KNOWLEDGE, ATTITUDES AND PRACTICES OF MALAWIAN SMALL SCALE FARMERS REGARDING PESTICIDES IN LEGUME AND CEREAL CROPS

MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCES THESIS

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DECLARATION

I hereby declare that this thesis is the original research undertaken by me under the guidance of my supervisors. No part of this study has been presented in any form for any degree or certificate in another institute of study. I also declare that all references and assistance received from various people have been duly acknowledged.

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CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and effort and has been submitted with our approval

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DEDICATION

This thesis is dedicated to almighty God whose grace and mercies have seen me successfully through my education; to my parents Mr. Esau Msada and Mrs. Liviness Chowe Msada for their encouragements and prayers; and to my lovely wife Ulemu Kambuwa Msada and my lovely kids, Dalitso and Divine Msada for always being there for me, and providing immense support and contribution towards my success in life.

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ABSTRACT

The use of synthetic pesticide poses a great risk to both human and environment health. The aim of this study was to assess knowledge, attitudes and practices of pesticide usage and the level of exposure by small scale farmers in Malawi. Pesticides play a vital role in food security. However, they pose a great threat to both human health and environment if they are not properly managed. It is therefore paramount to validate and document the knowledge farmers have about pesticides as it is useful in setting research agenda, planning campaign strategies and forms a basis for constructive collaboration between farmers and researchers (Lekei, 2004). A semi-structured questionnaire was used to interface 1014 small scale farmers, from 9 regions across Malawi, in a one-on-one interview to get qualitative and quantitative data, which was analyzed using Turkey multiple comparison test and logistic regression. 42% of the farmers were knowledgeable of the dangers of ingesting food with pesticide residues. Level of farmer's education, access to training on pesticide handling, gender and farming experience positively and significantly affected knowledge of pesticide use. Thus, farmers with high education, more access to training, males and more farming experience were more aware of risks of using pesticides. Knowledge of pesticide use affected attitude and practices of using synthetic pesticides. About 63% of the farmers keep pesticides in their houses, 65% do not use protective clothing when using pesticides and the majority use women and children to handle pesticides. Farmers handle and apply pesticides without following recommendations on the container thereby ignoring risks and safety instructions, and unsafe dispose of pesticide containers and residual pesticides. The risk of pesticide poising is very high and hence the need to adopt other more efficient alternative control options such as integrated pesticide management (IPM)

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LIST OF ACRONYMS AND ABBREVIATIONS

AEDO	Agriculture Extension Development Officer
APPSA	Agricultural Productivity Program for Southern Africa
EPA	Extension Planning Area
FAO	Food and Agriculture Organization
IPM	Integrated Pest Management
KAP	Knowledge, Altitude and Practices
MERAP	Malawi Economic Report on Environmental Policy
MoAFS	Ministry of Agriculture and Food Security
MoAIWD	Ministry of Agriculture, irrigation and Water Development
NGO	Non-Governmental Organization
SPSS	Statistical Package for Social Scientist
UN	United Nation
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Malawi is mostly ruralized with over 85% of its citizenry living in the rural areas and relying on agriculture as a source of their livelihood. Similarly, the economy of Malawi is agro-based and draws over 36% of its production potential as well as over 60% of forex value from agriculture. Due to climate change, the agricultural sector has reported an influx of pests, diseases and weeds. In order to safeguard the crops from losses or to increase productivity, farmers have reportedly increased the use of synthetic chemicals. Unfortunately, while they are used in good faith, chemical residues have negative effect on the users, consumers and the environment. This study has been constituted based on the aforementioned knowledge. The study seeks to find out if farmers are aware of the dangers of using synthetic pesticides and how they ensure they protect themselves, other consumers and the environment. The aim of this chapter is to set the background of the study, which highlights the motivation in terms of problem statement and justification. The chapter also sets the milestones to be achieved and is wrapped up by a highlight of the organization of study and chapter summary.

1.2 Background information

The changes that have occurred over the past decades in agriculture have seen farming systems and landscapes undergo complex transformations which have had serious implications on human health and wellbeing, particularly for populations largely dependent on agriculture and related ecosystems for their livelihood (Salameh et al, 2004). Among others, pesticide residue effects have become common place in agro-based communities (WHO, 2005). According to Lewis (2006) pesticide residues have become a global unavoidable part of the environment due to extensive usage in agriculture, hence they are often detected in almost all environmental segments. The World Health Organization (WHO) indicates that of the global human disease burden, about 25 percent is attributed to environmental factor causes (WHO, 2005). Kilelu (2011), indicates that although such agricultural transformation and their impact on human health and wellbeing and the environment, do not occur everywhere the same way nor to the same extent, trends are discernable. In developing countries, the use of pesticides is considered as part of a food security measure. The control of pests is very vital to the accomplishment of food security at all spatial scales as pests contribute considerably to food losses (Salameh et al, 2004). Pesticides are widely used in agricultural production to control pests, weeds, diseases, and other plant pathogens in an effort to reduce losses in yield and preserve high product quality. Pesticide residue refers to the amount of the chemical that remains on or in food after it is applied to food crops (IUPAC, 2010. The maximum allowable levels of these residues in foods are often specified by regulatory bodies in many countries. The general population is mainly exposed to these residues through consumption of treated food sources, or being in close contact with areas that have been treated with pesticides. Many of these chemical residues, particularly derivatives of chlorinated pesticides, have ability of bioaccumulation which could build up to harmful levels in the body as well as in the environment. Persistent chemicals magnify through the food chain, and various tests that have been carried out have revealed presence of these pesticides in products like meat, poultry, fish, nuts, various fruits, vegetable oil, and vegetables (Stephen et al, 2011).

In one way or the other, the use of pesticides has greatly improved the quality of human life by increasing crop and animal production. However, if these pesticides are not used appropriately, they end up causing economic loses and environmental pollution. This is because poor application of these pesticides may lead to contamination of agricultural products that may also cause adverse impacts on human health, wildlife and the environment. Because any presence of trace amounts of both pesticide residues and their degradation products could be a potential health hazard, United Nation Organization (UN) formulated specialized groups such as Food Agriculture Organization (FAO) and, World Health Organization (WHO) where one of the aims was to come up with restrictive measures to protect the environment against pollution**.** The experts in these organizations summarize international achievements in pesticides domain, establish legislation and make recommendations, compelling member states to act in agreement with international standards.

The Stockholm Convention (2001), a global treaty focusing on persistent organic pollutants was adopted in 2001. The main aim of this treaty was to protect the environment and human health worldwide. The use of persistent organic pollutants was banned during this treaty. Some of the persistent organic pollutants banned include aldrin, endrin, Dichlorodiphenyltrichloroethane (DDT), heptachlor, chlordane, texaphene and mirex. The convention allows use of less persistent organic pesticides on condition that there will be strict following of instructions of every pesticide used to make sure that there is no environmental pollution. However, these less persistent pesticides have been found in large quantities in air, soil and water although they have rapid degradation. According to Buyer Crop Science Limited (2017), even though synthetic pesticides are manufactured under very strict regulation procedures to function logical certainty and very low effects on the environment and human health, it is observed that serious concerns continue to be raised concerning the health risks emanating from residues from food . Some cases of pesticide residue violation have been reported worldwide. Odhiambo et al., (2014) reported that 2.5 billion pounds of pesticides are applied to agricultural products every year in the United States, and it has been observed that each year there are 10,000 pesticide related poisonings. Due to their nature, pesticides have posed threats not to human health only, but also on wild life and some sensitive ecosystems.

1.2.1 Pesticide utilization in Malawi

In Malawi, small scale farmers and the general public face a huge risk of exposure to pesticides due to use of toxic chemicals that are restricted in neighboring countries and consumption of residual pesticides in most of the crops and vegetables available on the market (FAO, 2005). The use of pesticides is vital to the food security and economy of Malawi, since agriculture contributes almost 42 percent of Growth Domestic Product (GDP) and accounts for over 81 percent of the foreign exchange earnings (FAO, 2005). However, small scale farmers and the general public face a huge risk of exposure to hazardous levels of pesticides through water, food and residual use of pesticides (Kosamu et al, 2020). There is usage of over 200 metric tons of pesticides in Malawi; this is due to rapid increase in agricultural development. About 70% of the pesticides are used in agriculture, where large proportion of the pesticides is used in food and cash crops (MoAIWD, 2017). Some of the commonly used pesticides include insecticides, fungicides, herbicides and fumigants. Fungicides are mainly used in tobacco industries, herbicides are commonly used in sugar plantation, coffee, cotton, tobacco fields and vegetables, while insecticides are mainly used in field crops (cereals and legumes). Insecticides are the mostly used pesticides, followed by herbicides (MoAIWD, 2017). Poor techniques and use of inappropriate equipment for applying the pesticides enhance the risk of exposure to the toxic pesticides. The effects of residual pesticides on human health are mainly manifested if there is bioaccumulation along the food chain after the initial plant uptake (Salameh et al, 2004).

The use of badly or totally unsuitable spraying equipment, inadequate storage techniques and wrong application techniques aggravates the risk of exposure to most of the farmers (MoAFS, 2012). Due to poor knowledge and awareness of pesticide residues, some of the farmers reuse the pesticide containers for food and water storage; this also increases the risk of exposure of the farmers to toxic pesticides (Ecobichon DJ, 2000). In Malawi, the Occupational Safety, Health and Welfare Act of 1997, places the duty of the protection of the employee on every employer to ensure the safety, health and welfare at work for all employees which includes the provision of protective clothing (MERAP, 1995). However, there is lack of enforcement of pesticide-related legislation in Malawi. This has resulted into farmers being exposed to pesticide poisoning due to lack of safety, as employers fail to meet the minimum safety standards required due to lack of enforcement by the government (Banda L, 2004).

1.3 Problem statement

In Malawi, cereal cropping is one of the key components in food security strategies, where by farmers grow crops for both consumption and commercial purposes. Agriculture sector, contributes about 42% of Malawi's GDP, provides 87% of the total employment, and contributes more than 81% of the foreign exchange earnings (FAO, 2002). However, most of the cereal crops grown are prone to a wide range of pests. In most cases, 30-40% post-harvest losses in cereal cropping are caused by pests (Damalas CA and Koutroubas SD, 2016). This forces most of the small-scale farmers in Malawi to use pesticides to minimize pre and post-harvest losses.

Some of the common pesticides that are used to control these pests include Cypermethrin, Dimethoate and Lambda-Cyhalothrin (Kosamu et al 2020). The use of synthetic chemical pesticides which include some persistent organochlorine pesticides, is widely practiced, and due to poor and in effective regulations, farmers end up following inappropriate ways of applying these pesticides which may result to accumulation of pesticide residues in various foods and feed items (Gupta, 2011). Organochlorine pesticides do not biodegrade readily; as a result, they bio-accumulate in natural systems. Long term exposure to these pesticides is associated with increased risk of chronic cancer, and cause reproductive disorders in people as estrogenic effects (Amoako et al 2012). Most of these pesticides that are commonly used in Malawi are associated with Asthma, Birth Defects, Neurological Effects, Cancer and Hormone Disruptions (MoAIWD, 2017).

Literature has shown that most of the farmers possess traditional knowledge about pesticides and alternative ways of controlling them (Salameh et al, 2004). This traditional knowledge that local farmers possess is most likely to be accompanied by an equally informed knowledge of how pesticides can be used to control pests. Farmers generally apply higher amounts of pesticides on their crops than recommended doses because of ignorance, lack of experience, training and awareness. Sometimes farmers apply pesticides based on advice from neighbors who also do not have the correct information about the pesticides (Mridula C et al, 2013). Most of the farmers also believe that by applying more pesticides, they will have more yield. As a result, they apply excess amount of pesticides. It is also reported that agricultural extension workers do not meet their farmers regularly; this makes farmers to remain unaware of recommended ways and amounts of pesticides to be applied to each crop (Damalas et al, 2016).

1.4 Study Objectives

1.4.1 Main Objective

The aim of this study was to examine the dimensional structure underlying the scale of farmer's knowledge, attitudes, and practices regarding the effects of use of pesticides in legumes and cereal crops on human health and the environment.

1.4.2 Specific objectives

The specific objectives of the study were to:

(i) assess the levels of farmers' knowledge of the effects of pesticide residues on both human health and the environment.

(ii) evaluate the attitudes and practices of farmers as regards their use of protective measures, safe storage and hygiene practices in pesticides use.

(iii) investigate socio-demographic and socio-economic determinants of farmer’s knowledge, attitudes and practices regarding pesticides in legumes and cereals.

1.4.3 Research questions

(i) Are the farmers aware of the risk associated with pesticide use?

(ii) How is the attitude and practices regarding use of synthetic pesticides?

(iii) What socio-economic characteristic that determine farmers’ knowledge, attitude and practices of pesticide use?

1.5 Significance of the study

Pesticides have numerous benefits in agriculture and public health. However, they pose significant risks to both humans and environment. Illnesses and death cases related to pesticides poisoning have been reported worldwide (Dawson 2010). Even though farmers in Africa use only 1-2% of the world’s pesticides, it is revealed that they suffer most of the adverse effects due to numerous reasons that include illiteracy, ignorance, unavailability of safety equipment, improper labelling of containers and lack of trainings (Kesavachandran 2009). It is therefore paramount to validate and document the knowledge farmers have about pesticides as it is useful in setting research agenda, planning campaign strategies and forms a basis for constructive collaboration between farmers and researchers (Lekei, 2004).

1.6 Organization of the study

This study is organized into five chapters. Chapter one deals with the background to the study, discusses the research problem and research questions that arise. The aim, objectives and the justification for the field-based research component of this study are also given attention in this study. Chapter two reviews the literature relevant to the study. Chapter three details the design of the study and methodology used. The fourth chapter presents and discusses the results of the study. The final chapter makes conclusions of the study and also offers recommendations based on the findings in the research.

1.7 Chapter summary

Pesticides are poisonous and have been associated with acute illnesses and death in waste cases. Sadly, in the absence of alternatives, pesticides cannot be avoided in agriculture to control pests and diseases. However, it is important to know if pesticide users are aware of the dangers associated with chemicals.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The use of pesticides is historical and dates back to as old as farming has existed. Several studies have thus been conducted on use of synthetic pesticides either in agriculture or other fields study, in Malawi or elsewhere. The aim of this chapter is to set the pace and foundation of the study. Key terms and concepts will be defined in the chapter. Key results of similar studies will also be critically reviewed as empirical evidence of the effect of pesticides.

