# FACTORS ASSOCIATED WITH SERUM CHOLINESTERASE LEVELS AMONG FARMERS IN KEIYO NORTH SUB-COUNTY, 2013

**ROSEBELLA CHEPTOO ROTICH**

**MASTER OF SCIENCE**

**(Laboratory Management and Epidemiology**

**JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY**

**2018**

# Factors Associated with Serum Cholinesterase Levels among Farmers in Keiyo North Sub-County, 2013

**Rosebella Cheptoo Rotich**

**A thesis submitted in partial fulfillment for the degree of Master of Science in Laboratory Management and Epidemiology in the Jomo Kenyatta University of Agriculture and Technology**

**2018**

## DECLARATION

This thesis is my original work and has not been presented for a degree in any other University

Signature…… Date……

**Rosebella Cheptoo Rotich**

This thesis has been submitted for examination with our approval as university supervisors.

Signature…… Date……

**Prof. Simon Karanja, PhD**

**JKUAT, Kenya**

Signature…… Date……

**Prof. Charles Mutai, Phd**

**MMUST, Kenya**

## DEDICATION

I dedicate this work to my dear family who have been very supportive through the whole period of my studies. They have always been morally, socially and financially supportive to me. They also taught me to be patient and work hard to achieve my goals thus I have successfully completed this piece of work.

## ACKNOWLEDGEMENT

My sincere appreciation goes to several individuals and institutions for the accomplishment of this work. First, my deepest gratitude goes to my most supportive supervisors Prof. Simon Karanja of College of Health Science, Jomo Kenyatta University of Agriculture and Technology (JKUAT) and Prof. Charles Mutai of Masinde Muliro University of Science and Technology (MMUST).Without their timely, unlimited support and tireless guidance this thesis would not be ready at such a time. My appreciation goes to the Ministry of Health Kenya for giving me the opportunity to pursue this course and CDC Atlanta and Kenya for all their support. My special thanks go to the entire staff of FELTP-Kenya and my colleagues who were an encouragement to me and constructively critiqued this study. Finally I thank all the study participants for their participation in this study. My gratitude's also goes to the staff of Iten District Hospital laboratory and Moi and Teaching Referral Hospital Laboratory for allowing me to keep and analyze the samples in their institution. I also thank all those who supported this study in any way but are not mentioned above. May almighty God bless you all.

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF APPENDICES

## ABBREVIATIONS AND ACRONYMS

**Ach E** Acetyl cholinesterase

**ALT** Alanine aminotransferase

**AST** Aspartate aminotransferase

**CDC** Centers for Disease Control and Prevention

**CNS** Central nervous system

**GGT** Gamma glutamyl transferase

**FAO** Food and Agricultural Organization

**FELTP** Field Epidemiology and Laboratory Training Program

**JKUAT** Jomo Kenyatta University of Agriculture and Technology

**KAP** Knowledge, Attitude and Practices

**MOA** Ministry of Agriculture

**MOH** Ministry of Health

**MMUST** Masinde Muliro University of Science and Technology

**OP** Organophosphates

**PPE** Personal protective equipment

**SChE** Serum cholinesterase enzyme

**US EPA** United States Environmental Protection Agency

**W H O** World Health Organization

**g** Relative Centrifugal Force

## ABSTRACT

Exposure to organophosphates (OP) is an occupational hazard among farmers in low income countries. In Kenya most farmers lack adequate personal protective equipment (PPE), have low level of awareness and inadequate knowledge on organophosphate toxicity. The objective of this study was to determine factors associated with Serum Cholinesterase levels among farmers in Keiyo North Sub-County. A cross sectional study was conducted during the month of June to August 2013. Multi Stage sampling methodology based on probability proportional to size (PPS) was used to select the study sites. Systematic sampling was used to select households. Data was collected using a pre-tested questionnaire and blood sample obtained from farmers to determine serum cholinesterase levels. Bivariate and multivariate analyses were conducted to determine factors associated with abnormal serum cholinesterase. The prevalence of abnormal serum cholinesterase levels among the 390 enrolled farmers was 13% .The most common related symptoms as experienced by the farmers with depressed SChE(Serum Cholinesterase Enzyme) after spraying were headache (84.4%), dizziness(76.2%) weakness (66.9%) and burning sensation on the skin (64.9 %). Farmers of the age group 26- 35 years (OR=0.6; 95% CI: 1.24-7.79), handling Dimethoate OP (aOR=9.7; 95% CI: 1.83-25.83), permanent farm workers (aOR=5.5; 95 % CI: 2.32-8.51) and unrecommended practices when spraying, (aOR=1.9; 95% CI: 1.34-11.33) were significantly associated with OP toxicity. In conclusion the major exposure factors were Dimethoate use and being a permanent farm worker. Analysis of factors associated with abnormal cholinesterase can form a basis for policies and regulations aimed at promoting safer farm practices for farmers. The two ministries of health and agriculture should integrate health education and trainings on recommended farm practices.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background

