals and objectives are well grounded, influence gaining research programs and, quick adoption of convenient technology as well as scientific knowledge and promoting capability in accessing and adopting an innovation and available information about technology. This gives the ability to solve research problems affecting communities and provide adequate knowledge developed within the local communities through practical experiences which can easily be transferred from one person to another hence easy adoption (Agriculture *et al.*, 2018)

2.6.2 The National Agricultural Sector Extension Policy

The policy enforces Agricultural Sector Development Strategy focusing mainly on extension programs. This is through encouraging extension officers to employ the use of sustainable, advanced, creative, and efficacious extension methods. This is particularly to those advancing to consumer preferences and approaches beneficiating the users during the application of the technology selected and the extension procedure used in channeling the information. This harnesses segregation in passing knowledge through the creation of various groups for example ordinary people with the same interests, farmers' associations, and face-to-face interaction. This is done through public awareness,

considering the significance of the new innovation, and its practical knowledge to the user (Agriculture *et al.*, 2018).

2.6.3 The National Food and Nutritional Security Policy

The Policy strive to ensuring production and supply of healthy and safe food to consumers. It also aims at meeting the nutritional value as well as sufficiency to meet the demand and satisfactory within the country. The Policy focuses on furthering agricultural production to environment-free production where soil fertility is improved through use of organic methods and agricultural biodiversity. Through this policy, farmers are encouraged to adopt the use of irrigation systems in their crop production. (Agriculture *et al.*, 2018).

2.6.4 World Bank Operational Policy on Pest Management

The World Bank (Kelly & Chhibber, 2005) evaluates how crop pests are controlled and managed through the use of various ways. It works to ensure IPM is applied as well as proper handling and safe application of pesticides. The World Bank does not guarantee pesticides belonging to classes of Ia and Ib of WHO. This reduces over-dependence on pesticides and ensures an economic and environmentally-friendly pest management approach. The bank also supports regular monitoring such as engaging the community in participation, Environmental impact assessment, and funding projects particularly to aid in IPM adoption and implementation (RoK, 2016).

2.6.5 Pesticides Control Products Act (chapter 346)

The act explains how counterfeit pesticides are illegal and therefore anyone found with such adulterated products of pesticide products shall be guilty of the committed offense. The person will be charged with a fine of Ksh. 250,000- 1,000,000 or imprisoned for 2 years. The Act also states that no person is allowed to import or export pesticide products which does not meet the required standards and regulations under the law (RoK, 2010). It ensures the protection of the environment and its surrounding natural resources against toxic substances and other pollutants hence preserving biodiversity (RoK, 2010).

2.6.6 The Agricultural Sector Development Strategy (ASDS)

The strategy seeks to enforce the Kenya Vision 2030 in agriculture where it investigates two key thrusts as vision of food security and a developing nation. This is through increasing crop production, monetization of agricultural commodities and initiatives as well as advancing and operating the major factors of agricultural production. The strategy also supports the improvement of irrigation systems to reduce the negative impacts of climate change on crop production which could trigger pests and disease outbreaks. This ensures that the government implements the climate change response strategy such as conventional prediction of natural disasters on agricultural production caused by climate change and their possible mitigation measures (RoK, 2020).

2.6.7 The National Agricultural Research Systems Policy

This policy gives the basis for the agricultural research sector as it purposes to enhance its improvement in the research organizations to promote the expansion of agricultural innovations, trade, and modernized crop production. The Policy focuses on meeting objectives such as problem-solving, creating research programs, facilitating the adoption of new technologies, and providing knowledge towards building the capacity among farmers to enable them access, adopt, and implement the suitable agricultural practices at hand (Agriculture *et al.*, 2018).

2.7 Research Gap

According to the literature review based on key objectives, many studies have shown the different IPM practices such as cultural methods, physical methods, biological methods, and chemical methods. However, it is not clear whether large-scale farmers have adopted all these practices or not. The literature has also discussed various determinants of IPM adoption such as education, age, farm size, pest and weed resurgence, household income, farmer field days participation, farmers' main occupation, and machinery ownership which influence its adoption. The literature has also discussed the dissemination channels used to spread the information on IPM adoption such as field exhibitions, agricultural extension officers, farmer field days, farmer-to-farmer training, and village gatherings. From the literature, little knowledge and information among many farmers regarding proper pesticide handling and usage is evident. However, it's not clear whether farmers

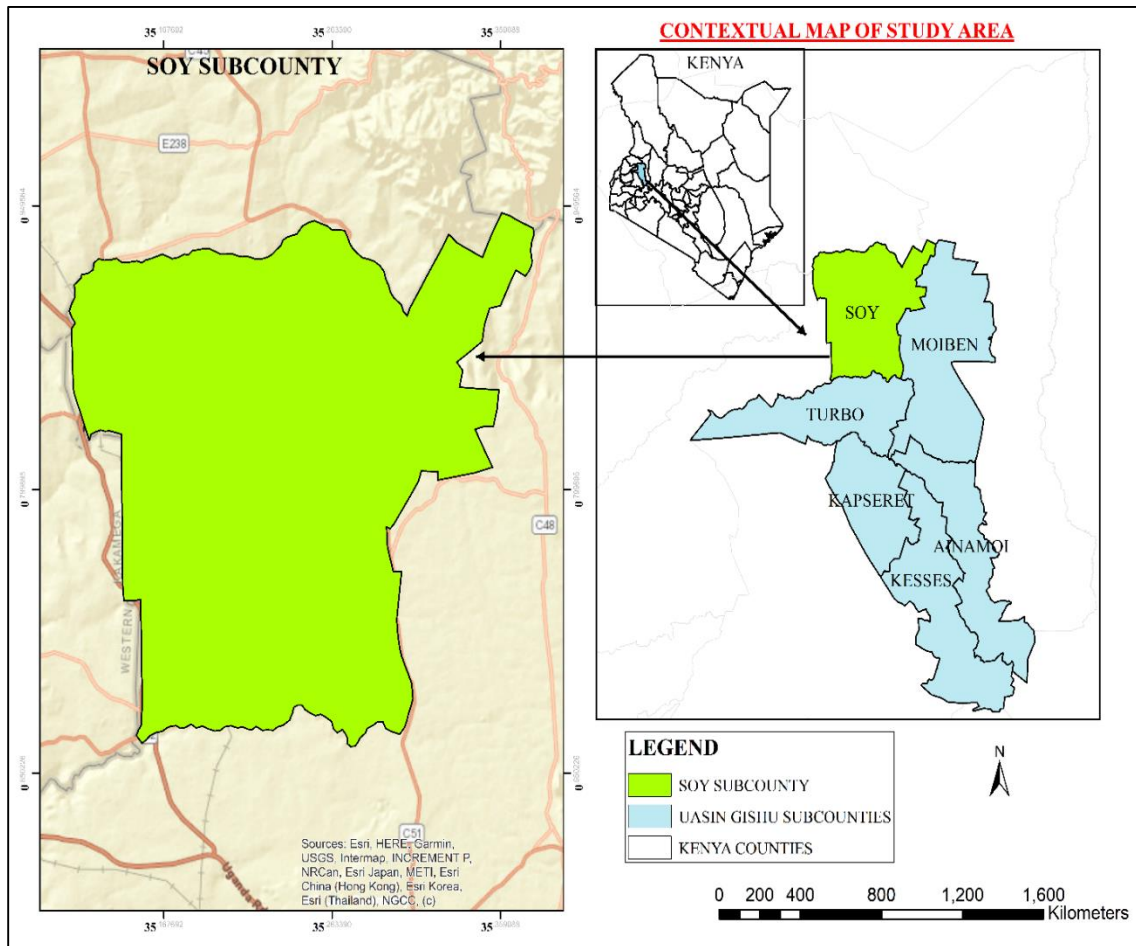
particularly large-scale farmers know other alternatives of crop protection practices that are environmentally safe such as natural IPM practices. Therefore, there is a need to understand the strategies used to educate large-scale farmers on IPM practices and the determinants for their adoption.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

Uasin Gishu County borders Trans Nzoia to the north, Kakamega to the northwest, Kericho to the south, Elgeyo Marakwet to the east, Nandi to the southwest, and Baringo to the southeast (Akenga *et al.*, 2017). The county comprises six sub-counties namely; Soy, Moiben, Turbo, Kapseret, Ainabkoi, and Kesses (Figure 2). Due to the research limitations, the study was conducted in Soy sub-county which lies between longitudes 35°10' East and 35°20' East and latitudes 0°40' North and 0°50' North where large-scale production of maize is predominant.

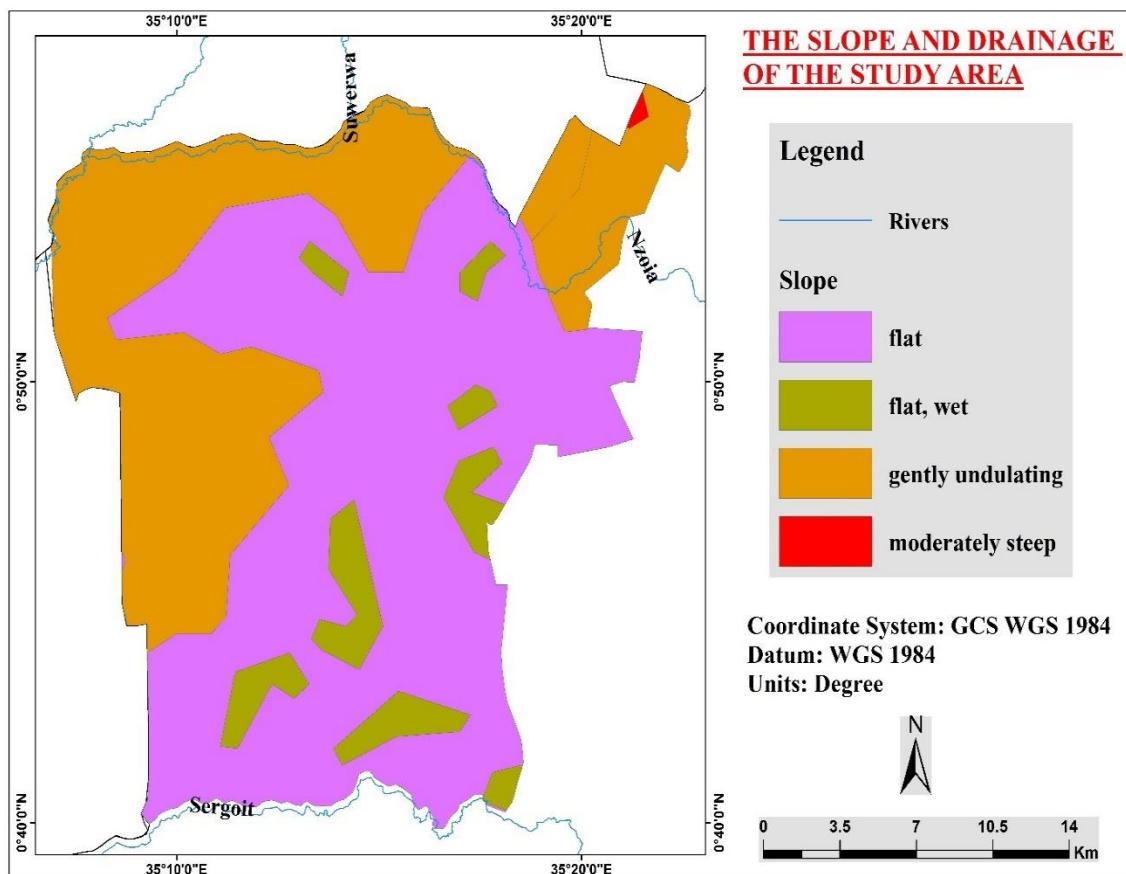


Source: ArcGis

Figure 2: Location of Soy sub-county

3.1.1 The Slope and Drainage of the Study Area

The county receives a high and reliable amount of rainfall of between 900 to 1,200 mm annually with a height of 1800 m above sea level (Akenga *et al.*, 2017). The county experiences temperatures ranging between 70 °C and 290 °C (RoK, 2022). The county has red loam and clay soils which are good for maize and other crop production. The area mainly consists of a flat and gently undulating landscape which is good for crop production as it reduces soil erosion and provides efficient development of good infrastructure. The area also comprises of several wetlands which help conserve water for agricultural production. The main river flowing through the sub-county is River Nzoia which drains excess water from the area during heavy rains hence reducing flood risks (Figure 3).