2.2 Pesticides

Pesticides are chemicals that are used to control pests and diseases in agriculture (WHO, 2005). According to Ahouangninou et al (2012), about 600 chemicals in about 50,000 formulations are used worldwide. Generally, pesticides are classified according to the group of pest organisms targeted. Some of the classes include fungicides, insecticides, nematicides and herbicides.

2.2.1 Herbicides

These are pesticides that generally kill weeds, mainly grass and small broad-leaved weeds. These pesticides affect inherent processes to plants only. This is why they are relatively low order of mammalian toxicity (Salameh et al, 2004). Generally, persistence of some herbicides is considered as detrimental to the environment. This is because, if pesticides stay active in the soil for a longer period of time, the less appealing environmentally they become (Lewis, 2006). Different herbicides vary widely in terms of their potential to enter water supplies. The final destination of herbicides is mainly dependent upon the conditions under which they are applied. According to Lewis (2006), pesticides can leach down or move with soil particles if they are applied on relatively bare soil surface, and the extent to which these events occur depends on several chemical and physical properties.

2.2.2 Insecticides

Most of the insecticides consist of an active ingredient which is the poison that improves the efficacy of its application and action of the insecticides together with other various additives. These chemicals are mainly classified into three general categories namely: Organochlorine, organophosphates and carbonates. Organophosphates are chemicals derived from phosphoric acid, these chemicals work by inhibiting some important enzymes in the nervous system (MoAIWD, 2017).

These pesticides are biodegradable; therefore, they are less likely to build up in soil and water. On the other hand, organophosphates are extremely toxic to humans. Carbonates are derivatives of carbonic acid and their mode of action is as same as organophosphates, this means they affect the activity of acetycholinesterases, an enzyme (Dent, 2000). Carbonates are biodegradable, therefore they are least dangerous and have relatively low mammalian toxicity. However, they are highly toxic to honeybees and beneficial insects and earthworms (Aktar et al, 2009).

2.2.3 Fungicides

These are mainly used to control diseases in vegetables and fruit crops, and seed coating to protect against seed rots. Some fungicides are used to protect harvested fruits and vegetables from decay, prevent wood decay and protect clothing from mildew. Currently some of the organic materials that are commonly used are thiocarbamates and triazoles; these have negative effects on human health because thiocarbamates are herbicides that are poisonous, hence causing clinical signs including tumor, salivation, dyspnea, vomiting and bloat (Aktar et al, 2009). Some of the registered fungicides used in Malawi include Captab, Fentin, Copper Ammonium Nitrate, Chrolothanil, Sulphur, Zineb, Copper Hydroxide and Maneb + Fentin acetate (MoASF, 2012).

2.2.4 Nematicides

These are pesticides that are widely used to kill nematodes in the field. They are generally known to contaminate soils and the water draining from treated soils. Some Nematicidal chemicals are volatile soil fumigants that actually kill all life in the soil, both beneficial and harmful microorganisms. However other Nematicides dissolve readily in water, these do not adsorb onto soil surfaces and consequently easily leach downward into the ground (Aktar et al, 2009).

2.3 Positive contributions of pesticides

Application of pesticides on crops protects them from pests that could have damaged them. The practice of using synthetic pesticides increases the crop yields for the short term (MoASF, 2012). According to report by Lekei (2004), increased insecticide use since Second World War is the result of several advantages they have over the techniques for insect control. Pesticide action is rapid, easy to use and readily available; its action is effective within very few hours and reduces the magnitude of the problem within few days. This is because, pesticides are specifically formulated chemicals that target a particular pest. When they are applied to crops that are invaded by particular pests, they start working immediately by affecting the normal biological functions of the organs of the pests. Synthetic pesticides are also economical compared to many other pest management practices. Their application procedures are not complicated; an individual with minimal knowledge can apply effectively. Pesticides reduce the risk of disastrous loss of food crops due to pests and diseases; this ensures that there is food security and dependable livelihoods in a country (Cooper, 2007). Some pesticides are used to protect wood and timber from destruction by termites and other wood boring insects; this reduces the cost of maintenance on buildings with wooden structures and timber, and increases the life span of the buildings.

2.4 Negative effects of pesticides

Most often pesticides are poisonous. This means over-using of these chemicals may generate some harmful side-effects to non-targeted organisms and the environment (Aktar et al, 2009. This may include harm to farmers themselves who are at a very high risk of easily coming into contact with these chemicals during application, and other people who may consume some of the residue pesticides left on some food crops. Continuous use of pesticides on crops to control pests may lead to development of resistance to pesticides by some pests. These pests develop some slight variations in their genetic make-up. Whenever pesticides are applied on crops, most of the pests will entirely be susceptible, this means not all the pests will be killed by the chemicals, pests with some variations in their genetic make-ups become resistant to the pesticides, hence they will survive. This means that every succeeding generation of the surviving pests will have the same pesticide resistant genetics; as a result, pests become entirely resistant to pesticides (Mkandawire, 2006). Pesticides also negatively affect the environment. Some of the pesticides applied, kill both targeted and non-targeted organisms in the environment such as honeybees, fish and wildlife that are both within and outside agro-ecosystem. This includes natural enemies of the targeted pests, leading to a problem of resurgence. This means there is a severe disruption of natural control of pests and consequently, crops suffer a lot. This may also lead to faster multiplication of minor pests that are kept in smaller numbers in the environment, due to low or absence of their natural enemies (Aktar et al, 2009.

Excessive use of pesticides on crops results into air pollution due to spillage of volatile pesticides. This poses health risks to humans and animals in that area (MoAFS, 2012). Continued application of pesticides to agricultural fields would lower the soil potential and deplete organic soil nutrients necessary for good crop yields, resulting from chemical imbalances. Eventually, it would negatively affect growth and productivity of some crops in the long term. Children are thought to be especially vulnerable to exposure to pesticide residues, especially if exposure occurs at critical windows of development.

Infants and children consume higher amounts of food and water relative to their body-weight, have higher surface area (i.e. skin surface) relative to their volume, and have a more permeable blood-brain barrier, and engage in behaviors like crawling and putting objects in their mouths, all of which can contribute to increased risks from exposure to pesticide residues through food or environmental routes. Neurotoxins and other chemicals that originate from pesticides pose the biggest threat to the developing human brain and nervous system (Central Intelligence Agency, 2020).

2.5 Global pesticide concerns

In most of the developing countries agrochemical safety meets a lot of obstacles. Some of the obstacles include: poverty, illiteracy, low sanitation and medical care standards that results into higher risks during accidental, occupational and long term exposure to pesticides and their residues (Zhang et al, 2011). If a large amount of chemical pesticides is consumed, it may cause some detrimental effects such as severe injuries or even death (Ekram, 2016). Carelessness is one of the factors contributing to accidental consumption of chemical pesticides. In most cases, in developing countries, pesticides are consumed when they are transferred from their original labeled bottle into another unlabeled bottle (Ekram, 2016). Studies carried out in developing countries, have shown that there have been so many cases where children have been affected by chemical pesticides through drinking the pesticides from the drinking bottles as well as drinking water that was stored in pesticide containers (Kamrin, 1997). A study carried out in India revealed that cooking oil that was stored in pesticide containers was responsible for killing of 23 school children (Ekram, 2016). Most of the farmers that apply synthetic pesticides in developing countries have little understanding of health hazards associated with pesticide handling (Ekram, 2016). According to WHO, there is rapid increase in pesticide use in developing countries (UNEP, 1990). However, this increase does not match with the available technical and human resources to properly control the chemical use.

Some studies on knowledge, attitudes and practices have shown that unsafe use and handling of pesticides is common in developing countries (Wesseling, 1997). Most of the farmers in developing countries lack adequate knowledge on handling and use of chemical pesticides. According to a study carried out in Sudan, it was discovered that most of the farmers do not know names of the chemical pesticides used in their farms, a large proportion do not follow the instructions on the labels, and most of them haven't attended any training on safe handling of pesticides (Ekram, 2016). The health hazards that are associated with pesticide use and handling are less understood by the pesticide users in developing countries (FAO, 2002). Globally, it is estimated that thousands of people die each year from the pesticides poisoning of which suicide happens to be the most problematic poisoning circumstance (Konradsen 2003).

Even though there is high burden of acute pesticide poisoning in most of the developing countries, there is significant under-reporting suggesting that the burden of disease due to acute pesticide poisoning is commonly underrated (London and Bailie 2001). Studies in developing countries of farmer's knowledge and practices have reported low to moderate levels of knowledge about pesticides (Ibitayo 2006), non-usage of personal protective equipment (PPE) (Sivayoganathan 1995), poor disposal of empty pesticide containers (Ibitayo 2006), unsafe pesticide storage at homes, improper use of pesticides and relatively low knowledge about pesticide safety labels (Ajayi 2007). Studies in developing countries indicate that farmers usually source pesticide information from pesticide vendors and from other farmers who are not knowledgeable about pesticide risks (Sodavy 2000). These risks may be aggravated by lack of information about the nature of the pesticide handled. For instance, a study in Tanzania revealed that some suppliers repackage and distribute products in unsafe and unlabeled containers (Lekei, 2004). A study in Ethiopia indicted that a significant proportion of the pesticides applied originate from unauthorized and unlawful sources, and sometimes brought in Ethiopia through illegal trading from the neighboring countries to local sellers. The study also indicated that the informal traders set low prices of the pesticides which implies that they source these products from outside the official distribution channels (Belay 2015). Research has shown that, Despite the various benefits in agriculture and public health, pesticides pose significant risks to humans, non-target organisms and the environment. For instance, intentional or accidental acute pesticide poisoning continue to affect a lot of people around the world (Dawson 2010). It is revealed that, although small scale farmers in Africa use very small proportion (Aktar et al, 2009) of the world's pesticides, they suffer most of the adverse effects as a result of a number of reasons that include unavailability of safety equipment, illiteracy, improper labeling of containers, wrong attitudes and ignorance (Kesavachandran 2009).

2.6 Knowledge, Attitude and Practices (KAP)

According to Ntawuruhunga (2016) KAP studies are conducted to investigate human behaviour concerning a topic, particularly focusing on what the respondents know about it (K), how the respondents feel about it (A) and what the respondents do about it (P) (IDAF, 1994). In their study, Jacinter A *et al* (2014) describe KAP surveys as representative studies of a specific population where information is collected on what is known, believed and done in relation to a particular topic. Ntawuruhunga (2016) indicates that KAP surveys were developed in the 1950's and were originally designed to study issues of family planning in the developing countries. These KAP surveys, their popularity grew in the 1960's and their applications were used by researchers in several fields and topics (Bulmer & Warwick, 1998). However, existing literature indicates that there are three different objectives of KAP studies which include; assessing KAP towards a concept, problem identification and intervention planning and evaluation tool (Swanson et al., 1994; Vandamme, 2009; Ntawuruhunga, 2016). For instance, Swanson et al., (1994) describe a methodology in the Strategic Extension Campaign (SEC) Programme which follows a systematic approach, starting with a farmer's knowledge, attitude, and practice (KAP) survey whose results are used as planning inputs and benchmark-baseline. Other studies have focused on identifying and describing critical elements, negative attitudes and reasons for non-adoption of a recommended technology using KAP surveys (Ntawuruhunga, 2016).

2.6.1 Knowledge

Khan (2012) indicates that knowledge plays a pivotal role and is attributed a wide variety of properties and qualities in the field of learning and instruction. Knowledge may be described in several ways and common examples include: the generic or general; domain specific knowledge; concrete and abstract knowledge; formal and informal knowledge; declarative and procedural knowledge; conceptual and procedural knowledge; elaborated and compiled knowledge; unstructured and (highly) structured knowledge; tacit or inert knowledge; strategic knowledge, knowledge acquisition; situated knowledge; and meta knowledge (Khan, 2012). Several researchers have attempted to provide a systematic description of knowledge. Some researchers have attempted to use cognitive theories, whereas other researchers have described knowledge on the basis of instructional design theory (Ntawuruhunga, 2016). However, these approaches all seek to approach and characterize knowledge from an epistemological view point (Ntawuruhunga, 2016). An epistemological point of view is based on characterizing the elements of knowledge base by the function they fulfill in the performance of a target task. Knowledge can be distinguished into four types: situational knowledge which knowledge about situations as they typically appear in a particular domain; conceptual knowledge which is static knowledge about facts, concepts and principles that apply within a certain domain; procedural knowledge which contains actions or manipulations that are valid within a domain; and strategic knowledge which helps individuals to organize their problem-solving process by directing which stages they should go through to reach a solution. Khan (2012)) further indicated that the elements of knowledge belonging to the first three types (situational, conceptual, and procedural) are specific and applicable to certain types of problems, whereas the last type namely, strategic knowledge, is applied to wider variety of types of problems.

2.6.2 Attitudes

According to Ntawuruhunga (2016), attitudes are a set of emotions, beliefs, and behaviors towards a particular object, person, thing, or event. They are a result of learning, modeling others, and our direct experiences with people and situations. Bowling (1997) indicates that attitudes influence our decision making, guide behaviors, and impact what we selectively remember. Most importantly, attitudes come in different strengths, and like most things that are learned or influenced through experience, they can be measured and they can be changed.

2.7 Empirical Literature

Schreinemachers et al. (2017), assessed farmers' knowledge, attitude and practices of South East Asian growers on pesticide use and pest management methods. The study used both descriptive and inferential statistics. Furthermore, the study found that the farmers were knowledgeable, reporting that 74% were able to identify caterpillars and moths as pests that damaged their crops, as well as that only 23% could identify useful arthropods. In another study by Ibitayo (2006), it was found that male farmers have more knowledge on cotton pests compared to women meaning they spend much more time in the fields. The study also assessed farmer's knowledge of integrated pest management. They found out that farmers were heavily reliant on pesticides which was attributed to the limited access and interactions they had with agricultural extension officers. A study by Kumar and Popat (2010), assessed perceptions and knowledge of groundnut growers in relation to Aflatoxins contamination. The study investigated socioeconomic effects of farmers on knowledge about pesticide use in India, which established that socioeconomic and psychological characteristics like education, farm size, social participation, extension participation, market orientation, economic motivation, innovativeness and perception were statistically significant with the farmer's knowledge. Murithi et al. (2016), found that knowledge and perception of farmers in Kenya on management of fruit-flies for their mango orchards were attributed to availability of extension services. This study also established that literacy levels of household heads was one of the significant indicators of pesticide application.