Organophosphates (OP) and carbamates are a diverse group of chemicals used in both domestic and industrial settings. Malathion, Parathion, Dimethoate, Dichlorvos, Diazinon, Methamidophos and Monocrotophos are some of the commonly used organophosphate insecticides. Organophosphate pesticides were developed in the early 19th century, but their toxic effects on humans were discovered in 1932. They are lipid soluble compounds and are classified as direct or indirect acetylcholinesterase (AchE) inhibitors (Reigart *et al.*, 1999).Organophosphorus compounds inactivate acetylcholinesterase by alkyl phosphorylation of a serine hydroxyl group at the esteratic site of the enzyme. The phosphorylated enzyme is inactive and thus unable to hydrolyze acetylcholine (Hayes & Laws, 1991). The biological effects of organophosphates are as a result of the accumulation of endogenous acetylcholine at sites of cholinergic transmission. Organophosphates are widely used in agricultural sector and because of this OPs are associated with acute and chronic toxicity more than any other class of pesticides. Organophosphorus compounds are readily absorbed across respiratory and gastrointestinal mucosa while the lipophilic OP compounds are very readily absorbed through the skin.

Globally, work-related to pesticide poisoning remains a pressing public health concern (Litchfield *et al.,* 2005). The number of intoxications with organophosphates is estimated globally at 3 million per year and the number of deaths and casualties 300,000 per year (Peter, 2003*).* In developing countries, pesticide poisoning among farmers is alarming, causing more deaths than infectious diseases (McCauley *et al.,* 2006). A study from Nicaragua showed that aerial drift of pesticides lowers cholinesterase levels in the populations living near sprayed cotton fields (Keifer *et al*., 1996). In Kenya, a study of cholinesterase inhibition and health effects of OP pesticide in agricultural workers has

been documented (Ohayo *et al.,* 2000).The results of the study suggested a relationship between exposure to OP pesticide and acetylcholinesterase inhibition and respiratory, eye and central nervous system symptoms.

Insect pests constitute a major problem in Africa (Oerke, 2002). Corresponding economic losses from pests run into millions of shillings at the national level and billions globally (Oerke, 2005). In Kenya, for instance, the economic losses from insect pests can reach as high as $90 million per year for maize (De Groot *et al*., 2003). Associated losses from pests and diseases have led farmers into applying pesticides to their crops to reduce losses. In doing so the farmers are exposed to organophosphate pesticides. In developing countries Kenya included, have high incidences of OP toxicity due to high illiteracy levels and inaccessibility to reliable protective clothing. Pattern of OP toxicity in any region depends on a variety of factors such as availability of poisons, socio-economic status of population, religious beliefs and cultural influences (Krishna, 2008).

Two kinds of measurement have been used for assessing exposure to pesticides; these are cholinesterase enzyme activity and pesticides residue in blood. Inhibition of plasma cholinesterase serves as a diagnostic tool for the assessment of exposure to toxic organophosphates (Amitai *et al.,* 1998). Inhibition of AChE activity has been widely used to assess OPs exposure. A study done in Menderes region of Turkey revealed a high prevalence of pesticides poisoning in agricultural farmers by OPs and carbamates exposure with the reduction of AChE. Green house farm workers also showed the same results (Karabay *et al*., 2004).