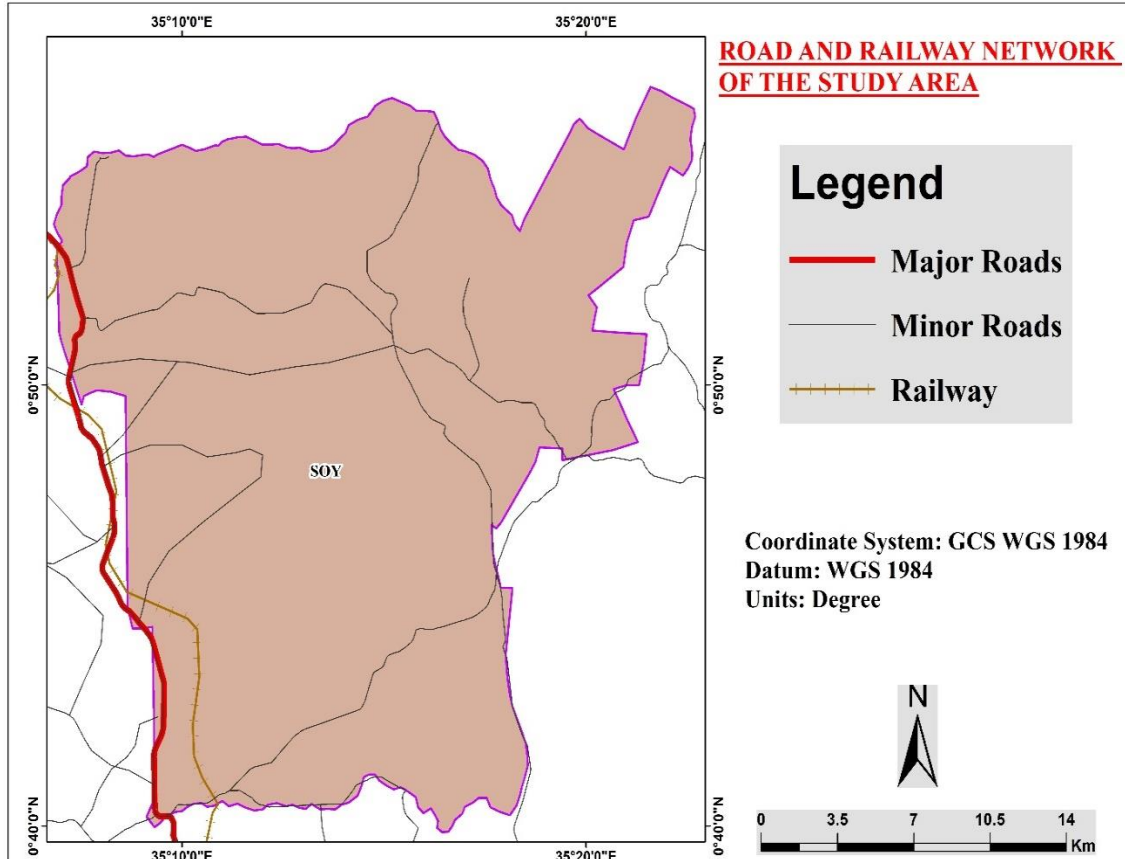


Source: Arc GIS

Figure 3: The slope and drainage of the study area

3.1.2 Infrastructure of the Study Area

The major road passing through the sub-county links the county to the neighbouring counties such as Trans Nzoia, Nandi, Elgeiyo Marakwet, and Kakamega hence making the county a hub for transport services. The minor roads within the sub-county promote easier transportation of agricultural produce to the market. The roads also provide easy movement of farm machinery during crop production (RoK, 2022). The Kenya-Uganda railway passes through the sub-county with a station in Moi's Bridge forming part of cheap means of transportation of goods including agricultural produce. The railway also creates an exchange of goods as it connects with the neighbouring country, Uganda (Figure 4).



Source: ArcGIS

Figure 4: Infrastructure of the study area

3.2 Research Design

The study employed a survey research design. The research design allowed the collection of data using different methods such as interview schedules, questionnaires, and focus group discussions (Costanzo *et al.*, 2012; DuBenske, *et al.*, 2014; Ponto *et al.*, 2010). Despite the method being expensive and time-consuming it enabled both qualitative and quantitative data collection which provided a comprehension of the various variables under study and gave reliable information from the data collected (Stern *et al.*, 2014; Van Wyk & Taole, 2015).

3.3 Sampling Procedure and sample size

The target population was the large-scale farmers in Soy sub-county. During field reconnaissance, the extension officers explained that based on the farmers' records, the sub-county had a total of 181 large-scale farmers. This study sought to investigate all the large-scale farmers in the sub-county. The study covered the accessible population of (85.6%), 155 large-scale farmers which were spread within the various locations in the sub-county.

3.4 Data collection

The study mainly involved primary data sources and secondary data. Primary data were obtained through household questionnaires administered to large-scale farmers, face-to-face interviews with extension officers, and a focus group discussion with the farmers association. A focus group discussion with the farmers was conducted to give information on their experience with integrated pest management practices and adoption. Face-to-face key informant interviews with extension officers gave information on the strategies for conveying information to farmers on IPM adoption. A total of 155 large-scale farmers in the sub-county were surveyed from 13 locations which included; Ziwa, Soy, Sirikwa, Segero, Moi's Bridge, Matunda, Kuinet, Kongasis, Koisagat, Kipsomba, Kibulkeny, Kapsang, and Barsombe. The single focus group discussion had a total number of 7 members with the moderator (researcher) and the participants (large-scale farmers) which was an effective method to obtain in-depth information that the questionnaire could not gather (Tümen Akyildiz & Ahmed, 2021). It also provided a conducive environment for the participants to express their ideas and feelings. (Tümen Akyildiz & Ahmed, 2021).

The focus group discussion schedule took a period of 1 hour where voice recording and note-taking were mainly used to collect the data (Nyumba *et al.*, 2018).

3.5 Data analysis

Descriptive statistics was used to summarize data through tables, graphs, and pie charts. Qualitative data from a focus group discussion with the large-scale farmers and face-to-face interviews with agricultural and extension officers from the Ministry of Agriculture was analyzed using qualitative content analysis. This was done through systematic writing of data collected and organized into different categories according to the different information obtained (Nyumba *et al.*, 2018). The data was then combined with the data obtained from household questionnaires.

3.6 Ethical consideration

The permission to conduct the study was granted by the National Commission for Science, Technology and Innovation (NACOSTI), county commissioner, county ministry of education, sub-county assistant commissioners and the chiefs from the locations in Soy sub-county. The participants taking part in interviews, focus group discussions and questionnaires were briefed regarding the research study to ensure they were well informed about the procedures, any possible risks associated with the receptive nature of the research study and the right to withdraw from participating in data collection. Respondents were protected from any harm including confidentiality of their individualities so that their personal details such as professionalism and personal qualities were not mentioned in the results. Privacy and anonymousness were also maintained to avoid psychological harm among the respondents.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter shows the results from the study based on the research objectives. The first part assessed integrated pest management practices and their level of adoption among large-scale farmers. The second part assessed the various determinants of integrated pest management adoption among the large-scale farmers and the third section assessed the information dissemination channels for the adoption of IPM practices among the large-scale farmers in soy sub-county, Uasin Gishu, Kenya.

4.2 Integrated Pest management practices and their level of adoption

From the survey conducted, IPM practices adopted were both natural methods and chemical control methods. Table 1 shows that out of 155 farmers surveyed, a total of 103 farmers had adopted the natural methods which were cultural, physical, and biological methods. The natural IPM practices were spread across Ziwa (3.88%), Soy (8.74%), Sirikwa (6.80%), Segero (9.71%), Moi's Bridge (11.65%), Matunda (12.62%), Kuinet (13.59%), Kongasis (4.85%), Kipsomba (6.80%), Kibulkeny (8.74%), and Kapsang (12.62%) locations. The respondents from Barsombe and Koisagat locations have been encountering the outbreak of persistent crop pests and diseases which has forced them to mainly depend on chemical control methods as they reported the method to be more effective.

On the other hand, a total of 138 large-scale farmers had adopted chemical control methods consisting of herbicides, insecticides, and fertilizers. The chemical control methods had higher adopters compared to natural methods and were distributed across all the locations; Ziwa (5.07%), Soy (9.42%), Sirikwa (7.25%), Segero (5.80%), Moi's Bridge (10.14%), Matunda (9.42%), Kuinet (10.14%), Kongasis (3.62%), Koisagat (7.25%), Kipsomba (5.07%), Kibulkeny (7.25%), Kapsang (12.32%) and Barsombe (7.25%) locations (Table 1). Kapsang location reported the highest dependence on chemical control methods due to the largest concentration of large-scale farmers .

Table 1: Adoption of IPM practices among large-scale farmers in different locations

Location	No. of large-scale farmers	Percentage	Natural methods adoption	Percentage	Chemical methods adoption	Percentage
Ziwa	8	5.2	4	3.88	7	5.07
Soy	17	11.0	9	8.74	13	9.42
Sirikwa	10	6.5	7	6.80	10	7.25
Segero	17	11.0	10	9.71	8	5.80
Moi's	14	9.0	12	11.65	14	10.14
Bridge						
Matunda	13	8.4	13	12.62	13	9.42
Kuinet	14	9.0	14	13.59	14	10.14
Kongasis	5	3.2	5	4.85	5	3.62
Koisagat	10	6.5	0	0	10	7.25
Kipsomba	7	4.5	7	6.80	7	5.07
Kibulkeny	10	6.5	9	8.74	10	7.25
Kapsang	20	12.9	13	12.62	17	12.32
Barsombe	10	6.5	0	0	10	7.25
Total	155	100.0	103	100	138	100

Table 2: Different IPM practices and their adoption among large-scale farmers

IPM practice	Total number of large-scale farmers	No. of adopters	Percentage
Cultural practices	155	101	65.2
Physical practices	155	83	53.5
Biological practices	155	54	34.8
Chemical practices	155	138	89.0

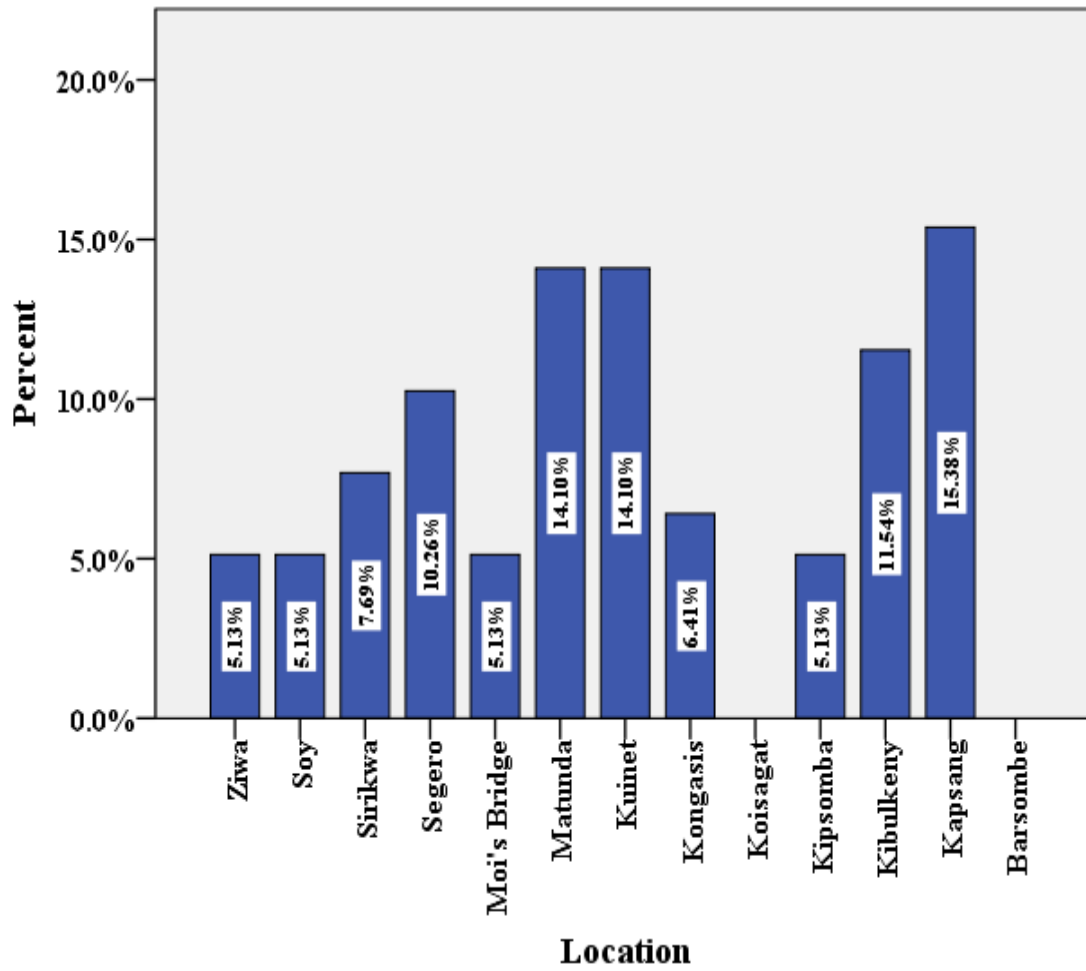


Source: Field survey, 2024

Plate 1: During a focus group discussion with the farmers' association

4.2.1 Cultural practices

The adoption of cultural practices among the respondents was evident as 65.2% of the large-scale farmers have adopted the practice (Table 2) with Kapsang location having the largest adopters of 15.38% (Figure 5). Majority of the respondents have embraced cultural practices and their significance in controlling crop pests and diseases. The main cultural practices adopted were cleaning and disinfecting farm machinery to prevent the transfer of pest larvae and weeds from one farm to another during plowing, planting, and spraying. Many farmers have also adopted intercropping and crop rotation with other crops such as beans, wheat, and sunflower crops as a way of enriching soil with nutrients hence reducing over-dependence on synthetic fertilizers. Other respondents also explained that maize stooking is done to reduce pest infestation and post-harvest diseases such as fungus. The practices adopted were as per (Dara, 2019). Despite the high adoption of cultural practices, the farmers still integrate with chemical control methods due to persistent weeds and pesticides which were explained to easily cause damage to crops.