This study used a binary logit model to estimate farmers' knowledge of the pea weevil pests. According to this study, 83% of pea farmers reported that the pea weevil was the major pest infesting their crops, where as 71% of the farmers indicated they had knowledge about the pea weevil. The study also concluded that gender, farming experience and membership to cooperatives positively influenced farmers' knowledge of the field pea pests. This is because they significantly affected the knowledge level of farmers on pesticide use. In Nepal, a similar study found that more than half of female farmers who were able to apply pest management practices were 40 years and below, whereas the ages for males was normally distributed. However, the study found that female farmers had less knowledge in interpreting and understanding of pesticide labels; less awareness on importance of protective gear during spraying; and that female farmers were not major decision makers on pesticide use in the household. The study concluded that the male domination in decision making, had an influence on the frequency, timing, doses and types of pesticides used in the fields. A study in Ghana, found out that about 90% of fruit growers were made aware of the fruit fly pest through fellow farmers, traders, extension agents, researchers and the media (Konradsen, 2003). This study found that a majority of the farmers wrongly identified the true fruit fly pest for Drosophila melanogaster, Apis malifera and Musca domestica accounted for 60.3%. It was also established that common practices of farmers the management of Fruit Flies included pheromone trapping, orchard sanitation, spraying with synthetic pesticides, and prompt harvesting of fruits.

Globally, it is estimated that thousands of people die each year from the pesticides poisoning of which suicide happens to be the most problematic poisoning circumstance (Konradsen 2003). Even though there is high burden of acute pesticide poisoning (APP) in most of the developing countries, there is significant under-reporting suggesting that the burden of disease due to acute pesticide poisoning is commonly underrated (London and Bailie, 2001). Studies in developing countries of farmer's knowledge and practices have reported low to moderate levels of knowledge about pesticides (Ibitayo 2006), non-usage of personal protective equipment (PPE) (Sivayoganathan 1995), poor disposal of empty pesticide containers (Ibitayo 2006), unsafe pesticide storage at homes, improper use of pesticides and relatively low knowledge about pesticide safety labels (Ajayi 2007). Studies carried out in developing countries indicate that farmers usually source pesticide information from pesticide vendors and from other farmers who are not knowledgeable about pesticide risks (Sodavy 2000). These risks may be aggravated by lack of information about the nature of the pesticide handled. For instance, a study in Tanzania revealed that some suppliers repackage and distribute products in unsafe and unlabeled containers (Lekei 2004). A study in Ethiopia indicted that a significant proportion of the pesticides applied originate from unauthorized and unlawful sources, and sometimes brought in Ethiopia through illegal trading from the neighboring countries to local sellers. The study also indicated that the informal traders set Low prices of the pesticides which implies that they source these products from outside the official distribution channels (Saka JK, 1999). Research has shown that, despite the various benefits in agriculture and public health, pesticides pose significant risks to humans, non-target organisms and the environment. For instance, intentional or accidental acute pesticide poisoning continue to affect a lot of people around the world (Dawson 2010). It was revealed that, although small scale farmers in Africa use very small proportion (Aktar et al, 2009) of the world's pesticides, they suffer most of the adverse effects as a result of a number of reasons that include unavailability of safety equipment, illiteracy, improper labeling of containers, wrong attitudes and ignorance (Kesavachandran 2009).

2.8 Chapter summary

This chapter has discussed the relevant literature to the study as well as revealed empirical studies on KAP. The chapter has also discussed the different types of pesticides used in cereal and legume crops. These have helped the study to give more reflections to the different methodologies and applications as presented by scholars broadly.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

The aim of this chapter is to describe in detail the elements of data collection and analysis. It highlights the design and approach the study adopted to collect data. The elements of data collection included area of study, sampling frame (population), sample size and sampling methods. The chapter also described data collection and analytical tools. Ethical considerations have also been described in the chapter.

3.2 Study area

3.2.1 Location

Malawi is located south of the Equator between latitudes **9^{0} $30^{'}$S13.2543^{0} S,** and longitudes **34.3015^{0}E**. The country is mostly hilly and mountainous, it is mainly boarded by Tanzania to the northeast, Zambia to the northwest and Mozambique on the west, south and eastern part. Malawi has a total land area of about 118,484 km^2 of which 20% is under water. The study was carried out in nine districts of Malawi from the three main regions. The districts in the northern region were Rumphi ($10^{0}45^{'}$ S, $33^{0}50^{'}$ E), and Mzimba ($11^{0}27^{'}$ S, $34^{0}01^{'}$ E). Districts in the central region were Kasungu ($13^{0}02^{'}$ S, $33^{0}29^{'}$ E), Lilongwe ($13^{0}58^{'}$ S, $33^{0}01^{'}$ E), Ntcheu ($14^{0}45^{'}$ S, $34^{0}45^{'}$ E) and Salima ($13^{0}45^{'}$ S, $34^{0}30^{'}$ E). Districts in the southern region were Machinga ($15^{0}04^{'}$ S, $35^{0}14^{'}$ E), Chikwawa ($16^{0}10^{'}$ S, $34^{0}45^{'}$ E), and Thyolo ($16^{0}04^{'}$ S, $35^{0}08^{'}$ E) (figure 1). These districts were selected from five main agro-ecological zones of Malawi: Highlands (Mzuzu, Karonga and Blantyre), Plateau (Lilongwe and Kasungu), Rift Valley Escarpment (Blantyre and Mzuzu), Lakeshore Plains (Mzuzu, Salima, Machinga and Karonga) and Lower Shire Plains (Shire Valley). These ecological zones are divided into ADDs, which are further subdivided into EPAs.

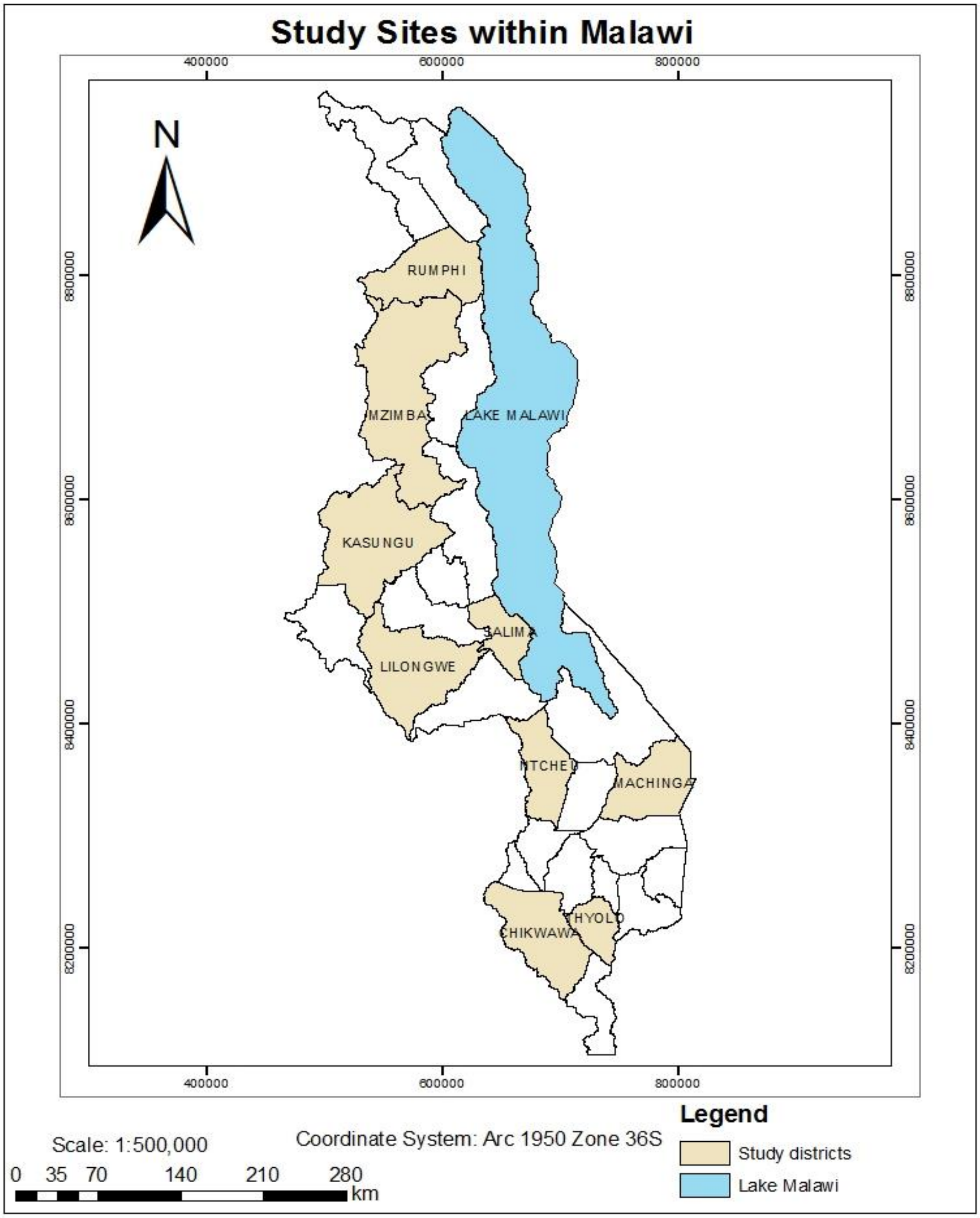

Figure 3.1: Map of Malawi showing study districts

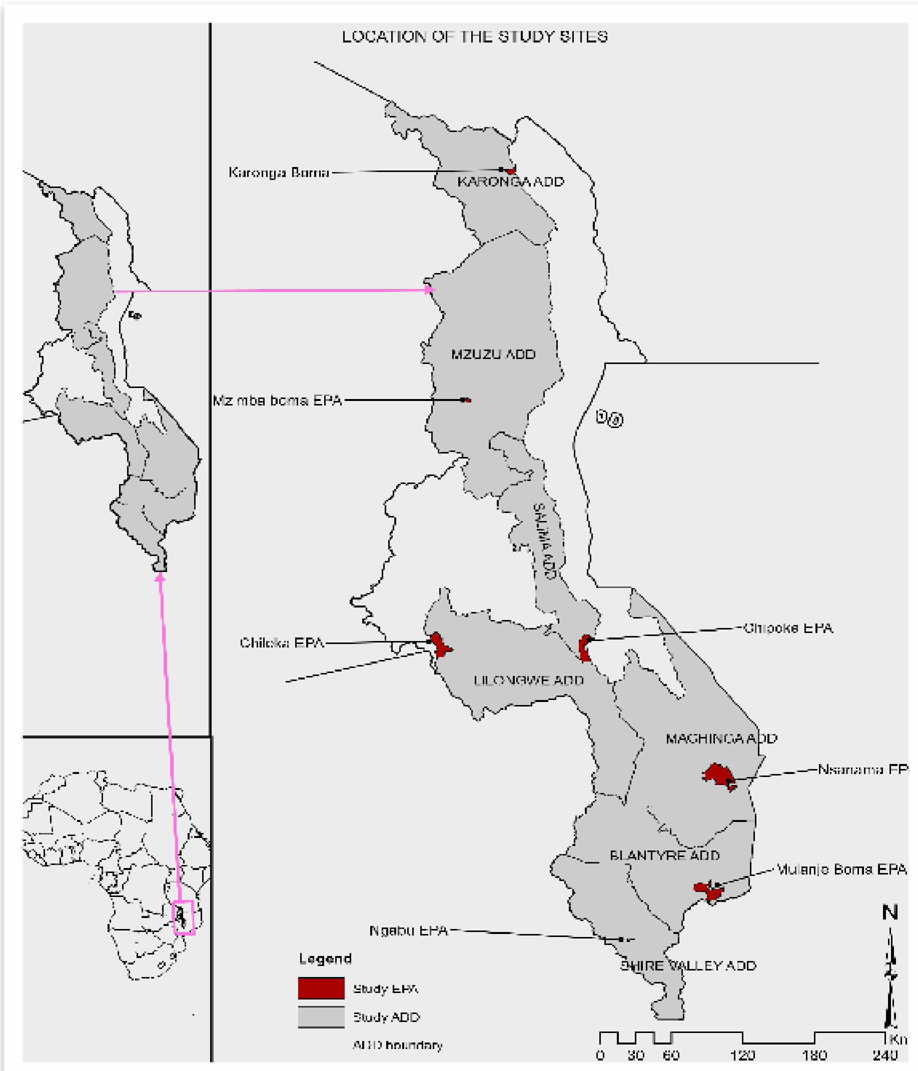

Figure 3.2: Map of Malawi showing study sites in each agro-ecological zone.

two distinct seasons; the dry season, this may also be divided into two periods, cool and dry period from mid-May to mid-August and hot and dry period from mid-August to October, then the rainy season from mid-November to April. Before the rainy season, from September to November, the temperature rises to the highest level of the year. However, temperatures vary with altitude. In Malawi, rainfall is unimodal with annual amounts ranging from 700 mm to 2400 mm and average rainfall amount of 1180 mm. Topography and proximity to Lake Malawi mainly influences the rainfall distribution. In Malawi rainfall is more abundant in the North, where in particular March and April are very rainy, and also in the southern slope of Mulanje, where rainfall even exceeds 2,000 mm per year (GoM, 2014).

3.3 Research Design

This research used exploratory research design. An exploratory design is conducted about a research problem when there are few or no earlier studies to refer to or rely upon to predict an outcome. Additionally, explorative study allows for flexibility on the part of the researcher, and can be used to address all types of research questions. The study further used a mixed research approach. There are three approaches or methods to conducting research: qualitative methods, quantitative methods and mixed methods. This study involved the collection and analysis of both quantitative and qualitative data; thus, a mixed method approach was adopted to address the research questions.

3.3.1 KAP survey

In order to obtain farmers' knowledge, attitudes, and practices on pesticides, as well as to identify pesticides that are commonly used by farmers, a KAP survey was carried out. KAP surveys are specifically designed to gather information about general practices and beliefs among individuals (Ntawuruhunga, 2016).