### 1.2 Problem Statement

Exposure to pesticides is one of the most important occupational hazards among farmers in developing countries (Wesseling *et al.,* 2001; Konradsen *et al.,* 2003; Coronado *et al.* 2004).Studies in developed countries have demonstrated the annual incidence rates of acute pesticide poisoning in agricultural workers to be as much as 18.2 per 100,000 full

time workers (Calvert *et al.,* 2004) and 7.4 per million among school children (Alarcon *et al.,* 2005). Extensive handling of pesticides by the farmers and subsequent exposure to agrochemicals has health implications which include neurotoxicity, lung and liver damage and respiratory failure, cancer and aplastic anemia among others (Coronado *et al.,* 2004*).* This situations have even become worse from the fact that small-scale or peasant farmers have inadequate personal protective mechanisms from pesticides, low education levels and poor spraying technology which have been reported to play a major role in the intoxication scenario (Hurtig *et al.,* 2003; Atreya, 2008).In Keiyo North Sub county, farmers use fertilizers, fungicides, pesticides, and other chemicals throughout the year to improve their agricultural yields and no studies have been done to assess their negative impacts.

### 1.3 Justification of the study

Kenya relies on agriculture as a source of food and revenue generation. In line with this farmers put more efforts on production and maximum profit margin which has led to extensive use of agrochemicals to curb or eradicate pests. Studies on organophosphate pesticide poisoning in developing countries are inadequate and most of them have only addressed the health effects of occupational exposures to pesticides in general (Mbakaya *et al.,* 1994) with few dealing with cholinesterase inhibiting pesticides (Kashyap *et al.,* 1994). The prevalence of abnormal serum cholinesterase and its determinants in rural population like in Keiyo District needs to be investigated. The introduction of passion fruits farming in Keiyo Sub-county has caused rampant use of pesticides. Currently, little is known about the actual handling and personal protective equipment (PPE) practices of farmers or about the knowledge and perception that may influence the pesticide use of Keiyo farmers. This study sought to explore the risk factors that these farmers are exposed to with a view of informing stakeholders, particularly the ministry of Agriculture and Health on mitigating measures to be adopted to reduce OP poisoning.

## 1.4 Research Questions

1. What are the profiles of serum cholinesterase levels among farmers in Keiyo North Sub County?
2. What is the knowledge, attitude and practices of farmers of Keiyo North Sub County?

## 1.5 Objectives

### 1.5.1 General Objective

To determine factors associated with abnormal serum cholinesterase levels among farmers in Keiyo North Sub County, 2013.

### 1.5.2 Specific Objectives

1. To determine the profiles of serum cholinesterase levels among farmers in Keiyo North Sub County,2013
2. To determine knowledge, attitude and practices among farmers in Keiyo North Sub County.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Background Information

Pesticide is any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage or marketing of food, agricultural commodities, wood and wood products or animal food stuffs or which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies (FAO, 1986). Although a number of organic phosphorus compounds were synthesized prior to 1900 it was not until the 1930s that the specific toxic properties of some known organophosphates were documented in mammals. Organophosphate use in agriculture and horticulture increased in the late 1950s with the decline in popularity of the organochlorine pesticides due to concerns over their environmental persistence. Since then Ops are widely used in agriculture sector in various parts of Africa despite their toxicity (Mbakaya *et al.*, 1994; Ohayo-mitoko *et al*.,2000).In addition to causing acute symptoms of OP poisoning, these pesticides are mutagenic, carcinogenic (Maroni &Fait., 1993, Choi *et al.*,2004).

Keiyo District is in North Rift Province of Kenya and nearly all the population depend on farming. Agrochemicals in these farms are in rampant use. This study was carried out among farmers in Keiyo North Sub-County to establish factors associated with serum cholinesterase levels.