Source: Field survey, 2024

Figure 5: Adoption of cultural practices within the locations

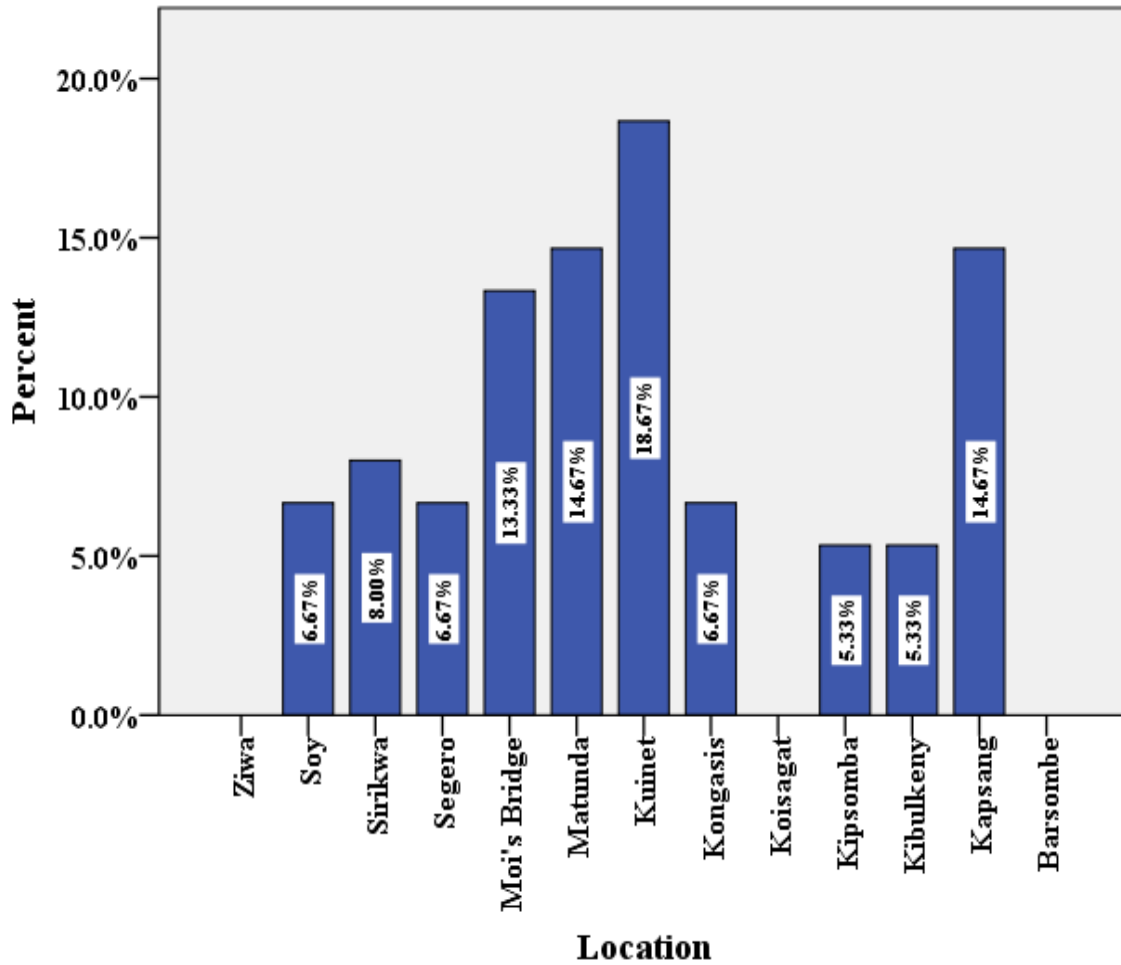


Source: Field survey, 2024

Plate 2: An example of maize stooking before harvesting

4.2.2 Physical practices

From the survey conducted, Table 2 illustrates that 53.5% of the large-scale farmers have adopted physical practices where 18.67% from Kuinet location were the largest adopters (Figure 6). The physical practices adopted were hand weeding and manual uprooting of weeds as an alternative to the use of synthetic herbicides. Other farmers use insect traps and scarecrows to scare away birds and other insects from attacking the crop field. The practices adopted were similar to (Khan *et al.*, (2021) on the description of physical practices. Despite its significance in protecting the environment against pollution from pesticides, the majority of large-scale farmers still rely on pesticides to control weeds and insect pests. The farmers reported that practicing physical methods such as manual weeding is labor-intensive and time-consuming.



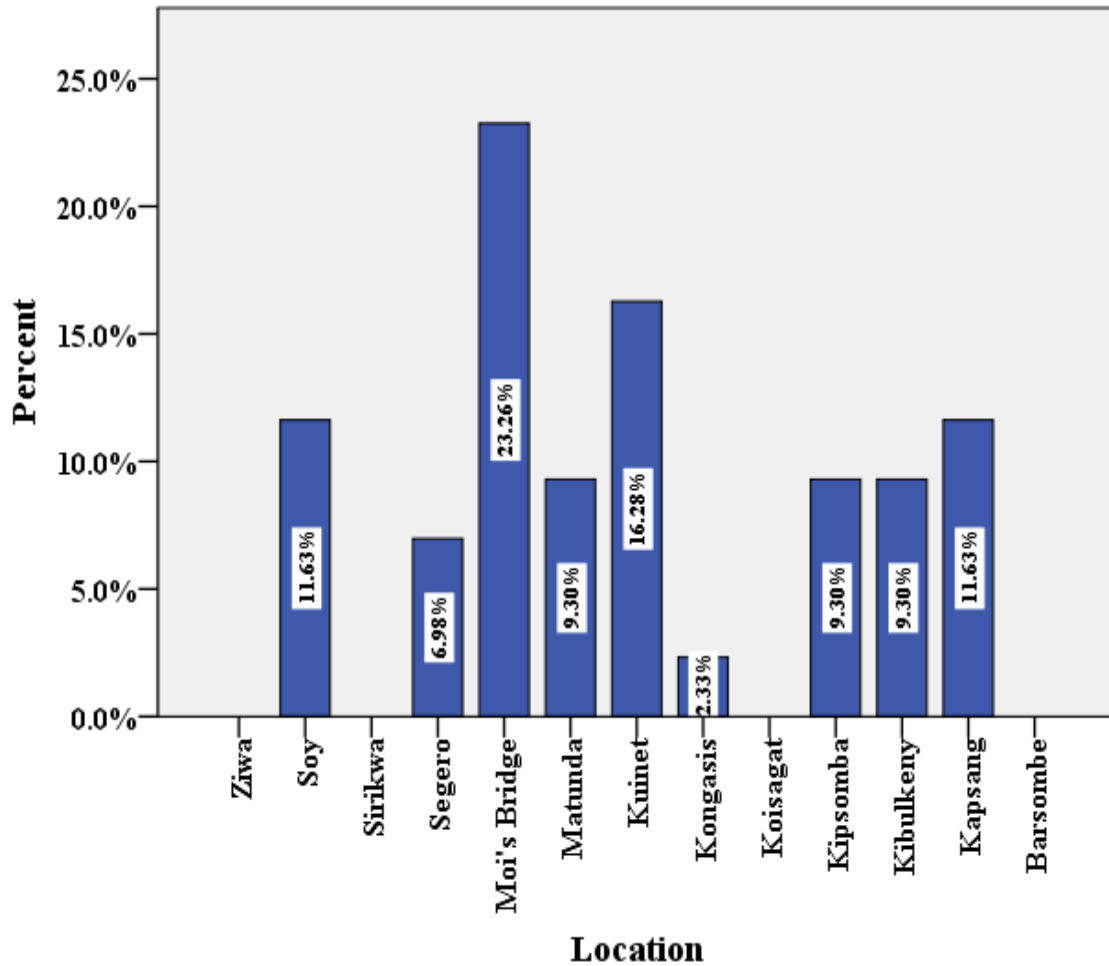
Source: Field survey, 2024

Figure 6: Adoption of physical practices within the location

4.2.3 Biological practices

According to Table 2, 34.8 % of the large-scale farmers have adopted biological practices with the largest number of adopters being 23.26% from Moi's Bridge location (Figure 7). Botanicals were the main biological practice where farmers obtained extracts from certain plants to be used in controlling pests and diseases in maize farms. Majority of the large-scale farmers reported that fall armyworms and stalk borers have developed resistance to synthetic pesticides and cause much damage on their maize crops leading to crop failure. A group of farmers discovered the idea of obtaining extracts from red pepper, tobacco, and neem where they found their effectiveness when the mixture is combined to control fall armyworms and stalk borers in maize production. The botanicals adopted were

reported to have been used to suppress insect pests which is similar to the study conducted by Khan *et al.*,(2021). However, its adoption among large-scale farmers is still low as the little extract obtained does not cover a large farm. Other respondents have adopted the use of compost manure as they reported that subsequent use of synthetic fertilizers increases soil acidity hence organic manure is an alternative method to balance the soil pH.



Source: Field survey, 2024

Figure 7: Adoption of biological practices within the locations



Source: Field survey, 2024

Plate 3: A sample of compost manure

4.2.4 Chemical control methods and their adoption

Out of 155 respondents, a total of 138 farmers had adopted chemical methods as the main control methods to boost maize production. Table 3 illustrates that the pesticides adopted were herbicides (100%), fertilizers (99.28%), and insecticides (76.81%). Glyphosates, metolachlor, and atrazine such as round-up, lumax, and primagram gold were mainly used as herbicides to kill weeds in the maize farm. Carbamates and organophosphates such as malathion, emamectin benzoate, and carbofuran were mainly used as insecticides. Synthetic fertilizers such as nitrogen phosphorous and potassium (NPK), Diammonium phosphate (DAP), Calcium ammonium nitrate (CAN), and Urea were mainly used to increase crop quality and quantity. The majority of these pesticides used among the respondents have been proven to be highly toxic and carcinogenic some of which are counterfeit products and therefore exposing animal and human health to risks as per the research done by Hashimi *et al.*, (2020). The respondents also lacked knowledge on proper disposal of pesticide containers causing environmental pollution.

Table 3: Chemical control methods and their adoption

Location	Herbicides adoption	Percentage	Fertilizers adoption	Percentage	Insecticides adoption	Percentage
Ziwa	7	5.07	7	5.11	0	0.00
Soy	13	9.42	12	8.76	8	7.55
Sirikwa	10	7.27	10	7.30	10	9.43
Segero	8	5.80	8	5.84	7	6.60
Moi's Bridge	14	10.14	14	10.22	14	13.21
Matunda	13	9.42	13	9.49	12	11.32
Kuinet	14	10.14	14	10.22	11	10.38
Kongasis	5	3.62	5	3.65	2	1.89
Koisagat	10	7.25	10	7.30	10	9.43
Kipsomb a	7	5.07	7	5.11	6	5.66
Kibulken y	10	7.25	10	7.30	7	6.60
Kapsang	17	12.32	17	12.41	9	8.49
Barsomb e	10	7.25	10	7.30	10	9.43
Total	138 (100%)	100	137(99.28 %)	100	106 (76.81%)	100



Source: Field survey, 2024

Plate 4: A sample of synthetic pesticides used by large-scale farmers



Source: Field survey, 2024

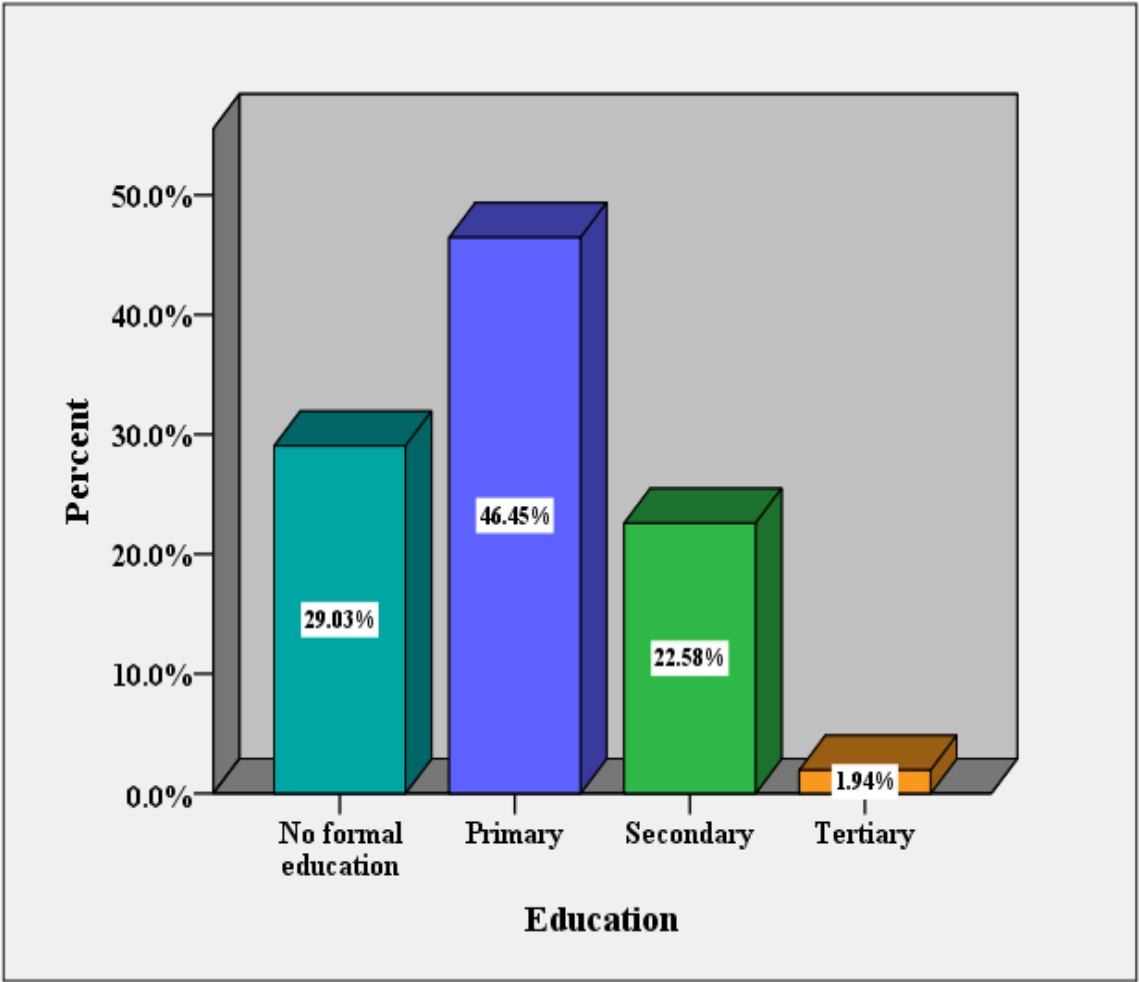
Plate 5: An example of environmental pollution caused by improper disposal of pesticide containers

4.3 Determinants of Integrated Pest Management Adoption

Integrated pest management adoption has been influenced by education level, knowledge on IPM practices, main occupation, household income, machinery ownership, age, farm size, farmer field days participation, and pest and weed resurgence.