3.3.1.1 Sampling technique

A multi-stage sampling technique was employed to select 1014 small scale farmers from the 3 regions of Malawi. This technique was employed because the population size was very large, since farming is the primary source of income for most of the Malawians. It is reported that over 84% of Malawians are involved in agriculture to earn a living (Chinsinga, 2008). Therefore, the population required to be divided into various clusters. Nine districts were purposively selected in the first stage based on ecological zones, region, and the fact that these are some of the main districts where legume and cereal crops are grown.

3.3.1.2 Sample size

Sample size was calculated using Cochran method. The method involved the following procedure:

Calculation of sample size (SS) for infinite population:

$$SS = \frac{(\text{Z−score})\,2 \times P\,(1-P)}{(margin\ of\ error)\,2} \quad \text{………………..Equation (1)}$$

Where: Z-score = 1.96 at 95% confidence interval, and Margin of error = 0.05

Then, the sample size was adjusted to the specific population:

Adjusted sample size = $\frac{SS}{1+ {(SS-1)}/{N}}$,   where: N = population size

In each selected district, two extension planning areas (EPA) were randomly selected, in which two sections were also randomly selected. On average 30 small scale farmers were systematically selected in each section.

3.3.1.3 Data collection

A well-trained team of interviewers was employed to administer the questionnaires in a local language. The team included agriculture experts, academicians and researchers. A brief explanation about the purpose of the study was always given to the farmers to be interviewed, and farmers gave their informed consent to participate in the study. A standardized questionnaire was administered, in order to collect data on farmers' knowledge, attitude and practices regarding pesticide use. Both closed and open ended questions were included in the questionnaire on actions taken when health effects are observed after handling and using pesticides, whether they experienced any pesticide poisoning, practices regarding storage of unused pesticides, use of protective clothing, disposal of pesticide containers, number of times pesticide containers are washed and whether pesticide containers are re-used for domestic purposes. Association between health effects and type of pesticide used was captured during the interview as respondents were stating names of pesticides causing the health effects if any.

3.4 Data analysis

3.4.1 Assessment of Knowledge, Altitude and Practices (KAP) study

Data from the survey was statistically analyzed using the IBM Statistical Package for Social Scientist (SPSS version 20). Descriptive statistics were used to summarize the data into frequencies, percentages, averages, tables, and graphs. Cross tabulations on the data were conducted using ANOVA (Turkey multiple comparison test) to compare groups.

3.4.2 Logistic analysis

Data from the survey were statistically analyzed using the IBM Statistical Package for Social Scientist (SPSS) version 20, running a binomial Logit model to assess the extent of farmers practices in the use of pesticides, focusing on socioeconomic factors.

3.4.2.1 The Logit Model (LM)

A Logistic regression analysis allows for the estimation of the probability that an event occurs or not by predicting a binary or dichotomous dependent outcome from a set of independent variables. The basic ideas underlying the Logit model is given below.

$$P_i = Exp\{Y = 1\ \text{I}\ X_i\} = \beta_0 + \sum_{i=1}^{k} \beta i\, Xi$$ …………………………...Equation (2)

Where P_i represents the probability of using pesticides on their farm,

X_i denotes the set of explanatory factors (socio-economic) determining farmer use of pesticides and Y is the dependent variable (Use or No use). β_0 *and* β_i are explained in equation 2.

Equation 2 can be written as below

$$P_i = E\{Y = 1\ \text{I}\ X_i\} = \frac{1}{1+e^{-\left(\beta_0 + \sum_{i=1}^{k} \beta_i X_i\right)}}$$ ……………. Equation (3)

If Z is to denote $\beta_0 + \sum_{i=1}^{k} \beta_i X_i$, then equation 2 can be written as

$$P_i = E\{Y = 1\ \text{I}X_i\} = \frac{1}{1+e^{-Z_i}}$$ ……………………………. Equation (4)

From equation 2 to 4, the probability of a farmers' use of pesticides is then given by *(1 – P_i),* and

$$(1 - P_i) = \frac{1}{1+e^{-Z_i}}$$ ……….…………………………….....Equation (5)

This can be written as:

$$\frac{P_i}{(1-P_i)} = \frac{1+e^{Z_i}}{1+e^{-Z_i}}$$ …… …………………………………… Equation (6)

Taking natural logarithms both sides of equation 2-6 will leave us with (Kuscu et al., 2009):

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum_{i=1}^{k} \beta_i X_i$$ ………….Equation (7)

L_i is called the Logit model. Here, the assumption is that the farmer's decision is reached after consideration of different factors, and farmer use is a measure of the extent of pesticide use. The significance of the technical factors that the farmers consider can be tested and Principal Component Regression (PCR) applied within a maximum likelihood estimation framework to determine the technical performance level.

3.4.2.2 Specification of the binomial logistic model

The dependent variable in this model is dichotomous, since the farmer has two choices, to use pesticides (1) or not (0) in their farms. The common models used for this type of regression analysis may include binomial regression model. However, it is noted that, the binomial regression model has the demerit of predicted values falling outside the permissible interval (0, 1). However, in this model the farmer either uses pesticides on their crops or not. When the choice of individual's is discreet and only two choices are involved, it is dichotomous choice and a Logit model is applicable.

3.4.3 Empirical Model

The general estimating equation for the study will be;

$$\text{Pesticide use } (U) = f(\,Socioeconomic\ factors)$$ …………….. equation (8)

The following model will be used to estimate the extent of pesticide use practices by farmers:

$$Y(0,1) = \beta_0 + \beta_1 Gen + \beta_2 Age + \beta_3 Edu + \beta_4 Hhs + \beta_5 Fex + \beta_6 Fms + \beta_7\, Ahi + \beta_8\, Eap + \beta_9 Ins + e$$

……………………………...……Equation (9)

Where: *Gen* = Gender of household head; *Age* = Age of Household head; *Edu* = Education level; *Hhs*= Household size; *Fex*= Farming experience; *Fms*= Farm size; *Ahi* = Awareness of health impacts; *Eap* = Easy availability of pesticides and *Ins* = Information sources on pesticides

3.4.3.1 Definition and Measurement of Variables

Table 0.1: Definitions and measurements of variables

Explanatory variable	Data type	Expected sign	Dependent Variable
Gender (sex)	Dummy variable	-/+	Pesticide use
Age (years)	Continuous	-/+	
Household size (number of people in household)	Continuous	+	
Education level (years)	Continuous	+	
Farming experience (years)	Continuous	+	
Farm size (acreage)	Continuous	-	
Awareness of health impacts	Dummy variable	-/+	
Easy availability of pesticides	Dummy variable	+	
Information sources on pesticides	Categorical	-/+	

Table 0.2: logistic model data measurement and expected sign

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

Households of most small-scale farmers depend on agricultural production as their primary source of livelihood, so do the economies of developing countries like Malawi. In view of climate change, pests and diseases have become a major production challenge and a food security concern. In response, most small-scale farmers resort to using synthetic pesticides and insecticides to savage the little produce for their survival. This chapter aims at providing data on pest and diseases have impacted the use of pesticides amongst small-scale farmers in Malawi and whether they are aware of the negative effects the chemicals have on human beings and the environment in general.

4.2 Demographic characteristics of respondents

4.2.1 Study area

Table 4.1 shows that one thousand and fourteen (1014) small scale farmers were involved in the study. These were selected from nine districts across Malawi. Three hundred and twenty farmers were selected from three districts in the southern region; Machinga (105), Thyolo (96) and Chikwawa (119). Four hundred and ninety-six were selected from four districts in the central region; Lilongwe (144), Ntcheu (135), Salima (117) and Kasungu (100). One hundred and ninety eighty farmers were selected from Karonga (103) and Rumphi (96) in the northern region. The study therefore did cut across almost all the eight ecological zones of Malawi.

Table 0.1: Distribution of respondents across districts and regions

	Machinga	Thyolo	Chikwawa	Lilongwe	Ntcheu	Salima	Kasungu	Karonga	Rumphi	Total
South	105	96	119	0	0	0	0	0	0	**320**
Central	0	0	0	144	135	117	100	0	0	**496**
North	0	0	0	0	0	0	0	103	95	**198**
Total	**105**	**96**	**119**	**144**	**135**	**117**	**100**	**103**	**95**	**1014**

4.2.2 Gender of respondents

Table 4.2 exhibit the social and demographic characteristics of the small-scale farmers who were involved in the study as respondents. The table shows that the majority of the respondents were women across all regions and districts. In total, 61.4% (n = 627) were women against 38.6 % (n = 387) males. However, it was noted that most of these women were not household heads. They were involved in the study on behalf of their husbands who were not available.

4.2.3 Demographic characteristics of respondents

The demographic characteristics of the respondents are summarized in table 4.2. The study showed that the majority (91.4%, n = 927) were either indigenous to the area or had stayed for more than 10 years unlike the 8.6% (n 87) who had recently moved to the area. The study was conducted across different ecologies because different environments have different pests and disease situations and severity and hence different management approaches. Therefore, farmers who are indigenous to the area or who have stayed long in the area provide the true reflection of the practices. This study therefore is more (91.4%) likely to provide information, which is true to the areas. The authenticity and reliability of data of residence is supplemented by the fact that the majority (89.2%, n = 904) had been farming for more than three years.

Table 0.2: Social and demographic characteristics of respondents across regions

	South		Central		North		Total	
	%	**n**	**%**	**n**	**%**	**n**	**%**	**n**
Gender								
Male	36.7	134	32.6	133	40	120	38.6	387
Female	63.3	190	67.4	279	60	180	61.4	627
Residence								
Over 10 years	95.1	285	89.8	372	90	270	91.4	927
Less than 10 years	4.9	15	10.2	42	10	30	8.6	87
Village residence								
Another village, same district	3.4	11	6.3	31	4	8	52.1	50
Another district, same EPA	0.3	1	1.2	6	10.6	21	28.2	28
Another EPA	1.2	4	2.7	13	0.5	1	18.8	18
Farming period								
<3	9	27	9.7	40	14.3	43	10.8	110
3-5	70	210	75.6	313	64.7	194	70.8	717
6-10	13.3	40	8.9	37	14.3	43	11.8	120
Over 10 years	7.7	23	5.8	24	6.7	20	6.6	67
Level of education								
None	28.3	85	25.4	105	13.3	40	22.7	230
Primary (1 – 4)	57	171	53.1	220	16.7	50	43.5	441
Primary (5 – 8)	13.7	41	18.1	75	20	60	17.4	176
Secondary	1	3	4.7	14	40	120	13.5	137
Tertiary	0	0	0	0	10	30	3	30

4.2.4 Education level of respondents

The study also showed that the majority (43.5%, n = 441) of the respondents had attained formal education but up to standard 4 of primary education seconded by 22.7% (n = 230) who did not attempt any education. Very few (3%, n = 30) respondents attained tertiary education. Level of education was important in the study as it affects knowledge of use of the chemicals as well as implications in terms of hazards to humans and the environment.

4.3 Level of farmers' knowledge of the effects of pesticide residues on both human health and the environment

4.3.1 Demographic characteristic vs use of pesticides

Table 4.3 and 4.4 present the summary of pesticide utilization amongst smallholder farmers. Table 4.3 shows that the majority of farmers (58%) use pesticides to control pests and weeds. However, the utilization differs across districts and the gender groups (male and female). In general, most males (33%, n 337) use pesticides in their production routines compared to 25% (n = 254) females. The logistic analysis showed that gender had a significant effect ($P < 0.01$) on use of pesticides. Pesticides utilization varied across locations. The highest utilization of chemicals was recorded from Karonga (83%), Chikwawa (82%), Rumphi (77%) and Thyolo (56%). The least utilization (41% and 44%) were recorded in Kasungu and Salima respectively. However, the logistic analysis showed that location had no effect on use of synthetic pesticides. The effect of gender on use of synthetic pesticides controlled by location showed varied results. More males than females used synthetic pesticides in Chikwawa, Lilongwe, Salima, Karonga and Rumphi, with the largest discrepancy in Karonga (60% males than 22% females). The trend was different in Machinga, Thyolo, Ntcheu and Kasungu where more females than males used pesticides but the differences were not significant. The study found that small scale farmers in Malawi use a wide range of synthetic pesticides (Appendix 4).

However, it was noted that Cypermethrin (37%) and Dimethoate (14%) are among those commonly used in treating various types of crops (appendix 4). These results agreed with studies on residue analysis of pesticide samples. For example, Mkandawire (2017) found significantly higher levels of Cypermethrin and Dimethoate in soil samples collected from tomato farms in some parts of Malawi. A survey on use and presence of persistent organic pollutants (POPs) that included research institutions, chemical companies, Agricultural Development and Marketing Corporation of Malawi markets, and many more stakeholders concluded that in Malawi there is a high demand for pesticides to be used in the agriculture sector (GoM, 2010).

Table 0.3: Use of pesticides controlled for gender and district

District			Yes		No		Total
			n	%	n	%	
	Gender	Male	21	20	11	10	32
Machinga		Female	29	28	44	42	73
	Total		50	48	55	52	105
	Gender	Male	24	25	15	16	39
Thyolo		Female	30	31	27	28	57
	Total		54	56	42	44	96
	Gender	Male	57	48	4	3	61
Chikwawa		Female	41	34	17	15	58
	Total		98	82	21	18	119
	Gender	Male	53	37	26	18	79
Lilongwe		Female	19	13	46	32	65
	Total		72	50	72	50	144
	Gender	Male	33	24	19	14	52
Ntcheu		Female	34	25	49	36	83
	Total		67	50	68	50	135
	Gender	Male	30	26	14	12	44
Salima		Female	21	18	52	44	73
	Total		51	44	66	56	117
	Gender	Male	19	19	21	21	40
Kasungu		Female	22	22	38	38	60
	Total		41	41	59	59	100
	Gender	Male	62	60	14	14	76
Karonga		Female	23	22	4	4	27
	Total		85	83	18	17	103
	Gender	Male	38	40	6	6	44
Rumphi		Female	35	37	16	17	51
	Total		73	77	22	23	95
	Gender	Male	337	33	130	13	467
Total		Female	254	25	293	29	547
	Total		593	58	423	42	1014

Mkandawire (2017) also noted that most of the tomato farmers in some parts of Malawi generally use synthetic pesticides to control pests, weeds and diseases. According to Chung et al., (2011), generally, without pesticides, most of the crops would be critically damaged by insects, weeds and diseases, as a result there would be severe loss of food crops. However, it is reported that synthetic chemical pesticides used in most of the developing countries do not meet recommended standards.