## 2.2 Epidemiology of Pesticide Poisoning

Work-related to pesticide poisoning remains a pressing public health concern worldwide, especially in low income countries (Jeyaratnam,1990; Litchfield *et al.*, 2005). The World Health Organization (WHO) reported that about one million serious unintentional pesticide poisoning occur each year (Jeyaratnam, 1990). In 2007, The

American Association of Poison Control Centers' received 96,307 calls (3.4% of all human exposures) related to pesticide exposures, many of which involved organophosphate (OP) agents (Bronstain *et al.*, 2007). A study of agricultural workers in low income regions of Asia estimated that as many as 25 million cases of mild pesticide poisoning occur annually (London *et al.*, 2001). Ill health related to these irreversible inhibitors of acetylcholinesterase has been reported in studies from India (Chaudhry *et al.*, 1998), South Africa (Panieri *et al*., 1997) and Thailand (Prasit *et al* ., 2010). Among the total cases, farm occupational poisoning accounted for about one-fifth of reported cases. Majority of the cases in these countries are males with a mean age of 25 years (Senanayake, 1998).

Organophosphate pesticides have also caused ill health following occupational exposure during application, e.g. spraying and mixing of pesticides. Rural farm workers engaged in crop spraying suffer from chronic OP poisoning (Keifer *et al*., 1996; Wesseling *et al.*, 2001). Farm workers are at high risk of occupational diseases due to exposure to pesticides resulting from inadequate education, training and safety systems and thus exposure to pesticides is one of the most important occupational risks among farmers in developing countries (Wesseling *et al.*, 2001; Konradsen *et al*., 2003; Coronado *et al*., 2004). Developing countries are known to consume less than 20% of the world production of agrochemicals, which are responsible for as much as 1.1 million (70%) of the total cases of acute poisoning in the working population (EPA, 2000). Kenya is one of the developing countries whose economy is mainly based on agriculture and in order to make foodstuffs of high quality and quantity, extensive use of agrochemicals is implemented. In view of this, the pivot of production is the farm worker who spends a lot of time exposed to these harmful agrochemicals.

Agrochemicals are known to find their way into the blood systems of human beings through the mouth, nose, intact skin and the eyes. Several adverse health effects are known to result from exposure to pesticides including temporary acute effects like irritation of eyes and excessive salivation as well as chronic diseases like cancer,

reproductive and developmental disorders. Effects in the Central Nervous System (CNS) like restlessness, loss of memory, convulsions and coma are also common. In addition, effects on parasympathetic and sympathetic nervous system have been widely reported including respiratory paralysis which is fatal (Kamal & Hoppin, 2004).

### 2.3 Pathophysiology of Pesticide Poisoning

Organophosphate/Carbamates compound exert acute systemic toxicity by inhibiting the enzymes acetylcholinesterase (AChE) through a process of phosphorylation. Pesticides bind to cholinesterase and block the hydrolysis of the acetylcholine and acetic acid at the post synaptic junctions and without functioning acetyl cholinesterase; acetylcholine accumulates at junctions between nerves and muscles resulting into mild to severe symptoms of OP poisoning (Chan & Critchley, 1998; Mason, 2000). A 2006 study on farmworkers in California found that acute effects of pesticide exposure include headache, nausea, eye irritation, muscle weakness, anxiety and shortness of breath (CDC, 2006). Delayed effects of pesticide are illnesses or injuries that do not appear immediately after exposure to the pesticide. Adverse effects may be delayed for weeks, months or even years after the first exposure to the pesticide. Depending upon the toxicity of the compound, dosage and exposure time, the adverse effects of pesticides poisoning ranges from headaches, vomiting, skin irritation, respiratory problems to other neurological disorders (Jors *et al*., 2006). Available evidence suggest that there is a possibility of adverse effects occurring below OP compounds concentrations that are generally considered to be safe based on measurement of AChE inhibition (Singh & Sharma, 2000; Salvi *et al.*, 2003).