4.3.1 Education level with knowledge of IPM practices

From the data collected, the highest number of respondents reached primary education level with 46.45%, 29.03% had no formal education, 22.58% reached secondary education level while the least number of respondents (1.94%) attained tertiary level of education (Figure 8). From the results in Table 4, majority of the respondents had knowledge on both natural and chemical methods of crop production. The majority of the respondents with the primary level of education had knowledge on all the IPM practices; cultural practices (46.85%), physical practices (47.45%), biological practices (40.52%), and chemical methods (46.38%). The respondents with no formal education had the knowledge on cultural (27.97%), physical (27.01), biological (29.31%), and chemical methods (30.43%) while the respondents who attained the secondary level of education had acquired knowledge on cultural (23.08%), physical (23.36%), biological (27.59%), and chemical methods (21.01%). Despite the least number of respondents having attained tertiary level, all had the knowledge on all the IPM practices.



Source: Field survey, 2024

Figure 8: Different levels of education among the large-scale farmers

Table 4: The knowledge of different IPM practice among the large-scale farmers

Education level	Knowledge on cultural practices		Knowledge on physical practices		Knowledge on biological practices		Knowledge on chemical methods	
	N	%	N	%	N	%	N	%
No formal education	40	27.97	37	27.01	34	29.31	42	30.43
Primary	67	46.85	65	47.45	47	40.52	64	46.38
Secondary	33	23.08	32	23.36	32	27.59	29	21.01
Tertiary	3	2.10	3	2.19	3	2.59	3	2.17
Total	143	100	137	100	116	100	138	100

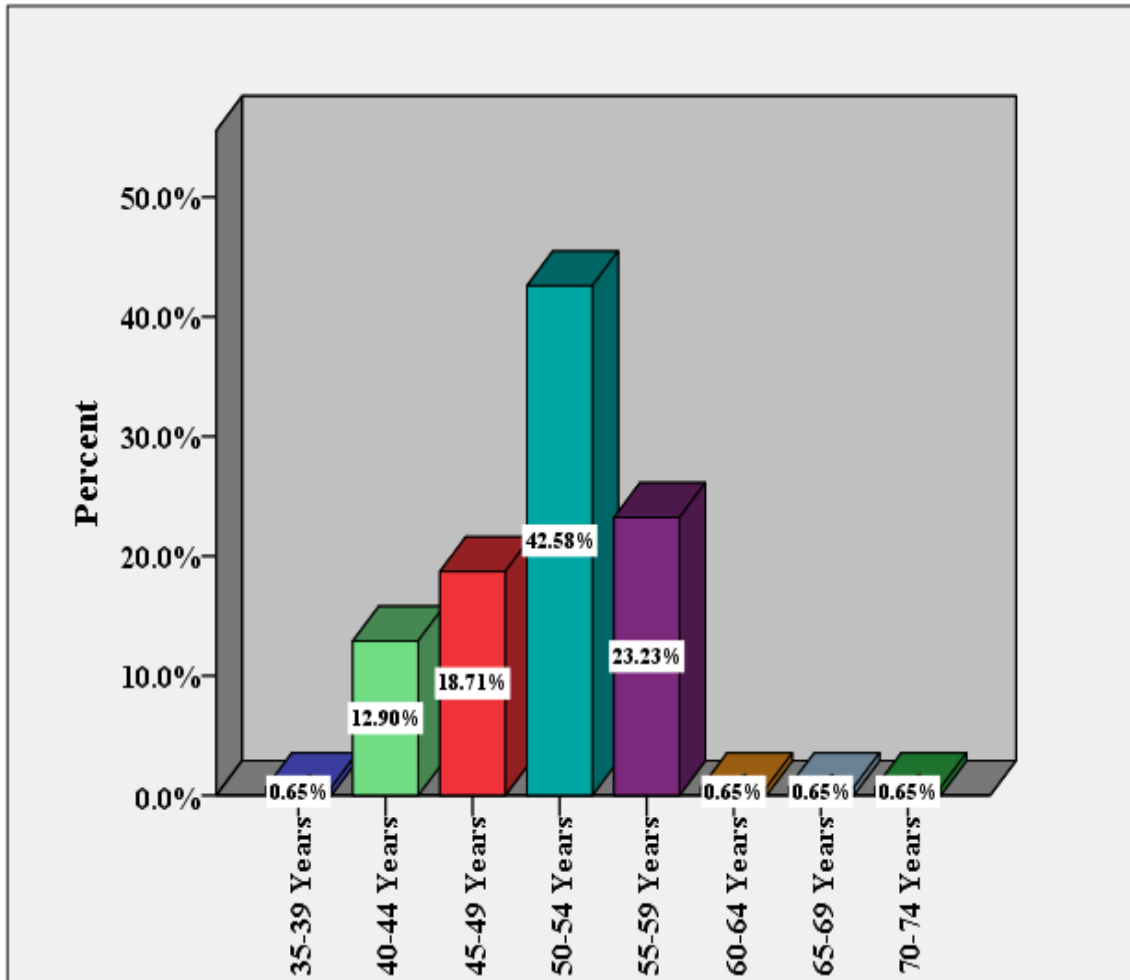
From Table 5 below, majority of the respondents with the primary level of education had adopted cultural (47.52%), physical (53.01%), biological (50.00%), and chemical methods (40.65%). Farmers with no formal education had adopted cultural (31.68%), physical (28.92%), biological (29.63%), and chemical methods (27.10%). The respondents with the secondary level of education had also adopted cultural (18.81%), physical (15.66%), biological (20.37%), and chemical methods (19.35). The respondents who have attained the tertiary level of education have adopted cultural (1.98%), physical (2.41%), and chemical methods (1.94%) (Table 5). The adoption of these IPM practices coincide with research done by Ndimbwa, (2021) that the adoption level depends on the knowledge which a farmer has on IPM practices regardless of education level as they can make better decisions based on the importance of IPM technology. Majority of the respondents with the primary level of education have invested in learning and adopting all the IPM practices as they are economical compared to overdependence on only chemical methods. The farmers have mainly adopted chemical methods because they are not interested in long-term practices of IPM (natural methods). Instead, they are mainly interested in learning easier and quicker methods of controlling crop pests and diseases to meet market demand for the produce through the use of synthetic pesticides.

Table 5: Adoption of different IPM practices among large-scale farmers based oeducation level

Education	Cultural practices		Physical practices		Biological practices		Chemical methods	
	N	%	N	%	N	%	N	%
No formal education	32	31.68	24	28.92	16	29.63	42	27.10
Primary	48	47.52	44	53.01	27	50.00	63	40.65
Secondary	19	18.81	13	15.66	11	20.37	30	19.35
Tertiary	2	1.98	2	2.41	0	0.00	3	1.94
Total	101	100	83	100	54	100	138	100

4.3.2 Age

Majority of the large-scale farmers under the survey were middle-aged between 40 to 59 years while the youngest were between 35-39 years and oldest were between 60-74 years (Figure 9). Table 6 shows that farmers aged 50-54 years have the highest number of IPM adopters with cultural (44.9%), physical (47.4%), biological (37.2%), and chemical methods (41.30%). This is because they have more interest in learning new IPM technology compared to older farmers who have more experience in commercial farming and mainly depend on chemical methods through the use of various synthetic pesticides to boost production. This makes it difficult for them to learn and adopt the natural IPM methods. This is similar to the research conducted by Kughur, (2020) on how young farmers are more likely to adopt IPM technology as they have more interest in learning new farming techniques compared to older farmers.



Source: Field survey, 2024

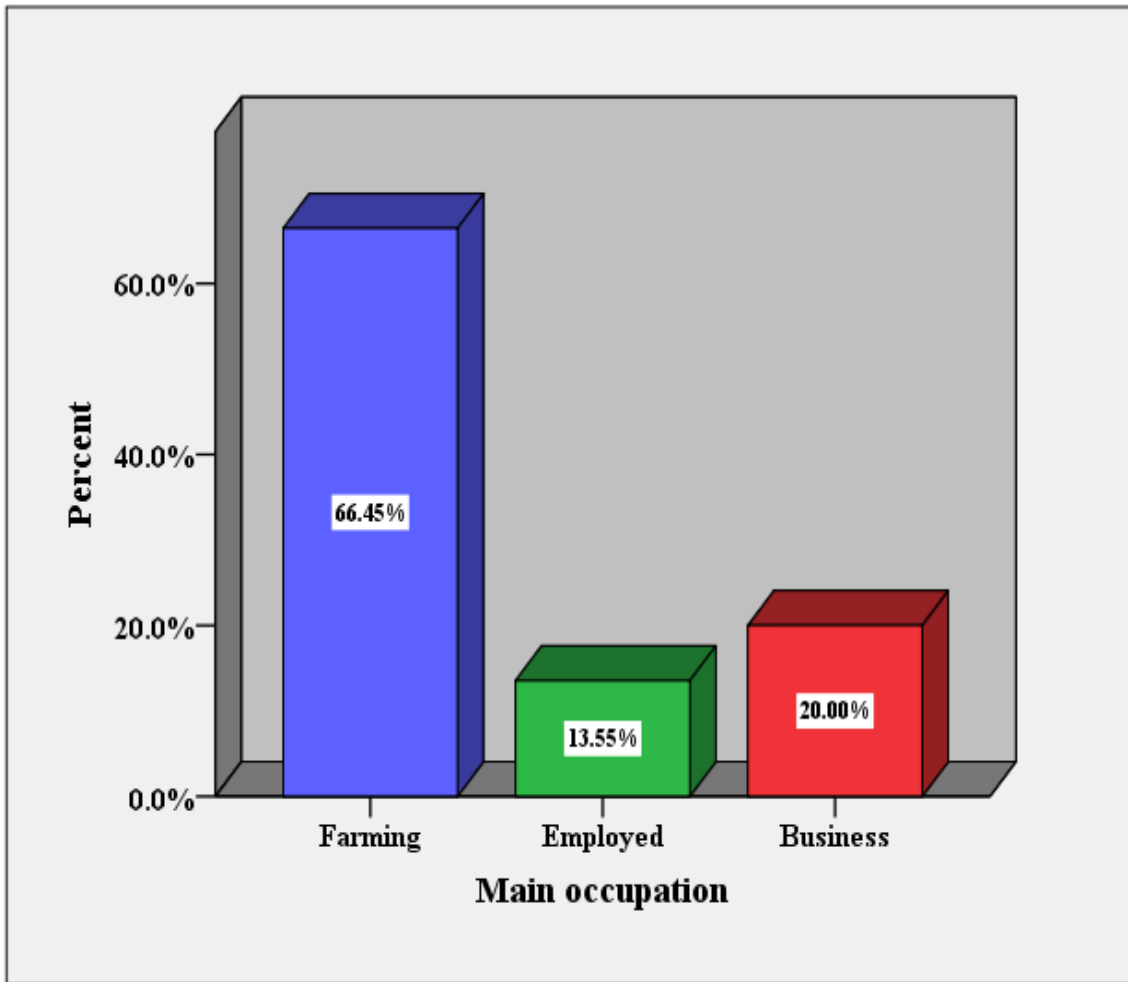
Figure 9: The different age brackets among the large-scale farmers

Table 6: Adoption of different IPM practices based on the age of the large-scale farmers

Age	Cultural practices		Physical practices		Biological practices		Chemical practices	
	N	%	N	%	N	%	N	%
35-39 Years	1	0.99	1	1.20	1	1.85	1	0.72
40-44 Years	11	10.89	8	9.64	7	12.96	19	13.77
45-49 Years	19	18.81	17	20.48	11	20.37	24	17.39
50-54 Years	45	44.55	37	44.58	21	38.89	57	41.30
55-59 Years	23	22.77	18	21.69	13	24.07	34	24.64
60-64 Years	1	0.99	1	1.20	0	0.0	1	0.72
65-69 Years	1	0.99	1	1.20	1	1.85	1	0.72
70-74 Years	0	0.00	0	0.0	0	0.0	1	0.72
Total	101	100	83	100	54	100	138	100

4.3.3 Main occupation

Figure 10 below shows the respondents' main occupations where majority of the respondents were farmers (66.45%), 13.55% were employed, and 20.00% were business traders (Figure 10). The respondents who mainly practice farming as their main occupation had the highest adoption of both natural and chemical IPM practices with cultural practices (60.40%), physical practices (63.86%), biological practices (62.96%), and chemical control methods (67.39%) (Table 7). This is because these farmers have a willing capacity to learn any new technology to boost the quality and quantity of crop yields. The farmers who do business have fairly adopted cultural practices (23.76%), physical practices (21.69%), biological practices (24.07%), and chemical methods (18.12%). The few employed respondents have little time to interact with other farmers in learning the natural IPM techniques and therefore mainly rely on pesticides to save on time. 15.84% of these farmers have adopted cultural practices, physical practices (14.46%), biological practices (12.96%), and chemical methods (14.49%) (Table 7). This is in contrary to research done by Strzelecka & Zawadzka, (2021) as diversification of farmer's occupation have little impact on IPM adoption. The respondents who mainly concentrate on farming as their main occupation have more interest in IPM practices.