Table 4.4 is the cross tabulation of targeted crop for pest management and control using different pesticides. Maize is the major crop that is produced and targeted for pest control across all locations seconded by tomato and vegetables, which are grown in six of the nine sampled districts.

Table 0.4: Cross tabulation of use of pesticides per districts and target crops

	District									Total
	Machinga	Thyolo	Chikwawa	Lilongwe	Ntcheu	Salima	Kasungu	Karonga	Rumphi	
Maize	48	52	92	28	39	35	32	19	58	403
Pigeon peas	1	0	0	0	1	0	0	4	0	6
Cowpea	1	0	0	0	1	8	0	1	0	11
Sorghum	0	0	1	0	0	0	0	0	0	1
Rice	0	0	0	0	0	0	0	35	0	35
Groundnuts	0	0	0	0	0	0	0	1	0	1
Tomato	0	1	0	19	11	1	0	0	6	38
Tobacco	0	0	0	5	1	0	4	0	3	13
Soybeans	0	0	0	1	0	0	3	0	0	4
Vegetables	0	2	0	14	14	0	2	0	1	33
Beans	0	0	1	2	0	1	0	0	3	7
Cotton	0	0	1	0	0	6	0	15	0	22
Millet	0	0	3	0	0	0	0	0	0	3
Irish potato	0	0	0	2	0	0	0	0	2	4
Not applicable	55	41	21	72	67	66	59	18	22	421
999	0	0	0	0	1	0	0	0	0	1
Cotton	0	0	0	0	0	0	0	2	0	2
Maize	0	0	0	1	0	0	0	3	0	4
Pegeon peas	0	0	0	0	0	0	0	1	0	1
Rice	0	0	0	0	0	0	0	4	0	4
	105	96	119	144	135	117	100	103	95	1014

The study showed that Cypermethrin is the popular (275) synthetic pesticide and is mostly used in Chikwawa (65), Salima (40), Lilongwe (36), Machinga (29) and Karonga (29) (table 4.5). The chemical is least used in Kasungu (19). Dimethoate was the second most used chemical pesticide mostly in Chikwawa (30), Ntcheu (22), Kasungu (15) and Rumphi (15). Roundup was the third most used synthetic pesticides mostly in Rumphi (31) and Karonga (17). Other chemicals (118) were mostly used in Karonga (24), Ntcheu (23), Chikwawa (22) and Lilongwe (21). Other chemicals comprised Karate, Snowclone, Attack etc. (Appendix 4).

Table 0.5: Cross-tabulation of chemicals and districts

	Chemical Name									**Total**
	Roundup	Harness	Cypermethrin	Dimethoate	Copper	Other chemicals	Bullet	Confidol	Actellic	
Machinga	5	3	29	11	0	3	0	0	10	79
Thyolo	2	0	11	7	1	8	0	0	33	62
Chikwawa	7	0	65	30	3	22	0	0	1	128
Lilongwe	2	0	36	7	5	21	0	0	9	80
Ntcheu	8	2	26	22	3	23	0	0	5	89
Salima	2	2	40	12	2	5	0	0	0	63
Kasungu	9	3	19	15	1	4	1	4	0	56
Karonga	17	15	29	9	0	24	0	0	0	94
Rumphi	31	11	20	15	0	8	2	1	0	88
Total	83	36	275	128	15	118	3	5	58	721

The results of the study show that Cypermethrin is majorly used to control fall army worm (FAW) (270) other insect pests (101) such as ants, aphids, and grasshoppers (4). Dimethoate is mainly used to control fall army worms (51) and insect pests (25). Roundup and Harness are used for weed management (table 4.6). The other chemicals such as Snowclone, are used to control FAW and other insect pests such as aphids, while bullet and others were herbicides. Actellic was also popularly used for control of storage pests, weevils, as well as other field insect pests. This shows that most of the pesticides are used control pests for crops that are still in the field.

Table 0.6: Cross tabulation of chemicals and targeted pests

	Target weed insect disease							Total
	Weeds	FAW	Diseases	Insect pests	Termites	Weevils	Grasshop pers	
Round up	70	0	0	0	0	0	0	70
Harness	36	0	0	0	0	0	0	36
Cypermeth rin	0	270	0	101	0	0	4	375
Dimethoate	0	51	0	25	0	0	0	76
Copper	0	7	3	5	0	0	0	15
Other chemicals	48	14	4	12	0	1	4	83
Bullet	3	0	0	0	0	0	0	3
Confidol	0	0	0	3	2	0	0	5
Actellic	0	0	0	8	0	50	0	58
Total	157	342	7	154	2	51	8	721

4.3.2 Farmers' knowledge about effects of pesticide residues on human health and environment

Awareness score was computed by considering correct answers from a series of questions (Table 4.7). Each correct answer to the questions was considered 1; this means that an individual could achieve a maximum awareness score of 4. The study showed that the majority of farmers were not aware of the effect of pesticides on human health as well as on the environment.

Table 0.7: Farmers' awareness responses about pesticides (n = 1014)

Question	**Percent (%)**	
	Yes	**No**
Can some of the pesticides applied on crops may end up in water and soil?	27.7	72.3
Do pesticides have effects on environment and humans?	37.9	62.1
Do some food crops have Pesticides residues?	36	64
Can intake of food crops with residue pesticides have adverse effects?	45	55

About 72.3% of the respondents were not aware that pesticides would contaminate the soil and water, and would affect the biodiversity. Over 62.1% were not aware that such pesticides residues or contamination would cause illness and death of human beings as well as other macro and micro flora and fauna. About 64% were not aware that some synthetic pesticides remain on the produce and poses a risk to consumers and animals.

Lack of knowledge of the effect of pesticides demonstrates that farmers are more likely to unsafely handle and use pesticides. Use of chemical pesticides in a way that is not consistent with label directions as well as precautions is illegal and dangerous to human health (Ekram, 2016). This study found out that only 51.6% (Table, 4) of the respondents received basic training on safe handling and using of chemical pesticides, this may enhance poor practices by farmers which may lead to harmful effects of pesticides on both environment and human health. These results are in line with what other studies in some developing countries found. Ekram (2016) found that over 61% of the sampled farmers in Bahri locality in Sudan did not receive any training on how to handle and use pesticides, which largely contributed to poor practices when handling and using pesticides.

4.3.3 Pesticide knowledge

Farmers' awareness on pesticide use was further assessed by determining farmers' pesticide knowledge (figure 4.1). The knowledge score was computed by considering correct answers from questions 51, 57, 58, 59, and 60. Each correct answer for the five questions was considered 1; this means that a person could achieve a maximum knowledge score of 5, and a lowest score of zero upon failing all the five questions. Total knowledge score of the respondents by demographic groups was compared using T-test for groups with only two categories (e.g. Gender and age) while ANOVA (Turkey multiple comparison test) was used to compare groups with more than two categories (e.g. District, Region, Education level). The average score for knowledge of pesticides among the different categories of the small-scale farmers was 2.03 ± 1.96 out of possible 5, an indication that knowledge across the sample population is just below average. The study showed that over 40% of the sampled farmers had very low knowledge of the pesticides. However, the study also demonstrated that there are some few farmers that have very good knowledge of the chemical pesticides.

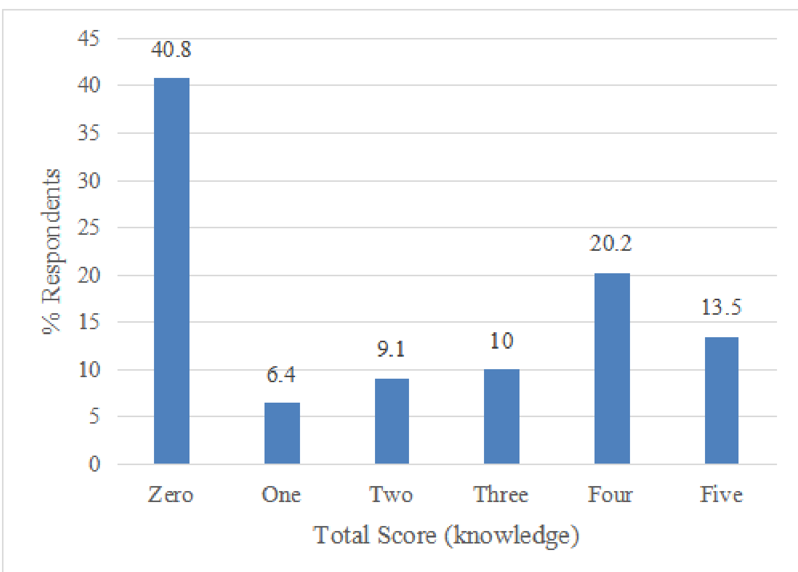

Figure 4.1: Knowledge of farmers about chemical pesticides

4.3.3.1 Demographic characteristics vs farmer's knowledge on pesticides

On demographic groups, the study found out that there were statistical differences in knowledge of pesticides among the three regions, districts, sex and education (Table 4.8).

a. *Education level vs farmer knowledge on pesticides*

The study showed that an increase in formal education increased level of knowledge of pesticide use. Farmers with tertiary education, for instance, recorded a knowledge score of 2.61 against farmers who attained secondary (2.41), primary (1.97) and no education (1.48) and the differences were highly significant at $P < 0.001$. The data depicted a positive correlation as was reported by Jolly (2009). Farmers with high level of education were able to read and follow the instructions on how to use chemical pesticide. However, it was noted that farmers, who lacked formal education, but received informal training by NGOs exhibited higher knowledge on pesticides use and handling. These were mostly observed in Ntcheu and Chikwawa,

b. *Farmer's gender vs knowledge on pesticides*

Gender had a positive influence on farmer's knowledge on pesticide use. Male participants had significantly more knowledge level (2.55) than their female counter parts (1.59) and the difference was significant at $p < 0.05$. According to Katungi (2006) males have more opportunities for education be it formal or informal than females as they can source for their own fees through piece works. Secondly, most households are male headed and therefore the opportunity for training often goes to the males. Socio-cultural values and norms accord males with freedom of mobility, participation in different meetings and trainings and hence makes them have a greater access to information. Habtemariam (2004) and Katungi (2006) also reveal that men tend to build and maintain large networks that give them more access to agricultural information than females. In another study by Yahaya (2001), it was reported that sourcing of agricultural information and its utilization is along gender lines as women are less likely to participate because they have limited time to access or utilize available information due to pressure of household responsibilities. The low knowledge level in women about pesticide use is worrisome because the study revealed that more women are involved in pesticide use.

c. *Farmer's age and knowledge of pesticide use*

The study showed that age of the farmer affected their level of knowledge of pesticide use. Differences were observed amongst farmers who were aged less than 39 years (2.01) and who were aged 40 and more years (2.08) and the difference was significant at $p < 0.05$. The result showed that farmers, who were older were more knowledgeable of pesticide use than younger people.

d. *Residence of farmers' vs knowledge of pesticide use*

Residence of the farmer in terms of region significantly affected level of knowledge of pesticide use at $p < 0.05$. Farmers from the north had the highest knowledge score (2.97) than their counterparts from the southern region (2.19) and central region (1.55). Thus farmers from the central region had the least knowledge of pesticide use and were more likely to mishandle pesticides and the residues there of. This is because farmers from the north had higher education levels than their counterpart from other regions. However, no significant differences were observed amongst districts in terms of knowledge level.

e. *Education level and knowledge of pests*

Education level also affected knowledge of pests, which inform of the pest to be procured and used (Table 4.9). The data showed that some (24.7%) farmers do not know names of the pests, insects and diseases affecting their crops (Table 4.9). Fall army worms displayed a large proportion amongst the targeted pests (16.1%), with southern region as the most affected region, where 93.4% of the fall army worms were reported. In their study, Damalas (2016) also indicate that a significant percentage of farmers did not have knowledge of the targeted pests.

Table 0.8: Knowledge of pesticides among demographic groups

Variable	Freq.	Mean	Std. Dev	Test Stat.	Sig.
Region					
Central	498	1.55[a]	1.84		
South	318	2.19[b]	1.89	0.000	***
North	198	2.97[c]	1.96		
Sex					
Female	547	1.59[a]	1.88	0.000	***
Male	467	2.55[b]	1.92		
Age					
39 and below	500	2.01[a]	1.95	0.570	
40 and above	514	2.08[a]	1.96		
Education					
None	165	1.48[a,b]	1.86	0.000	***
Primary	581	1.97[b]	1.93		
Secondary	258	2.41[c]	1.99		
Tertiary	10	2.6[a,b,c]	2		
District					
Salima	129	1.38[a]	1.81	0.000	***
Kasungu	100	1.50[a]	1.94		
Lilongwe	174	1.62[a]	1.82		
Ntcheu	135	1.68[a]	1.82		
Machinga	105	1.77[a]	1.9		
Thyolo	96	2.07[b,c]	1.97		
Chikwawa	117	2.66[b,c]	1.7		
Karonga	103	2.91[c]	1.94		
Rumphi	95	3.03[c]	1.98		
Knowledge Score (1-5)	1014	2.03	1.96		

Means that do not share a letter are significantly different. **$p < 0.05$

4.3 Attitudes and practices of farmers as regards their use of protective measures, safe storage and hygiene practices in pesticides use.

4.3.4 Farmers' altitudes

Correlation analysis between demographic characteristics and altitude of small-scale farmers towards pesticide use in cultivation of cereal and legume crops are presented in table 4.9. The findings indicate that two variables out of eight variables; extension media contact (r = 0.377) and annual income (r = 0.378) significantly associated with altitude towards chemical pesticides use.

Table 0.9: Summary outputs of correlation analysis (n = 593)

Demographic characteristics	Co-efficient of correlation (r)
Age	0.014
Household size	-0.124
Education	0.052
Farm size	0.004
Annual income	0.368**
Extension media contact	0.377**
Knowledge on insect pest management.	0.016

Degrees of freedom (df) = 98, **Significant at 0.01 level of probability (2-tailed)

4.3.4.1 Farmers annual income vs farmers' attitude toward use of pesticides

The findings show that out of eight explanatory variables, two variables such as annual income (r = 0.368) and extension media contact (r = 0.366) were significantly associated with their attitude towards chemical pesticide use at $P < 0.01$. The finding regarding annual income implies that with an increase in annual income, the respondents are likely to show positive attitude in using chemical pesticides. Market price might be one of the factors influencing farmers' attitude towards chemical pesticides use. According Mahantesh and Singh (2009) reported that use of pesticides is expensive and increase production cost, which can only be recovered with a good price. Ahaduzzaman (2003) found significant positive relationships between annual income and attitude of farmers towards farming modern technologies.