A study in Srilanka has shown inhibition of AChE enzyme and impairment of sensory and motor nerve conduction due to long term, low level exposure to OPs (Smit *et al.*, 2003). Farm workers and green house workers exposed to organophosphates reported more symptoms than unexposed workers (Strong *et al*., 2004). Pesticide poisoning is associated with increased symptom prevalence (Kamal & Hoppin, 2004; Jors *et al*., 2006). Farmers and farm workers who applied organophosphate had higher symptoms

prevalence than did non applicators (Beshwari *et al., 1999;* Ohayo-Mitoko *et al., 2000)*. Studies indicate that pesticide exposure is associated with chronic health problems such as: respiratory problems; memory disorders; dermatologic conditions; cancer; depression; neurologic deficits; miscarriages and infertility and birth defects *(*Arcury *et al., 2003)*

**2.4 Risk factors associated with pesticides poisoning**

Pesticide poisoning is a serious problem in farm workers in developing countries. This is where pesticide use is in widespread and where pesticides banned elsewhere because of carcinogenic or other adverse characteristics may be used. In developing countries farm workers and health professionals may not be adequately informed or trained in the recognition and prevention of pesticide poisoning and where means of reducing exposure, such as personal protective devices, may not be easily available (Jeyaratnam, 1990).

The application equipments used in developing countries are poorly maintained some are leaking and supplies are usually inadequate. Pesticides are often applied with inefficient hand-sprayers, ox drawn sprayers, or dusting equipment and inadequate protective clothing is used. In addition, many pesticides are applied by people wearing inadequate or unsuitable clothing, which is frequently worn for extensive periods after being contaminated by pesticides. Farm workers are also exposed to pesticides as a result of re-entry into sprayed areas. This increases the overall exposure of an individual. Moreover, in hot climates, protective clothing is rarely used; this is because the temperature is high and additional clothing's makes the farmer uncomfortable. In many developing countries, the hot climate and the general lack of education makes pesticide use dangerous to the operator (Luginbuhl, 2008). In these countries, pesticides are generally applied by farmers and agricultural workers, many of whom have insufficient education and training in different application methods. Labeling and packing of pesticide is also a problem because most farmers are illiterate and toxicity is explained poorly if the farmer cannot read (Kimani & Mwanthia 1995; Damalas *et al., 2006*).

## 2.5 Laboratory diagnosis of organophosphate toxicity

Inhibition of plasma cholinesterase serves as a diagnostic tool for the risk assessment of exposure to toxic OPs (Amitai *et al.,* 1998). Low levels of serum cholinesterase on moderate and prolong pesticide exposure has been reported by many researchers (Gertrudis *et al*., 2001; Hernandez *et al.,* 2004). Acetylcholinesterase activities significantly decrease at the period of maximum exposure to pesticides; pinpoints certain inhibitory effect of pesticides on this esterase (Hernandez *et al.,* 2004; Jors *et al.,* 2006).

Pesticides and their metabolites can also be measured in biological samples, serum, fat, urine, blood, or breast milk by analytical techniques or by biological method. A number of reports are available in which insecticides and/or their metabolites have been measured in body fluids after occupational exposures to pesticides (Coye, 1986). Prolonged exposure to multiple pesticides affects liver and kidney (Azmi *et al.*, 2006). Statistically significant Aspartate Aminotransferase (AST) levels were found in agriculture workers continuously exposed to pesticides (Hernandez *et al.*, 2006). Higher levels of Gamma Glutamyl Transferase (GGT), (GOT), were found in the blood of occupational workers chronically exposed to pesticides (Michalek *et al*., 2001). An increased rise of liver dysfunction was observed with elevated (AST), Alanine Aminotransferase (ALT) (Michalek *et al.,* 2001; El Demerdash *et al.*, 2001). AST and ALT are involved in the breakdown of amino acids into α- keto acid, which are routed for complete metabolism through the Kreb's cycle and electron transport chain. Consequently they are considered as a specific indicator for liver damage (Harper, 1997). Nephrotoxic changes in workers occupationally exposed to pesticides with higher levels of serum creatinine and or blood urea have been reported (Hernandez *et al.,* 2006; Attia, 2006).

## 2.6 Prevention and management of pesticide poisoning

A recommended solution to preventing occupational pesticide poisoning is to provide health education and training to promote the use of protective equipment and teach farmers on how to handle pesticides carefully. Other methods include, banning the most highly toxic pesticides and implementing alternative agricultural methods to reduce the use of pesticides (Brandt *et al*., 2001). In cases of OP poisoning, oral or injectable atropine should be administered to the patient if symptoms are moderate to severe. If symptoms are mild remove the person from the contaminated atmosphere. In case of ingestion of OP and the person is able to drink, then small amounts of milk or food may be helpful to delay stomach emptying, and might delay absorption of the toxin. On the other hand, large amounts of fluid may hasten stomach emptying. Vomiting should not be induced, nor administer chemical antidotes unless instructed to do so by a medical professional.