Source: Field survey, 2024

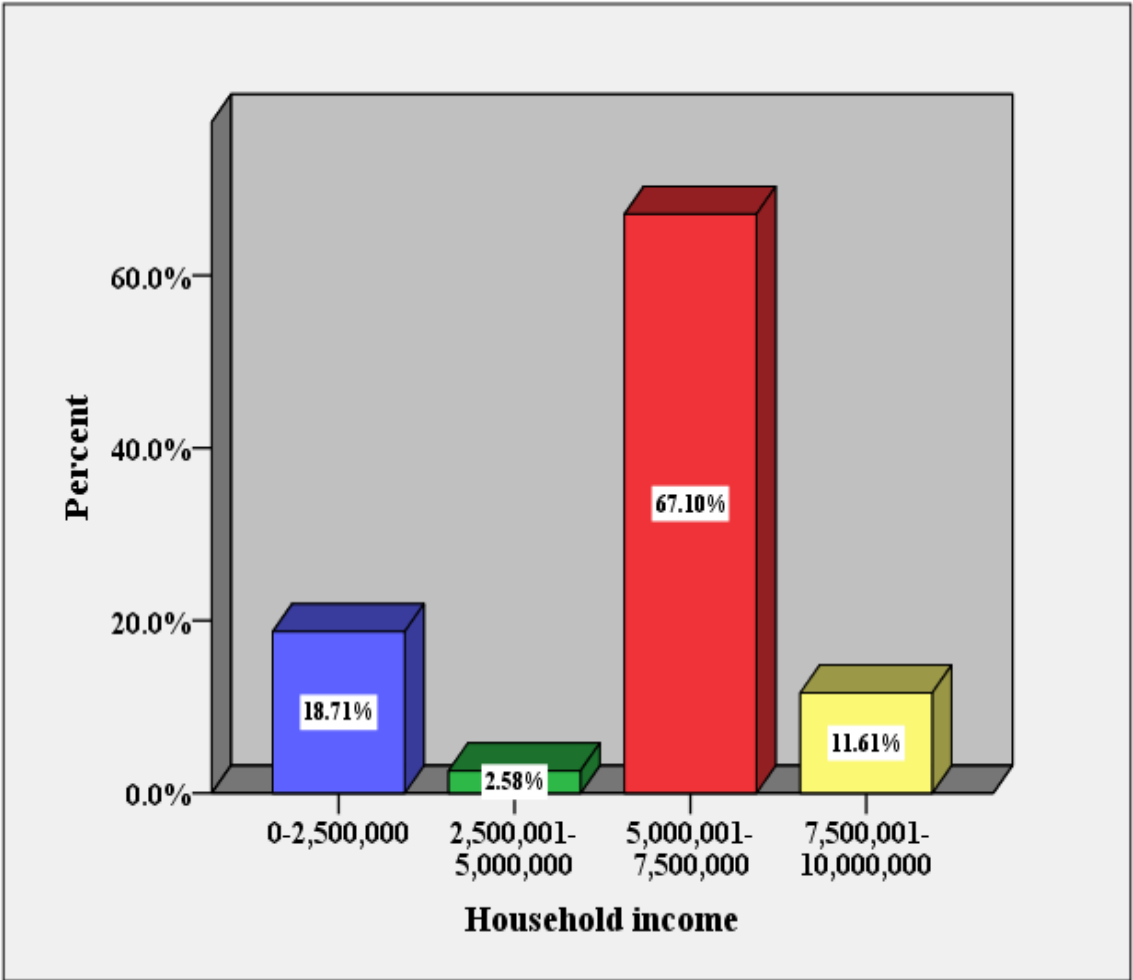
Figure 10: Different occupations among the large-scale farmers

Table 7: IPM practice adoption based on the farmers' occupation

Main Occupation	Cultural practices		Physical practices		Biological practices		Chemical methods	
	N	%	N	%	N	%	N	%
	Farming	61	60.40	53	63.86	34	62.96	93
Employed	16	15.84	12	14.46	7	12.96	20	14.49
Business	24	23.76	18	21.69	13	24.07	25	18.12
Total	101	100	83	100	54	100	138	100

4.3.4 Household income

From the survey conducted, majority of the respondents (67.1%) earn Ksh 5000,0001-7,500,000 annually. 18.71% of the respondents earn upto Ksh 2,500,000, 2.58 % earn between Ksh 2,500,001-5,000,000 while 11.61% earn Ksh 7,500,001-10,000,000 annually (Figure 11). The respondents earning Ksh 5000,0001-7,500,000 annually have contributed to higher adoption of cultural practices (67.33%), physical practices (69.88%), biological practices (74.07%), and chemical methods (65.22%) (Table 8). Despite the few numbers of farmers earning 0-2,500,000 (18.7%) and 2,500,001-5000,000 (2.6%), majority of them have managed to adopt both natural methods as well as integrating with chemical methods. The respondents with the highest household income have the least number of cultural practices (4.95%), physical practices (1.20%), and biological practices (7.41%). They have mainly adopted chemical control methods (10.87%) (Table 8). This is because farmers with higher income can easily purchase quality seeds and expensive pesticides mainly to boost production while farmers with lower income are unable to purchase all the pesticides and therefore choose to combine chemical methods with natural methods such as cultural, physical, and biological practices to save on expenses. This coincides with the studies showing how diffusion of innovation depends on farmer's willingness and readiness in relation to the cost of IPM implementation (Mwangi & Kariuki, 2015).



Source: Field survey, 2024

Figure 11: Different household income among the large-scale farmers

Table 8: Adoption of different IPM practices among the large-scale farmers based on household income

Household income	Cultural practices		Physical practices		Biological practices		Chemical methods	
	N	%	N	%	N	%	N	%
	0-2,500,000	25	24.75	21	25.30	9	16.67	29
2,500,001-5000,000	3	2.97	3	3.61	1	1.85	4	2.90
5000,0001-7,500,000	68	67.33	58	69.88	40	74.07	90	65.22
7,500,0001-10,000,000	5	4.95	1	1.20	4	7.41	15	10.87
Total	101	100	83	100	54	100	138	100

4.3.5 Farmer Field Day Participation

According to the respondents, farmer field days are usually conducted annually in Chebororwa Agricultural Training Centre in Uasin Gishu county. 34.90 % of the respondents participate in farmer field days (Table 9). They have adopted cultural practices (32.1%), physical practices (34.7%), biological practices (34.9%), and chemical control methods (38.06). These respondents reported that they are mainly taught about pesticide handling and application, new seed varieties in the market, pesticide products, and their actions against weeds and insect pests. The farmers are also taught about the negative impacts of these pesticides on the environment and possible alternative methods such as natural IPM practices which has influenced its adoption. On the other hand, 56.10% of the respondents do not participate in farmer field days yet the IPM adoption rate is still high (Table 9). These farmers have also adopted cultural practices (67.90%), physical practices (65.30%), biological practices (65.1%), and chemical methods (50.97%) where they mainly obtain information and learn IPM practices from their fellow farmers. This is contrary to studies (Dorothy *et al.*, 2019; Kughur, 2020; Pretty & Bharucha, 2015) as majority of the respondents in Soy sub-county do not participate in these farmer field days yet IPM adoption among them is evident (Table 9).

Table 9: IPM practice adoption based on farmer field day participation

Farmer field days participation	N	%	Cultural practices		Physical practices		Biological practices		Chemical methods	
			N	%	N	%	N	%	N	%
Yes	68	34.90	36	35.64	28	33.73	25	46.30	59	38.06
No	87	56.10	65	64.36	55	66.27	29	53.70	79	50.97
Total	155	100	101	100	83	100	54	100	138	100



Source: Field survey, 2024

Plate 6: During an interview with one of the large-scale farmers who participates in farmer field days

4.3.6 Machinery ownership

From the survey conducted, a total of 130 farmers own farm machinery (Table 11) since crop production in the area is mainly practised using mechanized farm machines such as plow machine, planting machine, boom sprayer, harrowing machine, and combined

maize harvester. 74.8% of the farmers own plow machine which is mainly used during early farm preparation before planting season (Table 10). 69.7% of the respondents own harrow machine which is reported to break down the soil into smaller and finer particles and ensure smooth and well levelled soil in readiness for planting. 62.6% of the large-scale farmers own planting machines which are being used during planting. Planting machines are reported to be efficient as it saves on time and ensure good distribution and seed spacing (Table 10). 41.3% of the large-scale farmers who own boom sprayer explained that they mainly use them in spraying the large farms with synthetic herbicides and insecticides. A combined maize harvester has the least ownership (1.3%) as it is expensive to purchase despite its multipurpose action in maize harvesting, peeling, shelling, drying, and cutting the dry maize stalks into small pieces to be used as natural manure in the soil.

The ownership of the farm machinery has enabled many farmers to adopt different IPM practices. According to Table 11, the IPM practices adopted were cultural (89.11%), physical (92.77%), biological (87.04%), and chemical methods (86.23%). Farmers who do not own farm machinery have least adopted cultural practices (10.89%), physical practices (7.23%), biological practices (12.96%), and chemical methods (13.77%). These farm machineries such as plow and harrow provide a cultural technique of integrated pest management as it exposes larvae to UV light hence reducing pest population and this is similar to the past studies on machinery ownership contributing to IPM adoption (Emerick *et al.*, 2016; Udimal *et al.*, 2017).

Table 10: Different farm machineries owned by the large-scale farmers

Farm machinery	Ownership	Percentage
Plow	116	74.8
Harrow	108	69.7
Planter	97	62.6
Boom sprayer	64	41.3
Combined maize harvester	2	1.3

Table 11: Machinery ownership and its influence on IPM adoption among large-scale farmers

Machinery ownership	N	%	Cultural practices		Physical practices		Biological practices		Chemical control	
			N	%	N	%	N	%	N	%
Yes	130	83.90	90	89.11	77	92.77	47	87.04	119	86.23
No	25	16.10	11	10.89	6	7.23	7	12.96	19	13.77
Total	155	100	101	100	83	100	54	100	138	100



Source: Field survey, 2024

Plate 7: A combined maize harvester



Source: Field survey, 2024
Plate 8: A boom sprayer



Source: Field survey, 2024
Plate 9: A plow with harrow

4.3.7 Pest and weed resurgence

53.5% of the respondents reported that they have encountered annual pests and weeds resurgence while 46.5% of the large-scale farmers do not face the challenge of pests and weed resurgence (Table 12). Farmers have reported that such resurgence has led to crop failure and therefore incurring many losses from the produce which makes them adopt IPM practices. Majority of the respondents rely on pesticides as a quick method of controlling pests such as fall armyworms, stalk borers, and niger weeds to reduce resurgence. Farmers reported that climate change has contributed to pests and weed resurgence which incur many crop losses similar to research done by (Munyuli *et al.*, 2017).

According to Table 13, the respondents who encounter pests and weed resurgence have adopted cultural practices (46.53%), physical practices (45.78%), biological practices (61.11%), and chemical methods (49.28%). Farmers who have not encountered any pests and weed resurgence have also adopted IPM practices to prevent such re-occurrence of harmful pests and weeds in their crop production. They have adopted cultural practices (53.47%), physical practices (54.22%), biological practices (38.89%), and chemical methods (50.72%). The push-pull method of cultural practices by intercropping maize with either napier grass or desmodium has been proven to be effective as it protects maize against niger weeds and stem borer hence minimizing overdependence on synthetic pesticides. The method also works to eliminate pests and weeds that have developed resistance to synthetic pesticide application. This is similar to the studies by (Dara, 2019).

Table 12: Farmer's encounter with pests and weed resurgence

Pest and weed resurgence	N.	Percentage
Encounter	83	53.50
Non-encounter	72	46.50
Total	155	100

Table 13: Influence of pest and weed resurgence on IPM adoption among large-scale farmers

Pest resurgence And weed resurgence	Cultural practices		Physical practices		Biological practices		Chemical methods	
	N	%	N	%	N	%	N	%
Encounter	47	46.53	38	45.78	33	61.11	68	49.28
Non-encounter	54	53.47	45	54.22	21	38.89	70	50.72
Total	101	100	83	100	54	100	138	100