4.3.4.2 Extension media contact vs farmer's attitude towards use of pesticides

Extension media contact significantly correlated with the use of pesticides by small scale farmers. The positive correlation implied that the farmers with frequent contact with extension media are more likely to use chemical pesticides. This is because such farmers are made aware of the benefits of using pesticides, how to use pesticides and the risks associated with pesticide use. On the other hand, the farmers, who had low extension media contact lacked knowledge and therefore were unable to make decision regarding pesticide use (Adebayo and Oladele, 2013, Khan, 2012 and Zakir, 2010).

4.3.4.3 Source of knowledge of pesticide handling

Some of the practices regarding pesticide use by the sampled farmers are shown in Table 4.12. Although a large proportion of small-scale farmers in Malawi uses pesticides, this study found that only 11% of the respondents received a formal basic training on safe handling and application of pesticides. The study indicated that only 58.4% (figure 4.2) of the pesticide users who received basic training on safe handling and use of pesticides, learnt how to use pesticides from the agriculture extension workers, while the other proportion indicates that they learnt from the information on labels, and dealers (Figure, 4.4).

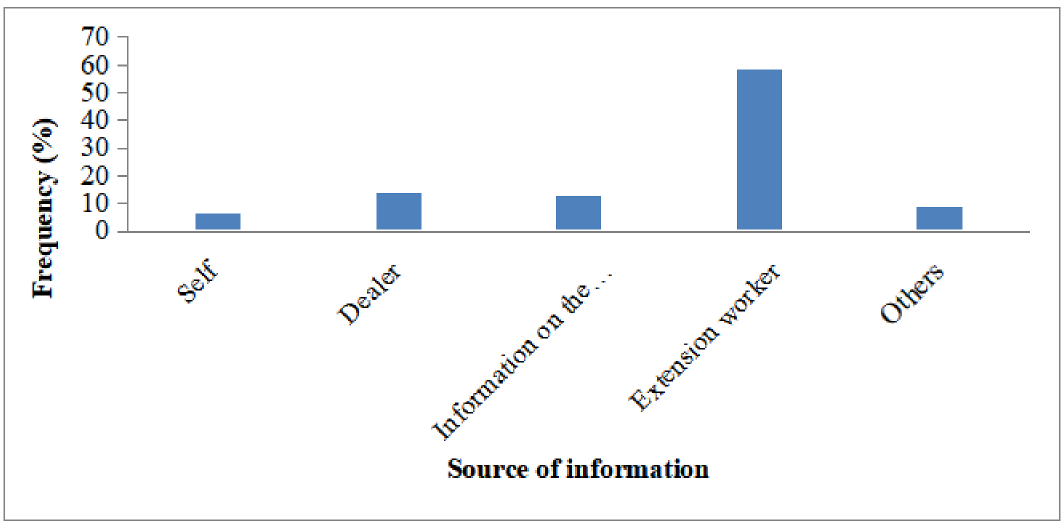

Figure 4.2: Bar graph showing where farmers learnt how to use pesticides.

4.3.4.4 Risk of pesticide poisoning

The study noted a high possibility of consumption of food crops with residual pesticide. The study found out that almost 23% of the sampled small-scale farmers experienced accidents as a result of pesticide poisoning (Table 4.11), with northern region registering very low pesticide poisoning. The low pesticide poisoning in the northern region could be attributed to high proportion of farmers with high levels of education which enable the farmers to read and follow the instructions on how to handle and use chemical pesticides. Intake of food crops with pesticide residue has adverse health implications. The data indicated that 58 % of the sampled population, do not know that intake of food crops with pesticide residues has adverse effect on human life (table 4.11).

The study found that maize which is the main food crop in Malawi, beans and sorghum are crops that are frequently treated with chemical pesticides (appendix 3). Ekram (2016) also found that almost all the respondents have never been informed of deaths due to pesticide poisoning, and that they were not aware that intake of pesticides can cause death or any harmful effect on human health.

4.3.4.5 Handling of left-over chemicals and their containers

The study noted that a significant proportion (59 %) of the small-scale farmers wash and reuse the pesticide containers for domestic purposes. However, the study also noted that over 49% of the farmers wash their pesticide containers only once before reusing them. This signifies one way in which farmers are subjected to adverse health effects of pesticide residues. Lack of proper training on safe handling and usage of pesticides was noted as one of the major challenges that contribute to poor handling of chemicals. Secondly, Malawi is vulnerable to illegal importation of pesticides because the country does not manufacture its own pesticides. It is thus difficult for Malawi to regulate pesticides, which are even sold by vendors. Significant proportion of the farmers (17.9%) buy unpacked pesticides from these vendors. As a result, most farmers (40%) throw away the left-over pesticides due to lack of proper storage conditions. Thirdly, Malawi does not have ultimate pesticides disposal facilities (such as pesticide incinerators). The compounding effect of the three challenges is the reuse of pesticide containers for domestic purposes such as for storing water (Heeren, 2003; Salameh et al, 2004), keeping left-over pesticides for re-use, improper disposal of left-over chemicals (Appendix 2). It is further sad to note that 35% of the subjects do not know that pesticides applied on crops may end up in water and soil, and that only 49% of the sampled population know that pesticide use has negative effect on environment and humans.

Table 0.9: Responses of farmers about pesticide use in the three regions

	South		Central		North		Total	
	%	**n**	**%**	**n**	**%**	**n**	**%**	**n**
Use of pesticides	84	242	71	280	63	188	58.48	593
Pesticides containers used for other purposes	70	177	65	191	25	47	59	415
Buy same pesticide brand	73.9	182	65.9	194	79.5	150	75	526
Know that intake of food crops with pesticide residues is harmful	30	76	35	103	63	188	42.1	483
Knows that some pesticides Applied may end up in water and soil	35.2	89	47	138	43.7	82	35	245
Think pesticide use has negative effect on environment and humans	40	108	45	132	56	105	49	345
Experienced accident as a result of pesticides poisoning	21	53	30	88	10	19	23	160
Received basic training on safer handling of pesticides	51	129	50	147	45	85	51.6	361

Disposing of pesticide containers after use was also described (table 4.12). Good practices (burying and burning) was represented by proportions of about 22.2 % and 19.9 %, respectively. About 53.3 % of the farmers who properly dispose their pesticide containers (burning and burying) received basic training on safe handling and using of pesticides. Almost 9.2% of the sampled population throw their pesticide containers in the open field.

Reusing of expired pesticides, unsafe disposal of pesticide containers and unwanted chemical pesticides is considered as one way in which pesticides may pollute the environment (Lewis, 2006). Most of the small-scale farmers throw away their unwanted pesticides and pesticide containers in unsafe ways (Lekei, 2014). This study found that unsafe ways of disposing pesticide containers are commonly used by most of the farmers in disposing their pesticide containers. The study also indicated that over 67% of the farmers unsafely throw away their expired pesticides. These practices may contribute significantly to environmental pollution through run off as some chemical pesticides may be washed away from application point to an intended environment. Mkandawire (2017) found significant availability of Cypermethrin and

Dimethoate in soil samples collected from tomato farms where synthetic pesticides were not used. Similar results were also reported in Lebanon. Salameh, (2003) reported that over 50% of the farmers in Lebanon discard their pesticide containers into the environment. This shows that, unsafe ways of disposing pesticide containers and expired pesticides are commonly practiced by small scale farmers in developing countries. These practices may greatly contribute to environmental contamination through leaching as well as run off.

4.3.5 Prevention measures

4.3.5.1 Use of children and women to apply chemicals

Preventive measures taken by the small-scale farmers are described in Table 4.12. High chances of extreme exposure of women and children was demonstrated in the study. The study presented that more women (61.1%) were involved in handling and application of pesticides than men 38.9%). On unfortunate note, a large proportion of the small-scale farmers (72.9%) allow children of less than 18 years to handle and apply pesticides, and about 52.4% allow pregnant women to handle and apply chemical pesticides while about 64.4% of the subjects allow pregnant and breastfeeding women to wash clothes used in the handling and application of pesticides.

These findings demonstrate that a significant proportion of both born and unborn children are at high risk of pesticides poisoning due to pesticide exposure. The results of the study were similar to the results of the study that was carried out in Mexico that indicated that women, who were handling pesticides were two times more likely to bare children with neural tube defects than those not using pesticides (Brender JD, 2010). A report by Centers for Disease Control and Prevention (CDCP) in 2003 about children and pesticides showed that children of ages ranging from 6 to 11 years have significantly higher levels of pesticide residues in their bodies than any other age group (Brender JD, 2010). This study reported that over 50% of the subjects allow children of 11 years and below to handle and use pesticides (appendix 1). This shows that more children in Malawi are also at a very high risk of pesticide exposure.

4.3.5.2 Handling of expired pesticides

The majority (95.9%, n = 569 of the farmers who use pesticides indicated that they throw away chemicals when they discover that it is expired. These farmers seemed to have knowledge of the dangers of using expired chemicals. One farmer indicated that he resells but did not spy to who and why, 8 farmers give the chemicals away while 15 farmers were hesitant to share their actions. The finding was relief as it exhibited knowledge of the risk associated with using expired chemicals.

4.3.5.3 Management of left-over pesticides

The study showed that 88.7% (n = 526) farmers keep left-over chemicals for re-use. Sadly, most chemicals quickly lose their integrity once open unless stored in recommended storage conditions. The study also found that a lot of farmers from Machinga throw away left over pesticides due to lack of knowledge of proper ways of storage of chemical pesticides.

4.3.5.4 Use of protective clothing

Wearing of protective clothing such as goggles, gloves, safety boots and face masks helps to minimize dangers of contamination by pesticides (Ekram, 2016). However, this study found that over 65% of the subjects do not use protective clothing when handling and using pesticides because of exorbitant cost of most of the protective clothing, while 26% fail to use them because they are not available in their areas. Other studies conducted in developing countries also found similar results as the ones found in this study. Salameh (2003) found that less than 25% of the sampled farmers in Lebanon used special protective clothing and manipulated pesticides with special tools. An assessment on KAP that was done on farm workers in the Gaza Strip reported that there was poor use of protective clothing (Yassin et al., 2002). These findings indicate that farmers are at high risk of dangers of pesticide contamination, such as acute and chronic health hazards. One of the contributing factors why farmers did not wear protective clothing was found to be lack of formal training on safe handling and use of pesticides.

4.3.5.5 Management of pesticide contact

a. *<u>Took shower</u>*

Most of the farmers took a shower (52.5%) when healthy effects were observed, while 16.8% took no action (table 8). The study revealed that a very small proportion (6.9%) of the farmers who experienced health effects after using pesticides visited a doctor while 52.5% just took a shower and 16.8% did not take any action. These findings are consistent with other studies carried out in some parts of Tanzania, where almost 60% of the poisoned farmers in Tanzania took no action about symptoms of the health effects (Lekei, 2014).

Table 0.10: Preventive measures taken by small scale farmers (n = 593)

	Frequency	Percent (**%**)
Age of allowing pesticide handling		
Less than 18 years	432	72.9
18 years and above	161	27.1
Buy unpacked pesticide	381	64.3
Expired pesticides		
Throw away	569	95.9
Sale	1	0.2
Give away	8	1.4
Others	15	2.5
Left over pesticides		
Keep to re-use	526	88.7
Throw away	23	3.8
Sale	5	0.9
Give away	30	5
Other	9	1.6
Wear protective clothing.	340	57.4
Type of protective clothing worn		
Gloves	202	34
Overall	100	16.9
Eye gloves	31	5.2
Respirator	79	13.3
Facemask	49	8.3
Boot shoes	53	8.9
Others	79	13.4
Use pregnant/breast feeding women	311	52.4
Pregnant/breast feeding wash clothes	382	64.4
Action taken when health effects were observed		
Took a shower	311	52.5
Took some drugs	73	12.3
Visited a doctor	73	12.3
Took milk	33	5.6
No action	100	16.8

A study carried out in South Africa found that 95% of the cases about health effects and pesticide poisoning were not reported in the Western Cape Province (London and Bailie, 2001). These practices increase the risk of exposure of farmers to pesticide effects.

b. *Took milk*

The study also found that over 26% of the affected farmers just took milk as a control measure to the problem, a misconception that has been reported in similar several studies. A study carried in Tanzania reported 64.7% of agriculture extension officers recommending milk as one of the precaution measures in pesticide poisoning (Ngowi, 2002), and about 25% of the farmers in rural villages also believed that taking milk after pesticide poisoning is a solution to control the health effects (Lekei, 2014). This indicates that most of the small-scale farmers are poorly informed about prevention measures of the effects of pesticides.

4.3.6 Practice leading to pesticide exposure

4.3.6.1 Things considered when buying pesticides

Out of the 593 small scale farmers who use pesticides, only 46.3% (n = 275) are concerned with the expiry date of the chemical. Thus, 53.7% (n = 318) are at risk of buying expired pesticides, which is a health concern. The study further indicated that only 25.7% (n = 152) procure pesticides from renown agro-dealer while 74.3% (n = 441) don't really care where to buy. Besides reliability of the agro dealer, the study also showed that most small-scale farmers do not care about originality and authenticity of the product (pesticides). Only 10% (n = 59) look at the label to check if the product is fake or not while 90% (n = 534) just buy. In a nut shell, the attitude and practice of most small-scale farmers towards and during procurement of pesticides increases the risks of pesticides.

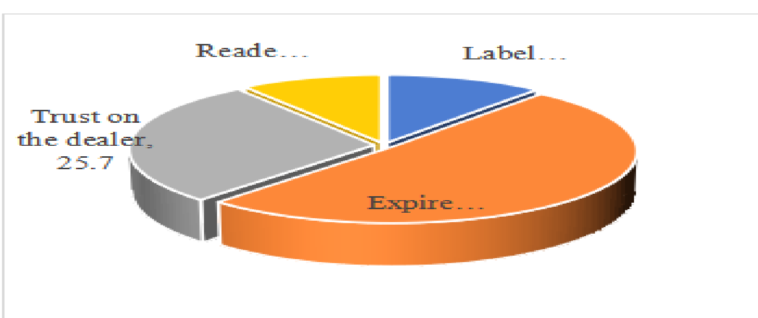

Figure 4.3: Things considered when buying pesticides

4.3.6.2 Storage of pesticides

Storage of pesticides is another factor that increases the risk of exposure. The study showed that only 23.4% (n = 139) farmers had proper structures for storage of pesticides. Otherwise, 53.3% (n = 316) keep the pesticides in the houses where they sleep, 16.9% (n = 100) keep the pesticides outside their houses and 6.4% did not specify. Thus, besides spraying, the exposure to chemicals starts immediately they are purchased and after they are used through poor storage practices.