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Study area

This study was conducted in Keiyo North Sub-County in Northern Rift of Kenya, Elgeyo Marakwet County. Keiyo North Sub County has five divisions with a population of 182,875 (Kenya Bureau of Statistics, 2010) and covers an area of 1,440.9 square kilometers. It has a total of 38,058 households (Census 2010). Communities living within the catchment area of Keiyo are largely farmers who grow mixed crop and keep livestock. The farmers use fertilizers, fungicides, pesticides, and other chemicals throughout the year to improve their agricultural yields. Unemployed members have also turned to horticulture as an alternative income-generating activity.

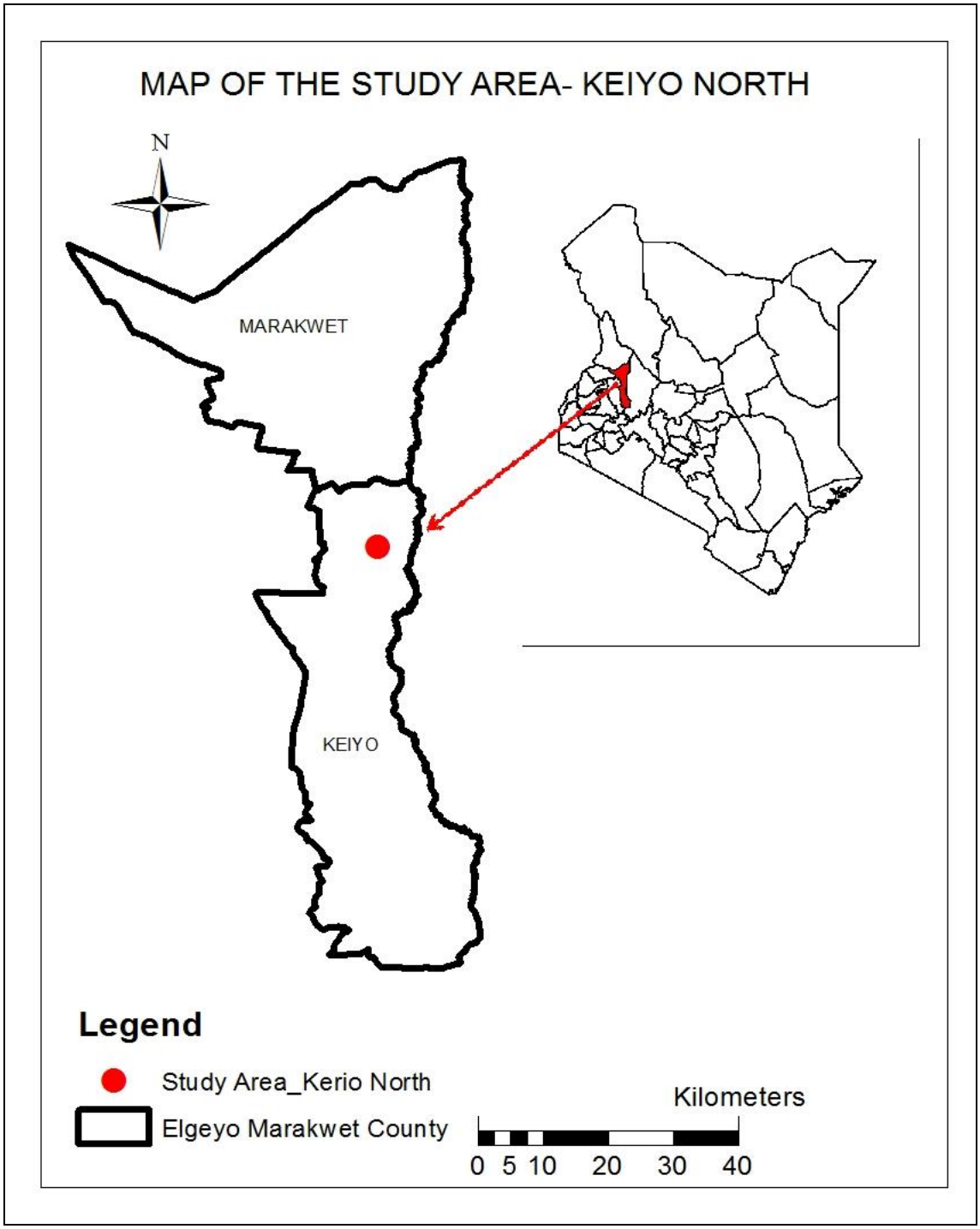


**Figure 3.1: Map of Kenya showing the study Area**

### 3.2 Study design

This was a descriptive cross-sectional study to determine factors associated with serum cholinesterase levels among farmers in Keiyo North Sub county 2013.

### 3.3 Study Population

The study population consisted of farmers residing in Keiyo North Sub County during the study period of between June and August 2013.

### 3.4 Sample size Determination.

Using the Cochran formula of 1977 the minimum sample size was calculated as shown below:

$$n= (\underline{Z^{2\times}p\times q}) /d^2$$

Where

*n* = required minimum sample size

Assumptions

*Z*= Z statistics for a level of confidence (The standard normal deviation at the required confidence level = 1.96)

*p*= Expected prevalence (The proportion in the target population estimated to have the characteristics being measured. Since the proportion is unknown 50% will be used. Thus P= 0.50)

*d*= Level of Precision (error reduction) set at 5%. (Thus d= 0.05)

$n = 1.96^2*(0.50)*(1-0.50) /0.05^2 =385.$

The minimum sample size calculated was 385

### 3.4.1 Sampling Technique

Multi Stage sampling methodology based on probability proportional to size (PPS) was used to select the study sites (Appendix ii)

**Stage1**: Sampling of Divisions

There are 5 Divisions in Keiyo North Sub-County; one division was excluded from the study as per the exclusion criteria and 2 Divisions randomly selected.

**Stage 2**: Sampling of the locations

In the selected divisions, 50% of the total numbers of locations were randomly selected.