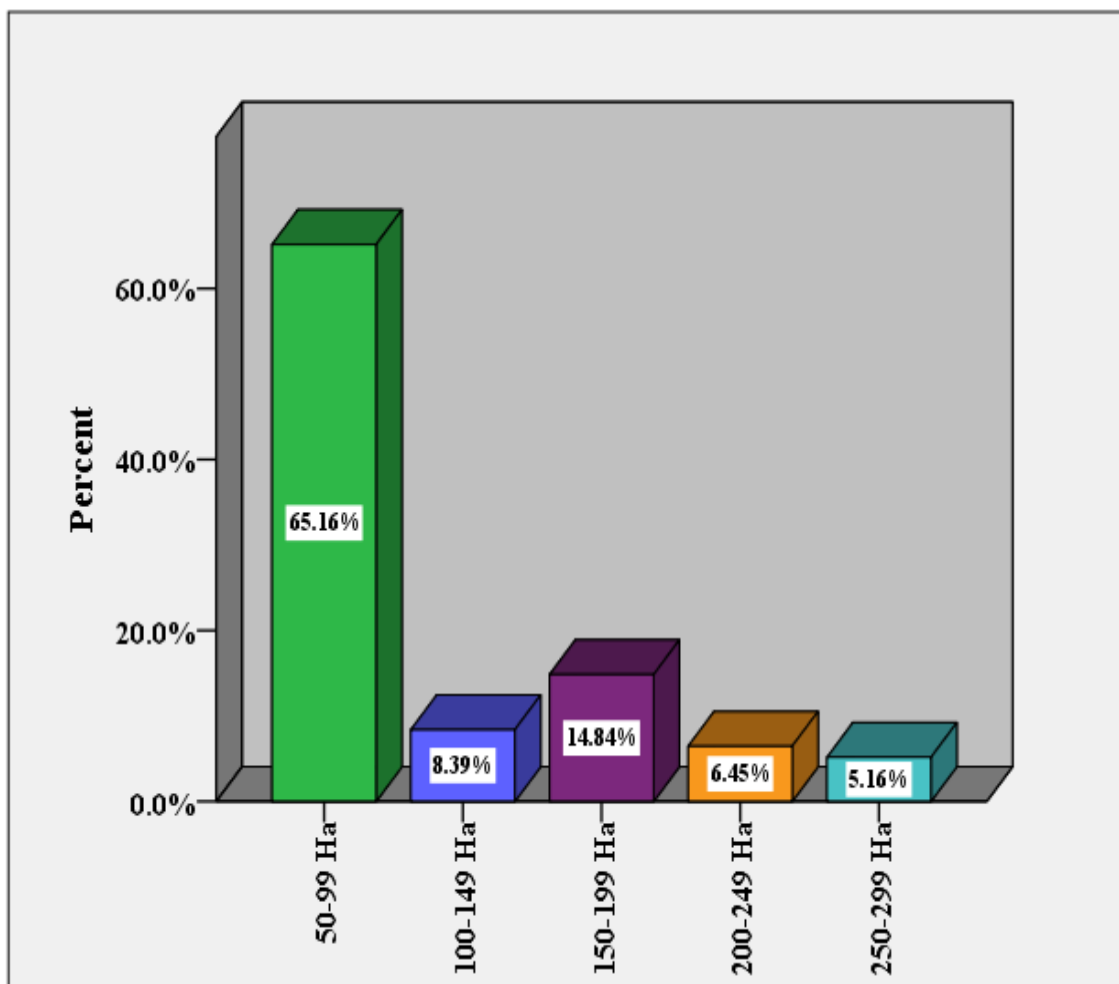
Source: Field survey, 2024

Plate 10: Niger weed reported to be resurgent and causes crop failure

4.3.8 Farm size

Based on the respondents interviewed majority own large farms mainly under crop production where 65.16% own 50-99 Ha, 8.3% own 100-149 Ha, 14.84% own 150-199 Ha, 6.45% own 200-249 Ha, and 5.16% own 250-299 Ha (Figure 12). Majority of them have adopted a combination of natural IPM methods and chemical control methods. The large-scale farmers owning 50-99 Ha have the highest number of IPM adopters where

cultural practices (73.27%), physical practices (77.11%), biological practices (75.93%), and chemical methods (67.39%) adoption were evident among them (Table 14). Farmers owning 100-299 Ha have the least adopters of natural methods as their farms are highly mechanized and mainly rely on synthetic pesticides. This is contrary to research conducted by Emerick *et al.*, (2016); Udimal *et al.*,(2017) on how farmers with large farms are more likely to adopt IPM technology as they can allocate parts of their farms in IPM trials and implementation. These respondents reported that physical practices such as manual weeding and uprooting are expensive and time-consuming compared to the application of pesticides using boom sprayers. They also stated that manual weeding requires supervision to ensure weeds are properly removed in the maize farm hence time-consuming and therefore they do not allocate any farm for natural IPM trials.



Source: Field survey, 2024

Figure 12: Different farm sizes owned by large-scale farmers in Soy sub-county

Table 14: IPM adoption influenced by different farm sizes

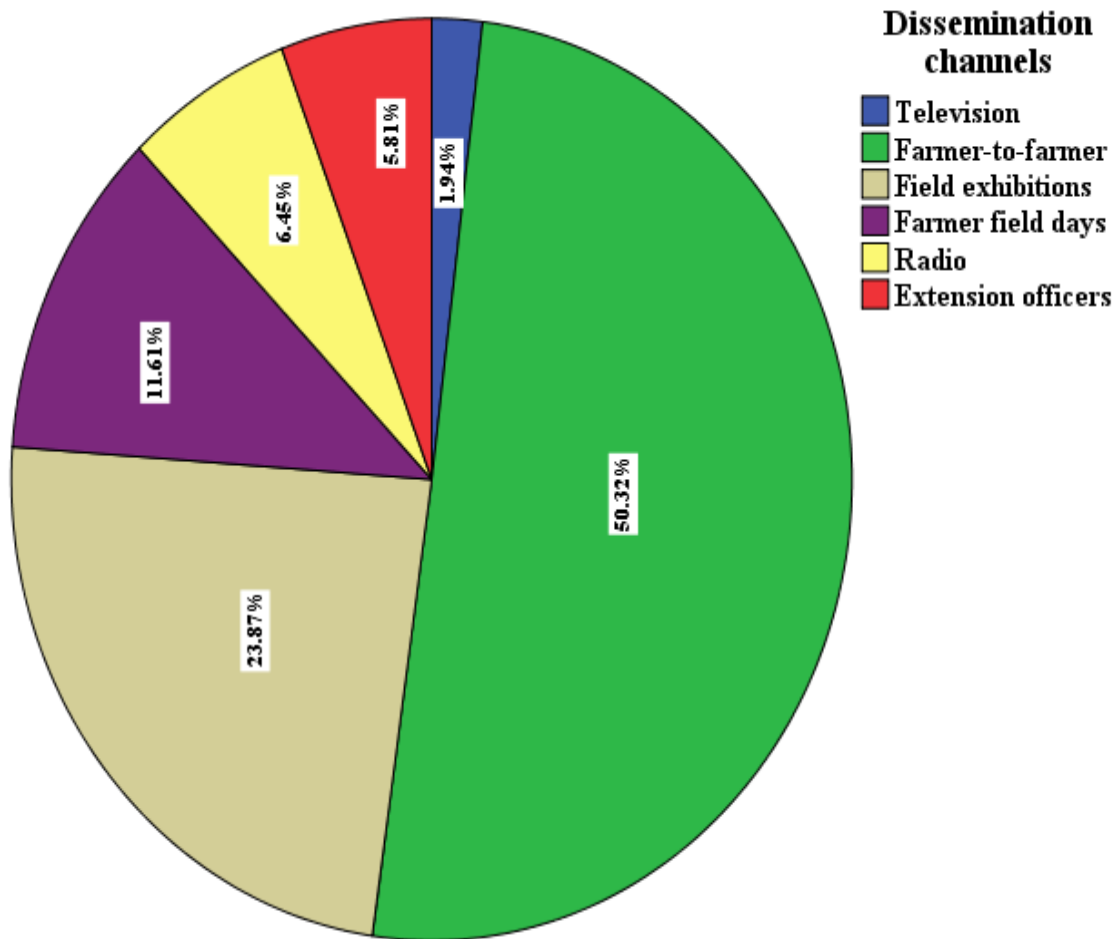
Farm size	Cultural practices		Physical practices		Biological practices		Chemical methods	
	N	%	N	%	N	%	N	%
50-99 Ha	74	73.27	64	77.11	41	75.93	93	67.39
100-149 Ha	7	6.93	6	7.23	7	12.96	13	9.42
150-199 Ha	7	6.93	3	3.61	2	3.70	17	12.32
200-249 Ha	5	4.95	2	2.41	1	1.85	7	5.07
250-299 Ha	8	7.92	8	9.64	3	5.56	8	5.80
Total	101	100	83	100	54	100	138	100

4.4 Information dissemination channels for the adoption of IPM practices

Figure 13 depicts the main channels that were used to convey information to large-scale farmers on IPM adoption. Farmer-to-farmer training (50.32%), field exhibitions (23.87%), farmer field days (11.61%) radio (6.45%), television (1.94%), and extension officers (5.81%) were the main dissemination channels (Figure 13). The respondents explained that they mainly rely on their fellow farmers to obtain knowledge on IPM adoption similar to a case study carried out in Punjab (Deguine *et al.*, 2021). They were also able to learn the technology through practical examples from experienced fellow farmers in their preferred language during field exhibitions which made it easy for adoption. Field exhibitions were reported to be carried out annually in the University of Eldoret as an agribusiness trade fair while annual field days were usually carried out in Chebororwa ATC. Other respondents reported that they have learned IPM technology by listening to experts from radio stations and television. Despite the few number of extension officers, they would mainly reach out to farmers by disseminating information on chemical control methods, the application time, and procedure.

There were limited number of extension officers in the sub-county and therefore could not disseminate any information on IPM technology hence no adoption. From the interview with the extension officers, they reported that their limited number is because there are inadequate funds to facilitate them in training the farmers on good agricultural

practices. The few extension officers only reach out to farmers when there is information about the new pesticide product and seed variety in the market and therefore do not educate the farmers on natural IPM methods.



Source: Field survey, 2024

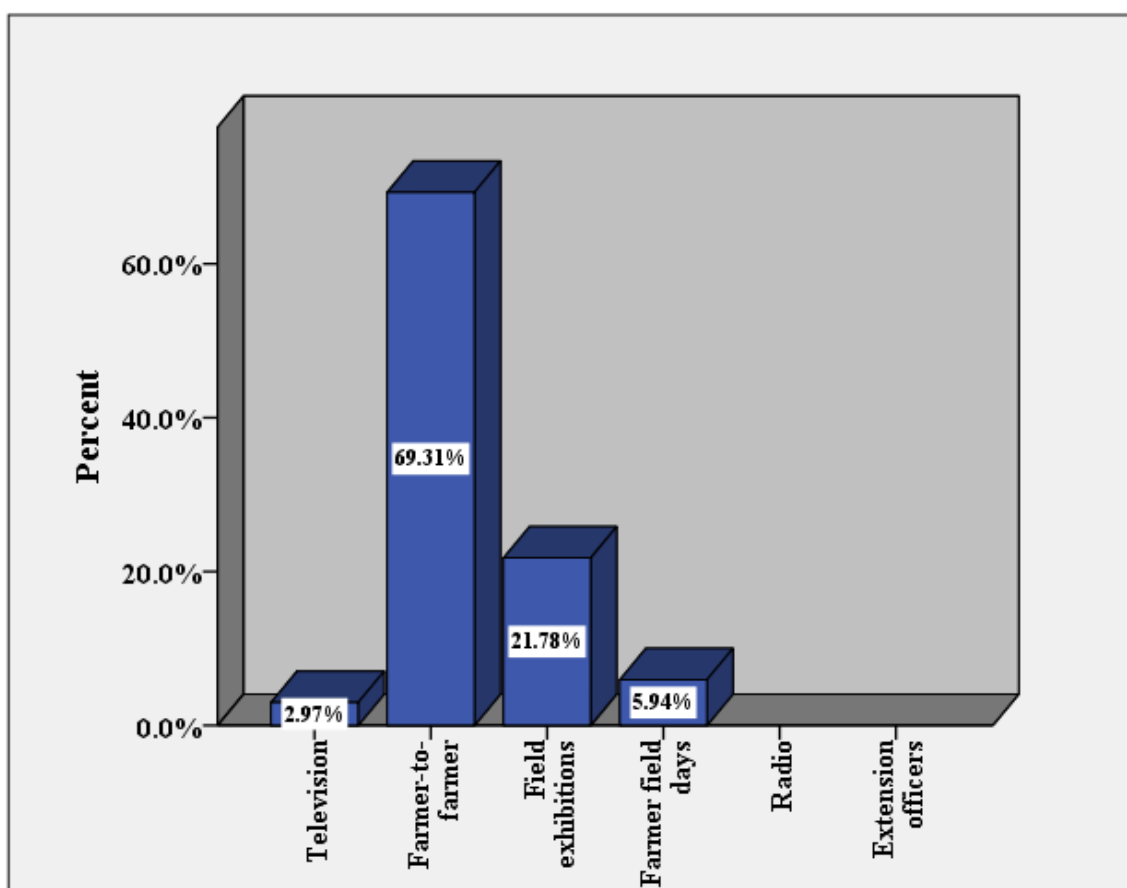
Figure 13: Different dissemination channels used to convey information on IPM adoption among large-scale farmers

4.4.1 Dissemination channels for cultural practice adoption

From the survey conducted, the cultural practices adoption was evident among the large-scale farmers and have embraced its significance in controlling crop pests and diseases.

Figure 14 illustrates that farmer-to-farmer training was the main dissemination channel

which led to high adoption (69.31%). The respondents also obtained information on cultural techniques through field exhibitions, farmer field days, and television which yielded its adoption (21.78%, 5.94%, and 2.97%) respectively. The main cultural practices adopted were cleaning and disinfecting farm machinery to prevent the transfer of pest larvae and weeds from one farm to another during plowing and planting. This is similar to a study carried out in Pakistan where cultural techniques through the push-pull method were found to be effective in destroying harmful pests particularly stemborers from damaging crops (Ali *et al.*, 2021).