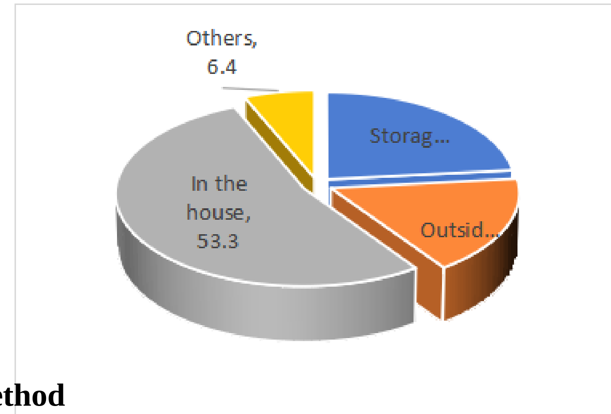

Figure 4.4: Storage of pesticides

4.3.6.3 Pesticides application method

Application of pesticides is one of the major ways that increases farmers' exposure to pesticides. The majority (42%, n = 254) use sprayers to apply chemicals, 30% (n = 178) apply pesticide through drenching, 14.4% (n = 85), while 7.1% (n = 42) and 5.6% (n = 32) use mixed methods. The study showed that over 57.1% are at risk of pesticide poisoning. This is further complicated by the non-use of protective gear such as face masks, gumboots and grooves.

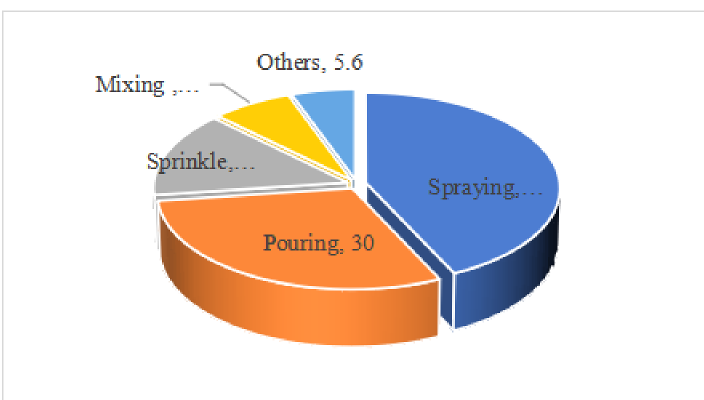

Figure 4.5: Pesticides application method

4.3.6.4 Handling of pesticide containers

It was also noted that most farmers use their own utensils for mixing of pesticides. The study noted that 49.6% (n = 294) wash the utensils once after use, 36.6% (n = 217) wash twice, 8.9% (n = 52) washed thrice and very few 1.7% wash four times. It was further noted that most of the farmers do not use soap to wash the consignment. Furthermore, 12.6% (75), 7.7% (46), 60.3% (n = 358), 10.4% (n = 62) and 9.0% (n = 53) wash the utensils at the well, along the river, in the field, at home and other places they choose. Thus 39.7% (n = 235) use practices that are likely to contaminate water sources, which increase the risk of contamination.

The study also found out that the majority of the small-scale farmers properly dispose off the containers for the pesticides except for 9.2% (n = 55), who throw out the cans in the open field. Otherwise, 19.9% (n = 118), 22.2% (n = 132), 25% (n = 148) and 17.1% (n = 101) burn, bury and throw in rubbish pit respectively.

Table 0.11: Practices regarding handling of pesticide containers (n= 593)

Practice	Percentage (%)
Cleaning of pesticide mixing containers before and after use	
Once	49.6
Twice	36.6
Thrice	8.9
Four times	1.7
Not specified	3.2
Place where pesticide mixing container are washed	
At the well	12.6
Nearby river	7.7
In the field	60.3
Home	10.4
Others	9.0
Disposing of the containers or packages	
Open field	9.2
Burnt	19.9
Buried	22.2
Rubbish pit	25
Toilet	17.1
Others	6.6

The study indicated a trend that shows that low education level contributed significantly to poor practices in handling and use of pesticides by the sampled small-scale farmers in Malawi. This is noted from the observation which showed that over 62% of the farmers that were interviewed, their highest level of education was either primary in lower classes (1-4) or did not attend any formal education. The data also showed that over 90% of the sampled farmers who indicated poor practices attended only primary school in lower level, or did not attend any formal education. This contributed to farmers' poor practices and poor understanding of health impacts and dangers of some particular pesticides on human and environment, respectively. This is contrary to World Health Organization recommendations which state that, it is necessary that farmers using chemical pesticides on their farms must be aware of the adverse effects of pesticides used in order for them to handle the chemicals properly (WHO, 2010).

A KAP study in Lebanon on pesticides also revealed that farmers with low educational level were getting information on pesticides through oral communication which resulted in low preventive measures and poor disposal of pesticide containers (Ngowi, 2001).

Promoting Integrated Pest Management (IPM) is one of the tools that help to reduce over dependence on chemical pesticides, thereby minimizing the risks of effects of intake of food with residue pesticides (Salameh et al, 2004). This study revealed that only 36% of the farmers practice other pesticide control techniques such as IPM. The study also found that about 58.2% of the farmers using pesticides did not receive any formal training on integrated pest management. Exposure to toxic chemicals can well be reduced by adopting viable organic or integrated pest management practices. This is because these practices involve use of mechanical, cultural and biological methods and very minimal pesticides are used as last option. A joint program established in Israel, Jordan and Palestine showed that it is possible to promote integrated pest management, and minimize the need to use pesticides (Richter, 1997).

4.4 Socio-demographic and socio-economic determinants of farmer's knowledge, attitudes and practices regarding pesticides in legumes and cereals.

According to the results (Table 4.14) of the binomial logistic regression of the socioeconomic factors determining pesticide usage among farmers, it is established that age, education level, farming experience, awareness of health impacts, and easy availability of pesticides were significant at 99% confidence level.

Table 0.12: Logistic model results

Variables	Odds ratio	Std. Err.	t		P -value
Gender	1.206876	0.6346269	0.3		0.770
Age	-0.9361244	0.0198174	-3.33	***	0.003
Household size	1.368528	1.010677	0.31		0.759
Education level	1.923291	0.6829513	0.96	***	0.004
Farming experience	0.5324152	0.0855577	-7.37	***	0.000
Farm size	1.065726	0.5434929	0.12		0.908
Awareness of health impacts	1.044222	0.0134726	3.21	***	0.004
Easy availability of pesticides	1.131143	0.0050109	24.59	***	0.000
Information sources on pesticides	0.0108274	1.425477	-3.17		0.349
Cons	1.36e-12	5.865496	-4.66	***	0.000

4.4.1 Age

According to the study, age was found to be significant at 1 % significance level, and had a negative influence on pesticide use. This agrees with the study expectation, as it hypothesized a positive or negative influence. According to this result, a year increase in the age of the farmer will lead to a decrease by 0.936 times in pesticide use practices. As the farmer gets older, an increase in years of will affect their productivity at the farm as such some activities may not be carried out at the farm. This finding agrees will Agboola (2004), who claimed that age increase decreases a farmer's productivity at the farm. Suffice to mention that, this result may also be attributed to the fact that younger farmers are more likely to adopt improved agricultural technologies. Younger people have more energy, and are more likely to adopt technologies, and be more active at the farm.

4.4.2 Education level

In regards to the education level, the study found a significant (at 1% significance level) positive relationship which agrees with the hypothesized expectation of the variable. A year increase in the years spent getting formal education will lead to an increase of 1.923 times in pesticide use practices by the farmer. It is posited that educated farmers are more likely to adopt agricultural technologies (Sabran et al, 2012). Similar results are also reported by Van den Berg (2013).

4.4.3 Farming experience

Farmers are more likely to continue practices that they have been used to, and are comfortable with, following what is known as a "rule of thumb" (Dasgupta, 1993). The study established a significant (1% significance level) positive relationship, which agrees with the prior hypothesized sign for the variable. Thus, a year increase in farming experience will lead to 0.532 times increase in the pesticide practice use by farmers.

4.4.4 Awareness of health impacts

The awareness of health impacts of pesticide use was also found to be significant at 1% significance level, and was positively related to pesticide use practices. This finding suggests that the awareness of the farmer about the pesticide's health impacts the more they will pay particular attention to their usage practices of pesticides. According to the results, awareness of health impacts increases leads to 1.044 times more likelihood to practice pesticide use on the farm. Similar results are reported by Adam R.I et al, (2015), who found that the awareness of health impacts of pesticide use influenced the use of pesticide use among farmers in Tanzania.

4.4.5 Easy availability of pesticides

The easy availability of pesticides determines the access that a farmer has to pesticides, and ultimately their usage. According to the results, the easy availability of the pesticides to the farmer, the odds of pesticide usage practices are expected to increase by 1.131 times. This variable was found significant at 1% significance level, and agreed with the hypothesized expected sign. According to Adejumo et al. (2014) farmers will use pesticides that are available to them, and cost factors are part of the decision.

4.5 Dangers of Cypermethrin

This study has shown that Cypermethrin is the mostly used synthetic chemical pesticide by the small scale farmers that were involve in this study (table 4.5). this agrees with other studies which also found that, Pyrethrins and their derivatives commonly known as pyrethroids are one of the highly effective pesticides that are used worldwide in agricultural fields and households (WHO,1989).

Cypermethrin is a type II pyrethroids which acts by delaying the closure of voltage sensitive sodium channels at higher concentrations. Its toxicity mainly in humans, occurs due to exposure through inhalation, skin contact or ingestion. In humans, acute oral intoxication of Cypermethrin commonly manifests with neurotoxic and gastrointestinal effects (Das, 2006).

Effects of Cypermethrin ranges from mild local symptoms such as paresthesia due to dermal contamination to neurological symptoms like seizures, fasciculation, tremors, coma and gastrointestinal symptoms like nausea, vomiting and gastrointestinal irritation (Proudfoot, 2005). Preventive measures of poisoning by designing the poison containers with warning labels and good practices when handling and using Cypermethrin are recommended (Das, 2006).

This demonstrates that, small scale farmers in the study areas are at a risk of these effects due to poor practices that this study has highlighted.

4.6 Chapter summary

The chapter has presented findings and how they relate to results of similar study. The study has established that synthetic chemicals (insecticides and pesticides) such as Cypermethrin, Actellic and others are used for pre-harvest and post-harvest management of field and storage pests such as FAW and maize weevils respectively. Other chemicals such as round-up are herbicides for the control of weeds. Small scale farmers are exposed to the chemicals during application, cleaning of utensils and disposal of pesticide containers. Practices and attitude to the use of pesticides is determined by social and economic factors such as level of education, age, sex etc.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

This study has shown that small scale farmers in the selected areas in Malawi heavily depend on synthetic pesticides in managing pests and diseases in legume and cereal crops. The study has concluded that most of the farmers especially in central and southern region have low knowledge level on pesticide use. The study has shown that most of the farmers do not know the names and proper ways of handling pesticides used in controlling pests and diseases. Most of the farmers do not practice integrated pest management to minimize the need to use more pesticides. Farmers lack formal training in integrated pest management as well as safe handling and use of chemical pesticides. The study therefore, established that most of the farmers heavily depend on synthetic pesticides because of lack of knowledge about other alternatives like integrated pest management and organic production. A significant proportion of the farmers are not aware of the health effects of consumption of food crops with pesticide residues. The study has concluded that due to lack of formal training, pesticide use is coupled with poor practices that enhance the potential detrimental health effects of pesticide residues. The study has demonstrated that most of the farmers do not wear protective clothing when handling and using pesticides. Several sources of potential domestic and occupational pesticide exposure were identified during the study. Storage of unused pesticides and mixing containers in unguarded areas by a large proportion of farmers in their houses, and reusing of the pesticide's containers for domestic purposes by a significant proportion of farmers demonstrated severity of the risk of exposure. The study therefore resolved that there is high potential of domestic pesticide exposure in some parts of Malawi. The study has demonstrated that more women (61.1%) were involved in handling and application of pesticides, and over 52% of the subjects allow pregnant/breastfeeding women to handle and apply pesticides, while about 64.4% allow pregnant and breastfeeding women to wash clothes used in the handling and application of pesticides. Therefore, the study concluded that women and children are the most likely group of people to experience effects of pesticide residue in Malawi.

The study has shown that low knowledge is main root of exposure and harmful effects of pesticide residues on human health and environment. The study revealed that there is high environmental pollution in the selected areas due to poor disposal of pesticide containers and un-used pesticides as well as poor pesticides application methods. The study has concluded that most of the famers lack health education on pesticide safety period and the need to visit a doctor when they experience health effects of pesticides. Over all, the study concludes that farmers handle and apply pesticides without following the recommendations: they use unsafe storage facilities, ignore risks and safety instructions, they recycle or reuse pesticide containers, they do not use protective materials when handling and applying pesticides, and they unsafely dispose pesticide containers. It has also shown that their knowledge level, attitude and practices are influenced by lack of health education programs, level of education, lack of training on safe ways of handling and applying pesticides, and ignorance. Lastly, the study has shown that indeed there are socioeconomic factors that influence pesticide use. Out of the 9 explanatory socioeconomic factors determining pesticide use practices among farmers, 5 were found to be significant at 1% significance level including: age, education, farming experience, awareness of health impacts and easy availability of pesticides.

5.2 Implications

Based on the findings of this study, a large number of small-scale farmers have very low knowledge, and lack basic training on safe handling and use of pesticides. This contributes greatly to poor practices that make them susceptible to health effects of residue pesticides.

5.3 Recommendations

In order to improve the knowledge, attitude and practices for farmers, the study recommends the following;

- There is need for agriculture extension development officers (AEDO) to provide formal trainings to farmers on safe handling and use of pesticides.
- Farmers must also be trained in integrated pest management to minimize the need to use more pesticides. The interventions to minimise pesticide dependence must be gender-

sensitive and recognize the fact that women and children play a vital role in pest management.