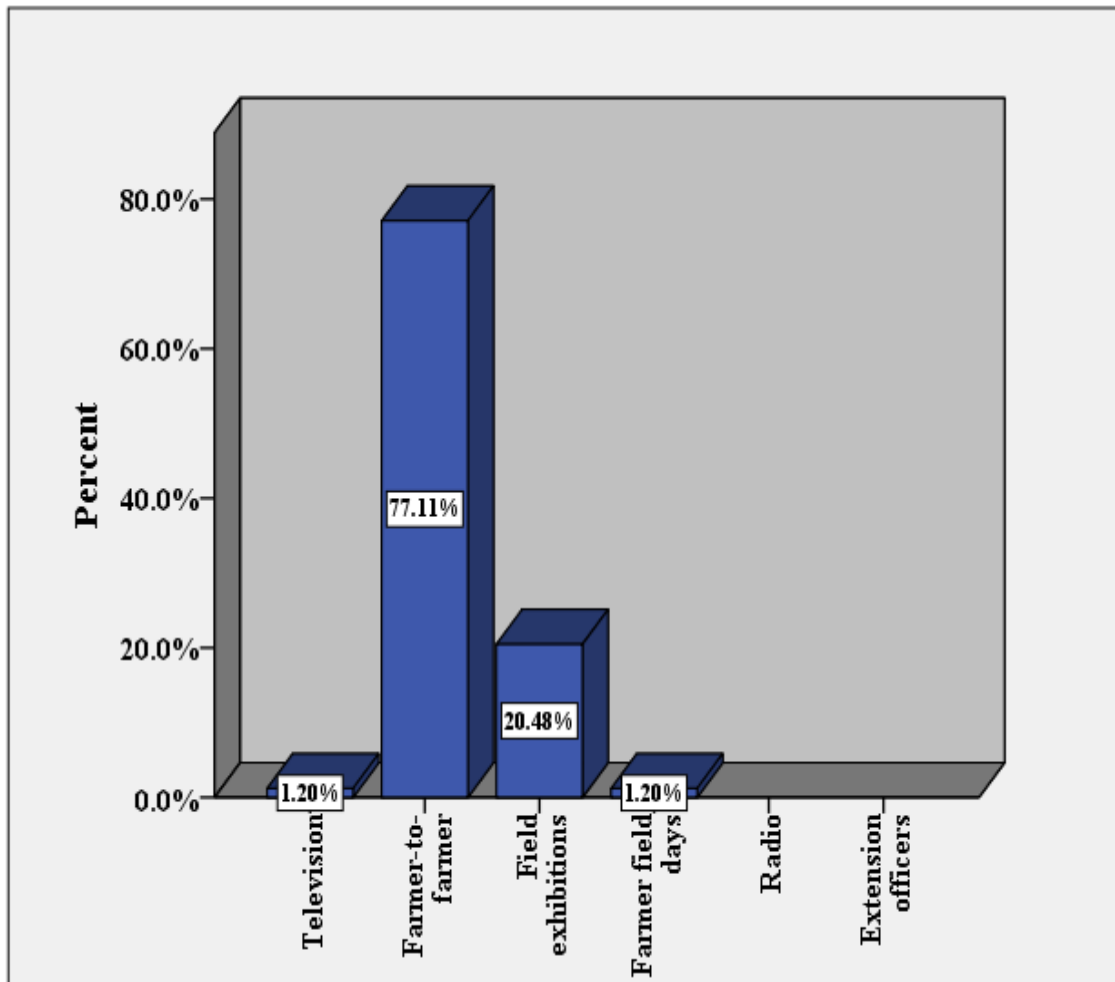


Source: Field survey, 2024

Figure 14: Dissemination channels used for cultural practice adoption among large-scale farmers

4.4.2 Dissemination channels for physical practice adoption

The physical practices adoption was evident among the respondents. Figure 15 shows that the main dissemination channel that contributed to its adoption was farmer-to-farmer training (77.11%). Field exhibitions, farmer field days, and television also provided information that led to its adoption (20.48%), 1.20%, and 1.20% respectively. The physical practices adopted were hand weeding and manual uprooting of weeds which is similar to Khan *et al.*, (2021) study on the physical methods of IPM.

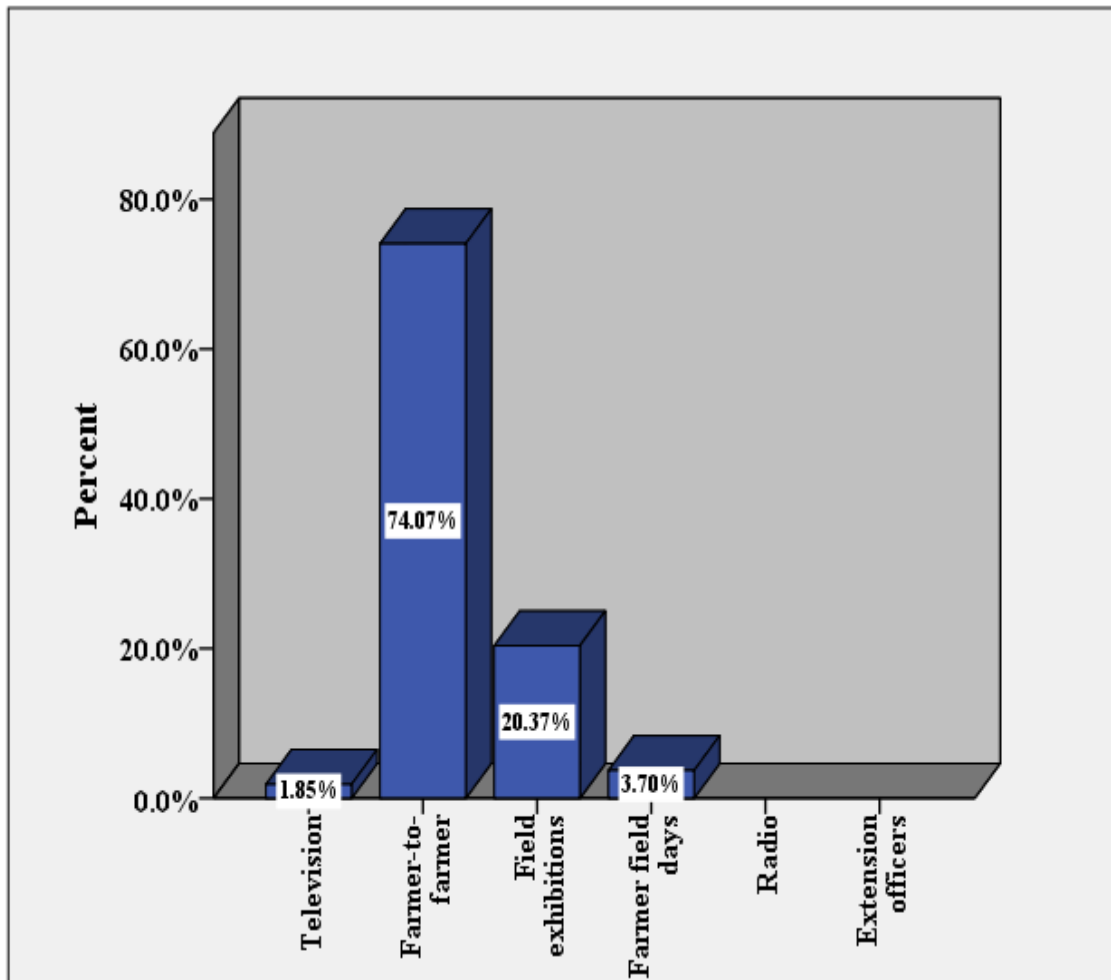


Source: Field survey, 2024

Figure 15: Dissemination channels for physical practice adoption among large-scale farmers

4.4.3 Dissemination channels for biological methods adoption

According to Figure 16, the spread of the technique among large-scale farmers mainly through farmer-to-farmer training led to its adoption (74.07%). Respondents who have attended field exhibitions and farmer field days also learned the technique that led to its adoption (20.37% and 3.70%) respectively. Other respondents obtained the information through television programs hence adoption (1.85%).

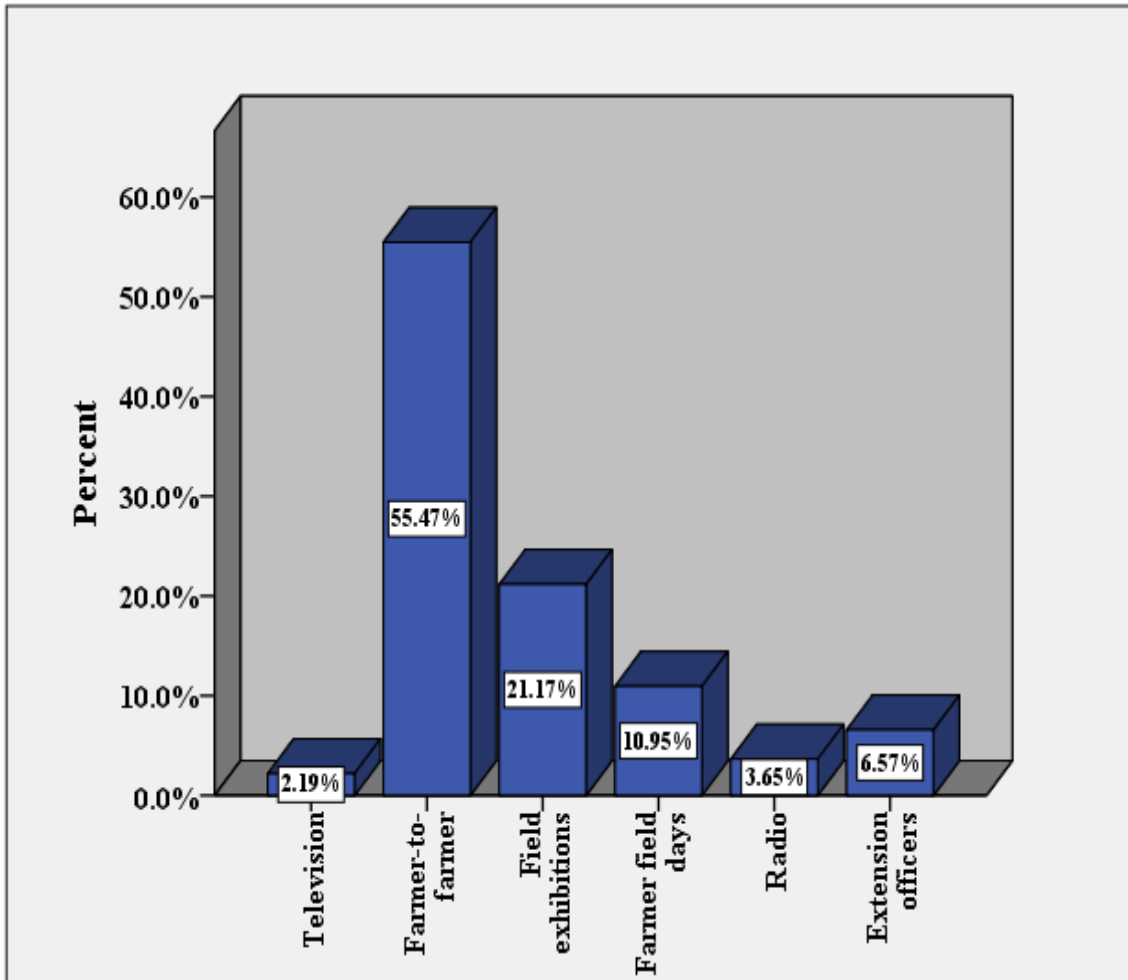


Source: Field survey, 2024

Figure 16: Dissemination channels for biological practice adoption among large-scale farmers.

4.4.4 Dissemination channels for the adoption of chemical control methods

According to Figure 17, farmer-to-farmer training was the main channel for conveying information on various pesticides and their effectiveness in maize production which led to their adoption (55.47%). Respondents who attended farmer field days and field exhibitions led to adoption (10.95% and 21.17%) respectively as they were able to learn new pesticide products from various pesticide companies and their mode of action. Radio and television encouraged the adoption of pesticides (3.65% and 2.19%) respectively since they provided farmers with information on modern commercial farming and farm inputs. Extension officers have also encouraged the adoption of pesticide usage (6.57%) as they mainly reach out to farmers particularly when there is a new pesticide product in the market, educate them on the importance of the pesticide, and train them on the application process.



Source: Field survey 2024

Figure 17: Dissemination channels for chemical control methods adoption among large-scale farmers

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

This study explains the integrated pest management practices and their level of adoption among large-scale farmers. It also shows how various determinants (social, economic, and environmental factors). The study also explains how information channels have been used to educate farmers on IPM practices and their importance in adoption. The findings show that majority of the large-scale farmers have adopted both natural methods and chemical control methods where high dependence on chemical control methods was evident among the respondents. In the natural IPM methods, the findings show that cultural practices were mainly adopted among large-scale farmers. They have a clear understanding of these practices and their importance in controlling weeds, pests, and diseases mainly through disinfecting and cleaning farm machinery, intercropping, crop rotation, and use of compost manure as an alternative to synthetic pesticide use. This was followed by the adoption of physical practices where farmers practised manual removal of weeds, and, the use of traps and scarecrows in their maize fields. Biological control methods were least adopted among the large-scale farmers as they have little knowledge on complex biological control methods and their implementation process.

Based on the determinants of IPM adoption, farm machinery was mainly owned by large-scale farmers as they save on time and labor. Plow and harrow machines were mainly owned with the highest number of IPM adopters. Middle-aged farmers between 50-54 years had a higher percentage of both natural methods and chemical methods of IPM adoption. They have more experience in crop farming and have more interest in trying IPM compared to older and younger farmers. Farmers with primary level of education were mainly IPM adopters as their knowledge on weeds, pests, and disease control is mainly the traditional methods hence natural IPM adoption. Farmers with secondary and tertiary level of education have advanced their knowledge and learned other ways of crop production including various agrochemicals and their uses hence high adoption of chemical methods.

The large-scale farmers who only practised farming as their main occupation were found to have high number of both natural and chemical IPM adopters. This is because they have more time to concentrate on their crop production hence more ability to learn different IPM practices compared to employed and business-oriented farmers who do not have time to learn natural IPM practices and therefore preferring synthetic pesticides as they are more effective. The farmers explained that farmer field days mainly advertise pesticide products from different companies and are therefore not able to learn about other natural IPM practices hence less adoption.