- Non-governmental organizations (NGOs) and AEDO must provide farmers with health education programs that will inform and enhance their awareness about the health impacts of pesticides in general.
- Farmers must be encouraged to use protective clothing when handling and using pesticides.
- There is also a need for government to enhance legislation as regards to public health impacts and hazards of pesticides.

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APPENDINCES

Appendix 1

Minimum age of allowing children to handle and apply chemical pesticides

Age	frequency	Percentage (%)
10	340	49
11	105	15
12	18	3
13	9	1
14	21	3
15	90	13
16	32	5
17	19	3
18	53	8
19	13	2

Appendix 2

Cross tabulation of district and what farmers do with their left-over pesticides

District	What do you do with left over pesticides?					Total
	Keep to re-use	Throw away	Sell	Give away	Other	
Machinga	44	40	0	2	1	87
Thyolo	94	2	0	6	6	108
Chikwawa	86	13	0	2	0	101
Lilongwe	64	5	0	6	2	77
Ntcheu	63	2	1	4	2	72
Salima	50	4	1	1	0	56
Kasungu	35	8	0	8	1	52
Karonga	69	4	1	2	1	77
Rumphi	54	8	0	7	1	70
Total	501	86	3	38	14	700

Appendix 3

Crops that are commonly treated by chemical pesticide in Malawi

	region			
Crop	South	Central	North	Total
Beans	62	100	13	177
Coffee	0	0	1	1
Cotton	1	3	17	21
Cowpeas	0	9	0	9
Irish Potatoes	0	1	2	3
Maize	148	213	99	426
Millet	52	30	0	82
Okra	0	1	0	1
Pigeon peas	20	1	6	27
Rice	0	20	36	56
Sorghum	38	20	0	58
Soy Beans	0	4	0	4
Tobacco	0	9	2	11
Vegetables	13	85	7	85
Watermelon	0	1	0	1
Total	318	497	199	1014

Appendix 4

Chemical pesticides commonly used by small scale farmers in Malawi

Pesticide name	Frequency	Percent
Actellic	54	4.2
antac	2	.2
Asphalt	4	.3
Bullet	8	.6
Comite	4	.3
Confidor	98	7.6
Copper	96	7.4
Cypermethrin	475	36.6
Desis	182	9.4
Dimethoate	182	14
Dithane	90	6.9
Dudu	5	.4
Harness	37	2.9
Karate	19	1.5
Lambda	2	.2
Nova cord	3	.2
Round-up	74	5.7
Sknowcron	17	1.3
Superchrone	2	.2

Appendix 5: Study questionnaire

QUESTIONNAIRE ON SUB-PROJECT ENTITLED "KNOWLEDGE, ATTITUDES AND PRACTICES OF MALAWIAN FARMERS REGARDING PESTICIDES IN LEGUME AND CEREAL CROPS.''

SMALL SCALE FARMERS

We are currently conducting a survey on farms in selected districts of Malawi The purpose of this survey is to investigate pesticides use. This survey is being undertaken by the Malawi Government through the Ministry of Agriculture irrigation and water Development-APPSA Project. We assure you that your answers will be kept strictly confidential. Kindly answer the questions to the best of your knowledge.

All responses contained in this questionnaire are strictly confidential.

Official Use Only	
	Name of Interviewer:_________________________
Time Started:__________________________Time Finished:________________________	
Region _______________________________	District___________________________
EPA_________________________________	Section____________________________
Village_________________________________	

PART 1 GENERAL INFORMATION OF THE FARM HOUSEHOLD (HH) (Fill in, Circle or Tick were applicable)			
RESPONDENT AND HOUSEHOLD (HH) CHARACTERISTICS			
Gender	Are you the HH?	If no, what is your relationship with the HH head?	Age (years)

<table>
<tr><td rowspan="2">M ☐ F ☐</td><td rowspan="2">Yes ☐</td><td rowspan="2">No ☐</td><td colspan="2">1 2 3 4 5</td><td>☐</td></tr>
<tr><td colspan="2">Husband Wife Son Daughter
Other________</td><td></td></tr>
<tr><td colspan="4" rowspan="2">Highest Level of education Household Head (HH)</td><td colspan="2">1 2 3 4 ☐</td></tr>
<tr><td colspan="2">None Primary Secondary Tertiary</td></tr>
<tr><td colspan="4" rowspan="2">Highest level of education of Respondent</td><td colspan="2">1 2 3 4 ☐</td></tr>
<tr><td colspan="2">None Primary Secondary Tertiary</td></tr>
<tr><td colspan="5" rowspan="3">If you have stayed in this village less than 10 years, Where were you staying just before coming to stay in this village?</td><td>1 ☐ Another village, but the same district</td></tr>
<tr><td>2 ☐ Another district, but the same EPA</td></tr>
<tr><td>3 ☐ Another EPA</td></tr>
<tr><td colspan="5" rowspan="2">How much do you earn per year (annual income)? (in thousand kwacha)</td><td><100 100-200 201-300 Over 300
Thousand kwacha per year</td></tr>
<tr><td>☐ ☐ ☐ ☐</td></tr>
<tr><td colspan="5" rowspan="2">9. How many people, including yourself, live in this household?
(Excluding visitors that have stayed for less than 3 months.)</td><td>☐</td></tr>
<tr><td></td></tr>
</table>

PART 2. PROPERTY AND CROP CHARACTERISTICS		
10 What is the total area of your farmland (excluding rented and communal land)?		____________acre
11 WHAT IS THE TOTAL AREA OF YOUR CULTIVATED LAND?		____________ACRE
12. Of your total cultivated land, how much is allocated to	PLANT MAIZE?	____________ACRE
	PLANT COMMON	____________ACRE
	PLANT SOY BEAN?	____________ACRE
	Plant other crops	____________acre
	FALLOW LAND	____________ACRE
	MIXED CROPPING	____________
13. Of your Total Farmland, How Much is Virgin Land?		____________ACRE

PART3. PESTICIDE USE IN CROP PRODUCTION	
14. Are chemical pesticides used on your farm? Tick appropriate	Yes No ☐ ☐
If the answer to question 15 is No, proceed to question 61	
If Yes to question 15, what kind of chemical (pesticides) have you used before and, for which crops, pests (insect, diseases, weeds, and how much? Fill in the table below and Tick appropriately.	
TABLE	

Target crop/ season-1-winter, 2-summer	Target weed/insect /disease	Chemical/ Trade Name	Application rate/ area (Ha, acres, m^2), before dilution	Frequency of Application Once Weekly Monthly	Non-chemical strategy	Observed Results
				☐ ☐ ☐		

				☐ ☐ ☐		
				☐ ☐ ☐		
				☐ ☐ ☐		
				☐ ☐ ☐		
				☐ ☐ ☐		
				☐ ☐ ☐		
				☐ ☐ ☐		
				☐ ☐ ☐		
				☐ ☐ ☐		

PART 4. HISTORY OF USAGE AND HANDLING

How many years have you been using pesticides? ☐

Where did you learn how to use pesticide?

1	2	3	4	5
Self	dealer	information on the label	extension worker	others_____

How many days or weeks prior to harvest are these Chemical pesticides applied?

Name of Crop / Name of Chemical	Days	Weeks	>3 weeks
	1 2 3 4 5 6	1 2 3	State Number
	☐ ☐ ☐ ☐ ☐ ☐	☐☐☐	
	☐ ☐ ☐ ☐ ☐ ☐	☐☐☐	
	☐ ☐ ☐ ☐ ☐ ☐	☐☐☐	

	☐ ☐☐ ☐☐☐	☐☐☐	
	☐ ☐☐ ☐☐☐	☐☐☐	
	☐ ☐☐ ☐☐☐	☐☐☐	
	☐ ☐☐ ☐☐☐	☐☐☐	
	☐ ☐☐ ☐☐☐	☐☐☐	

How are they applied? Tick appropriate mode

Spraying	Pouring	Sprinkle	Others (specify)
☐	☐	☐	☐_________________________________

Do you experience situations when you are forced to apply pesticides when it is not the right time to do so?

Yes ☐ No ☐

If yes to question 21, under which conditions are you forced to do so?

How many times are pesticides mixing containers cleaned before and after use?

____

Cleaned once	twice	three times	four times	not specified
1	2	3	4	5

How many days/weeks prior to use

are the pesticides applied				☐			
Where are the Pesticides and application equipment stored when not in use?	1.In the storage room ☐		2.Outside ☐	3.In the house ☐	4.Other (specify) ____________		
Do you wear protective clothing when applying pesticides?				1.Yes ☐	2.No ☐		
If yes to question 26, which one or more of the following do you use:	Gloves ☐	Overalls ☐	Eye glasses ☐	Respirator ☐	Face mask ☐	Boot/shoes ☐	Others (describe) _________
If you use a respirator, how often do you change it?	Daily 1 2 3 4 5 6 7 ☐☐☐☐☐☐☐		Weekly 1 2 3 ☐ ☐ ☐		>3 weeks State number		
If you use face mask, how often do you change it?	Daily ☐		Weekly ☐	State number ☐			
If no to question 26, choose one reason	Too expensive ☐	Not available ☐	Uncomfortable ☐	Pesticide is safe ☐	Others __________		

Where do you get your pesticides used on this farm?	Buy	Given by friend/relative (Share)		
	☐	☐		

If you buy, where do you buy your pesticides?

1.Agro-dealer

2. mobile markets

3. Near shops

4. Hardware

	Yes	No
Do you sometimes buy unpacked pesticides on a scale?	☐	☐

Who is the main person with the responsibility of applying pesticides in this household

☐The Household Head

☐The respondent

☐The other family member

☐Other (please specify) ___________________

From where do you do the dilution of Pesticides before application?	At the well	Nearby river	In the field	Other (Specify)
	☐	☐	☐	☐_________
36. Where is the pesticide application equipment washed?	At the well	Nearby river	In the field	Other (Specify)
	☐	☐	☐	☐_________

	Yes	No
37. Are the pesticide containers used for other purposes afterwards?	☐	☐

If the answer is *Yes* to Q37, for what purpose?

____

___

	Yes	No
Do you always buy the same brands of pesticides used on this farm?	☐	☐

If No to question 39, why do you regularly change brands of pesticides	New brand is cheap	New brand is better	Old brand is in effective against pests	Recommendation from Agro dealers	Recommendation from agricultural officers	Others (specify)
	☐	☐	☐	☐	☐	

When you buy pesticides, does it happen sometimes that the container(s) have no label/s?	Never happen	It does happen sometimes	often
	1	2	3

When buying a pesticide what things do you consider	Label Authenticity	Expire date	Trust on the dealer	Reader ability
	1	2	3	4

Have you ever experienced poor labeling or labels in another language which you cannot understand?	Yes	No
	☐	☐

PART 5: PACKAGING, SAFETY AND DISPOSAL

How are the containers or packages disposed off?	Returned to company/ Distributor	Thrown in open field	Burned	Buried	Thrown in the rubbish pit	Others (specify)
	☐	☐	☐	☐	☐	________________

At what age do you involve children in handling and applying pesticides?

Age in years

☐

Do pregnant/breastfeeding mothers participate in handling and applying pesticides?

Yes No

☐ ☐

Do pregnant/breastfeeding mothers wash cloths used in the handling and application of pesticides?

Yes No

☐ ☐

When using pesticides or being exposed to them, have you experienced the following (choose one or more):

☐Dizziness ☐Difficulty breathing ☐Headache ☐Itching/Skin rashes ☐Blurred vision ☐Diarrhea ☐Excessive sweating ☐Irregular heartbeat ☐Convulsion Staggering ☐Excessive salivation ☐Nausea/vomiting ☐None of theabove ☐Sleeplessness/insomnia /Restless

☐Others (Specify) ________________

What pesticide/s causes any of the above? _________________________________

What measures do you take to remedy the symptoms? ________________________________

How harmful do you think the chemical (synthetic-pesticides) are to the environment and human health?

Very ☐ Just ☐ Less ☐ Not ☐ Other (specify) ☐__________________

Have you ever experienced any accident as a result of pesticide poisoning in your household?

Yes ☐ No ☐

If the answer to question 52 is yes, under what circumstance did the accident happen?

____ _

How many times per year have you had such accidents?

Once ☐ Twice ☐ Thrice ☐ More than three times ☐

What do you do with left over pesticides

Keep to re-use ☐ Throw away ☐ Sell ☐ Give away ☐ Other ☐_______________

What do you do with expired pesticides?	Throw away	Sell	Give away	Other
Do you know that some of the pesticides applied on crops may end up in water and soil?	☐	☐	☐	☐ ____________________________

If yes to 57, do you think it has any effect on environment and humans?

Yes No

☐ ☐

Do some food crops have pesticides residue

Yes No

☐ ☐

Can intake of food crops with residue pesticides have adverse health implications?

Yes No I don't know

☐ ☐ ☐

Yes No I don't know

☐ ☐ ☐

Do you currently practice any pest control techniques to reduce the need of using pesticides?

Yes No

☐ ☐

If yes to question 61, which methods do you use?	Organic production	Mechanical-physical techniques	Integrated pest management (IPM)	Biological control	Crop rotation	Others (specify)
	☐	☐	☐	☐	☐	____________

___

If NO to question **63**, have you ever practiced an IPM technique but not currently practicing it?	Yes I am an ex-IPM practitioner	No I have never practiced IPM

If yes to question 61, why did you abandon the practice?	Pesticide system is cheaper	Requires lots of labor	Was getting less crop (quantity and quality)	It is less profitabl e		Doesn't work	Other (specify)
	☐	☐	☐	☐	☐	☐	___________

PART 6. AWARENESS		
Have you received any formal training on IPM?	Yes	No
	☐	☐
If yes to Q65, what kind of training and who provided it?		
Have you received basic training on safe handling and application of pesticides?	Yes	No
	☐	☐
If yes to Q67, who provided the training?		
In your opinion, what do you think about pesticide use and their residue effect on the soil and crop in Malawi?		

Thank you very much for your participation in this survey. Your answers will extremely be useful for our research. Again, I assure you that all the answers you have provided in this survey will be kept strictly confidential and will never be revealed to any other person outside our research group. Would you mind telling me your name please?

Name of respondent: ____