Farmers with smaller farms of 50-99 Ha had a high percentage of IPM adopters because they are able to manage the manual methods of crop production. Farmers with larger farms were found to have few natural IPM adopters as they explained that the practices are very expensive to implement and manage hence opting for chemical control methods. Farmers who have encountered pests and weed resurgence have mainly adopted IPM practices as they reported that majority of pests and weeds have developed resistance on synthetic pesticide use and have opted to practice natural IPM practices to eliminate them in their farms. Information on IPM practices were mainly obtained through farmer-to-farmer training. Other information channels included field exhibitions, farmer field days, television, radio, and extension officers. Despite the natural practices being environmentally safe, their adoption among large-scale farmers is still low compared to the chemical control methods.

5.2 Conclusion

Despite many farmers having available resources for IPM implementation, the adoption level is still low as they have mainly embraced the use of synthetic pesticides. Few large-scale farmers have implemented natural IPM practices while majority depend on synthetic pesticides for high yields. Majority of these pesticides used have been banned in other countries, yet still made available in Kenyan markets with little awareness among Kenyan farmers. The mainly used pesticides in Soy sub-county are glyphosates and organophosphates which have been proven to be highly toxic and carcinogenic and some of which are counterfeit products exposing animal and human health to risks. It is difficult for many farmers to adopt organic fertilizers and therefore prefer synthetic fertilizers as

they save on time. The Government on the other hand has provided subsidies for these synthetic fertilizers, and are made available within the Kenyan markets hence hindering organic fertilizer adoption. The findings suggest that IPM practices are adopted and implemented when there is adequate and availability of dissemination channels. It also showed that IPM techniques are embraced particularly when the information is well relayed to the large-scale farmers. The adoption of IPM practice is therefore low as the little information obtained is mainly from farmer-to-farmer training. The diffusion of innovation theory together with the prospect theory have been used to explain how large-scale farmers can adopt or reject the IPM technology based on social, economic, and environmental factors. More complex practices such as biological methods have very low adoption rates as it requires proper training. While the study contributed to valuable knowledge, it was limited to the language barrier as the majority of the respondents could not be able to express their ideas fluently due to their illiteracy. Additionally, it was not possible to analyze data using inferential statistics because the nature of the data collected could not meet the assumptions required.

5.3 Recommendations

From the research findings, the recommendations can be divided into short-term recommendation and long-term recommendations. Short-term recommendations can be achieved within a short period of time while long-term recommendations take a longer period to be achieved.

5.3.1 Short-term recommendations

- i) Providing training programs on IPM practices through increasing the number of extension officers from one community to another to ensure that every farmer is reached.
- ii) The majority of the farmers were willing to adopt the use of plant extracts and compost manure despite their inadequacy. Therefore, setting aside different large farms for growing plant extracts such as neem, pepper, and tobacco as well as organic manure preparation will ensure their availability hence promoting the adoption of these biological practices.

iii) Removal of subsidies for pesticides such as fertilizers and advocating for the adoption of organic manure would influence a significant reduction in synthetic fertilizers and excessive application.

5.3.2 Long-term recommendations

i) Banning highly hazardous and toxic pesticides while introducing selective and non-persistent pesticides in Kenyan markets to reduce the negative impacts on the environment.

ii) Due to inadequate dissemination channels, setting aside farms for IPM trials and training where farmers can learn different practices, particularly natural IPM methods, and their implementation process will encourage its adoption.

5.4 Areas for Further Studies

1. Further studies need to be done to explore the effects of banning harmful pesticides in encouraging farmers to adopt IPM practices to control weeds, pests, and diseases in crops. In addition, a model can be used to show the impacts of each non-selective pesticide on environment.

2. Consideration of different natural IPM trials in different farms where a simulation can be obtained from the various variables to give a prediction on IPM implementation process.

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APPENDICES

Appendix 1: Work Plan

Activities	Nov	Dec	Feb	April	Jun	Jul	Aug	Nov
Concept formulation								
Proposal formulation								
Drafting and editing the proposal								
Submission to graduate school								
Data collection								
Data Analysis								
Drafting the final project								
Final write-up and submission to the graduate school								

Appendix 2: Budget

Activity	Quantity	Cost (Ksh)	Total cost (Ksh)
Traveling		50,000	50,000
Camera for hire	1	1500	1,500
Printing and photocopy	3 copies	600@	1,800
Binding	3 copies	1000@	3000
Stationeries		600	600
Accomodation		50,000	50,000
Miscellaneous		12,000	12,000
Total			121,000

Appendix 3: Questionnaire



KENYATTA UNIVERSITY

SCHOOL OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF SPATIAL AND ENVIRONMENTAL PLANNING.

QUESTIONNAIRE

I am a Masters Student from the Department of Spatial and Environmental Planning and Management at Kenyatta University. I am conducting a research project titled:

Determinants of Integrated Pest Management Adoption in Soy Sub-County, Uasin Gishu County, Kenya. Please I'm asking for your time and participation in filling in this questionnaire.

SECTION A

1. Please fill in the table below

Farmer's Name	
Location	
Sub-location	

2. Household characteristics

Sex	Age (yrs.)	Education Level	Household income	Machinery ownership

SECTION B

1. Which type of crops do you grow annually?

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.....
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.....

2. Which types of pesticides do you use in controlling pests and diseases in crop production?

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.....
.....

3. How often do you use pesticides and why?

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4. Do you know of any Integrated Pest Management practices?

Yes , No

5. If yes, which practices have you adopted?.....

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.....

6. Why did you decide to adopt the IPM practices?

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.....

7. Can you describe the impact of IPM adopted

No.	IPM adopted	Impact (describe)
1		
2		
3		
4		
5		

8. Do you face any problems in the implementation of IPM?

Yes [], No []

9. If yes, mention them

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10. Has there ever been any disaster, e.g., crop disease outbreaks, pest resurgence, and flooding in this area?

Yes , No

11. If yes, how do you manage these disasters?

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12. Are there any trainings or extension programs on IPM adoption technology?

Yes , No

13. If yes, how often are these trainings?

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14. If no, where do you get the information on IPM practices?

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15. How much do you pay for the extension programmes?.....

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16. Do you participate in farmer field schools?

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.....

17. On average, what is the cost of IPM implementation?.....

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.....

18. How does the government offer support or funds for IPM practices?

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.....

KEY INFORMANT INTERVIEWS (EXTENSION OFFICERS)

Institution Name.....

Date.....

Name of the respondent.....

1. Do you have any programs that train farmers on good agricultural practices?

Yes [], No []

2. If yes, which methods do you use to disseminate the information to farmers?.....

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

3. Which methods are effective to reach the farmers easily?

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.....

4. What is your opinion on IPM?

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5. Are there any documents used by your institution, in running the IPM dissemination programs?

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.....

6. On average how many farmers have adopted the IPM practices?.....

.....
.....

7. From your experience, which challenges have you encountered in disseminating the information to farmers on IPM adoption?

- a)
- b)
- c)
- d)
- e)

8. In your opinion, how can these issues be solved?

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

9. Is there any regular monitoring of IPM practices and adoption among large-scale farmers?

Yes , No

10. If yes, how often?

.....

11. How do large-scale farmers respond to IPM adoption and why?

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12. Do you organize for field demonstrations and field schools to train farmers on complex IPM practices?

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13. What steps has your institution taken to ensure the information on good agricultural practices reaches all large-scale farmers?

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.....

Appendix 4: Research permit

 REPUBLIC OF KENYA	 NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION
Ref No: 518835	Date of Issue: 16/August/2023
RESEARCH LICENSE	
	
<p>This is to Certify that Miss.. NELLY CHEROTICH of Kenyatta University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Uasin-Gishu on the topic: DETERMINANTS OF INTEGRATED PEST MANAGEMENT ADOPTION AMONG LARGE- SCALE FARMERS IN UASIN GISHU COUNTY, KENYA for the period ending : 16/August/2024.</p>	
License No: NACOSTI/P/23/28685	
518835	
Applicant Identification Number	Director General NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION
Verification QR Code	
	
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THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013 (Rev. 2014)
Legal Notice No. 108: The Science, Technology and Innovation (Research Licensing) Regulations, 2014

The National Commission for Science, Technology and Innovation, hereafter referred to as the Commission, was established under the Science, Technology and Innovation Act 2013 (Revised 2014) herein after referred to as the Act. The objective of the Commission shall be to regulate and assure quality in the science, technology and innovation sector and advise the Government in matters related thereto.

CONDITIONS OF THE RESEARCH LICENSE

1. The License is granted subject to provisions of the Constitution of Kenya, the Science, Technology and Innovation Act, and other relevant laws, policies and regulations. Accordingly, the licensee shall adhere to such procedures, standards, code of ethics and guidelines as may be prescribed by regulations made under the Act, or prescribed by provisions of International treaties of which Kenya is a signatory to
2. The research and its related activities as well as outcomes shall be beneficial to the country and shall not in any way;
 - i. Endanger national security
 - ii. Adversely affect the lives of Kenyans
 - iii. Be in contravention of Kenya's international obligations including Biological Weapons Convention (BWC), Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Chemical, Biological, Radiological and Nuclear (CBRN).
 - iv. Result in exploitation of intellectual property rights of communities in Kenya
 - v. Adversely affect the environment
 - vi. Adversely affect the rights of communities
 - vii. Endanger public safety and national cohesion
 - viii. Plagiarize someone else's work
3. The License is valid for the proposed research, location and specified period.
4. The license any rights thereunder are non-transferable
5. The Commission reserves the right to cancel the research at any time during the research period if in the opinion of the Commission the research is not implemented in conformity with the provisions of the Act or any other written law.
6. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research.
7. Excavation, filming, movement, and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
8. The License does not give authority to transfer research materials.
9. The Commission may monitor and evaluate the licensed research project for the purpose of assessing and evaluating compliance with the conditions of the License.
10. The Licensee shall submit one hard copy, and upload a soft copy of their final report (thesis) onto a platform designated by the Commission within one year of completion of the research.
11. The Commission reserves the right to modify the conditions of the License including cancellation without prior notice.
12. Research, findings and information regarding research systems shall be stored or disseminated, utilized or applied in such a manner as may be prescribed by the Commission from time to time.
13. The Licensee shall disclose to the Commission, the relevant Institutional Scientific and Ethical Review Committee, and the relevant national agencies any inventions and discoveries that are of National strategic importance.
14. The Commission shall have powers to acquire from any person the right in, or to, any scientific innovation, invention or patent of strategic importance to the country.
15. Relevant Institutional Scientific and Ethical Review Committee shall monitor and evaluate the research periodically, and make a report of its findings to the Commission for necessary action.

National Commission for Science, Technology and
Innovation(NACOSTI),
Off Waiyaki Way, Upper Kabete,
P. O. Box 30623 - 00100 Nairobi, KENYA
Telephone: 020 4007000, 0713788787, 0735404245
E-mail: dg@nacosti.go.ke
Website: www.nacosti.go.ke

Appendix 5: Graduate school proposal approval



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke

Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 4150

Internal Memo

FROM: Executive Dean, Graduate School

DATE: 25th July, 2023

TO: Cherotich Nelly
C/o Department of Spatial & Environmental Planning

REF: N50/CTY/PT/20692/2020

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

We acknowledge receipt of your revised Research Proposal as per our recommendations raised by the Graduate School Board of 14th June, 2022 entitled "Determinants of Integrated Pest Management Adoption among Large-Scale Farmers in Uasin Gishu County, Kenya".

You may now proceed with your Data Collection, Subject to Clearance with Director General, National Commission for Science, Technology and Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking and Progress Report Forms per semester. The forms are available at the University's Website under Graduate School webpage downloads.

Also, please ensure that you publish article(s) from your project before submitting it to Graduate School for examination as per the Commission for University Education and Kenyatta University guidelines.

Thank you.

ELIJAH MUTUA
FOR: DEAN, GRADUATE SCHOOL

C.c. Chairman, Department of Spatial & Environmental Planning.

Supervisors:

1. Prof. Caleb Mireri
C/o Department of Spatial & Environmental Planning
Kenyatta University

EM/inn

Appendix 6: Graduate school Research Authorization



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke

Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Our Ref: N50/CTY/PT/20692/2020

DATE: 25th July, 2023

Director General,
National Commission for Science, Technology
and Innovation
P.O. Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR CHEROTICH NELLY – REG. NO. N50/CTY/PT/20692/2020.

I write to introduce Cherotich Nelly who is a Postgraduate Student of this University. The student is registered for M.Env degree programme in the Department of Spatial & Environmental Planning.

Cherotich intends to conduct research for a M.Env Project Proposal entitled, “Determinants of Integrated Pest Management Adoption among Large-Scale Farmers in Uasin Gishu County, Kenya”.

Any assistance given will be highly appreciated.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'E. Kimani'.

PROF. ELISHIBA KIMANI
EXECUTIVE DEAN, GRADUATE SCHOOL

EM/inn

Appendix 7: Uasin Gishu County research permit



REPUBLIC OF KENYA
MINISTRY OF EDUCATION

State Department for Early Learning and Basic Education

Email: cdeuasingishucounty@gmail.com
: cdeuasingishucounty@yahoo.com

When replying please quote:

County Director of Education,
Uasin Gishu County,
P.O. Box 9843-30100,
ELDORET.

Ref: No. MOE/UGC/TRN/9/VOLL. IV/274

25TH August , 2023

Miss. NELLY CHEROTICH
Kenya University,
P.O Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION.

In reference to your License Ref no. **NACOSTI/P/23/28685** dated 16th August, 2023 from National Commission for Science, Technology and Innovation (NACOSTI), you are hereby granted the authority to carry out research on ***Determinants of Integrated Pest Management Adoption Among Large-Scale Farmers in Uasin Gishu County Period Ending 16th August 2024,*** Within Uasin Gishu County.

We take this opportunity to wish you well during this data collection.


Andrew Mibei

For: County Director of Education
UASIN GISHU.