**Stage 3:** Sampling of Sub -locations

A complete list of all the sub- locations in the selected locations and their population were used (Kenya census, 2010). Random sampling based on probability proportionate to size (PPS) was used to select the number of Sub-locations and villages.

**Stage 4**: Sampling of the Households and Subjects.

The first household was randomly picked from a village having approximately 130 households and for subsequent households, every 5th household was systematically selected till 26 household were sampled in 15 selected villages (26 x 15= 390 households) sample size of 390 subjects. Assuming homogeneity of equal population distribution the number of subjects was equally divided among the villages. One subject who is a farmer was sampled per household. If no one was at home the next household was selected, and when a household had more than one eligible subject only one was randomly selected.

### 3.4.2 Inclusion Criteria

- All consenting farmers of age 18 years and above
- Farmers residing in Keiyo Sub-County along the highlands and escarpment
- Farmers handling pesticides in their farms

### 3.4.3 Exclusion criteria

- Farmers not willing to participate in the study

## 3.5 Collection of Blood Samples for Estimation of Serum Cholinesterase Levels

A Whole blood sample of 2.5ml was obtained by venipuncture of median or cephalic veins from a fully consented farmer in the homestead using a red top vaccutainer tube, under sterile procedures. Samples were packed and transported in an ice pack container to Iten Referral hospital laboratory. Blood samples were centrifuged at 1500 g" and separated serum put in cuvettes. Serum was stored in a freezer at $-20^0$ C awaiting analysis at Moi and Teaching Referral Hospital. According to the manufacturers recommendation stored serum can be tested within 60 days of storage at $-20^0$ C. Biosafety measures were observed at all levels from sample collection to disposal.

## 3.6 Laboratory procedure for Detection of Serum Cholinesterase Levels

The blood samples were aliquoted and labeled serially indicating date of collection.

Serum cholinesterase levels were estimated spectrophotometrically using automated chemistry autoanalyser from Roche diagnostic company, Germany, Hitachi 902. The machine was calibrated and quality controlled using commercially known controls. The principle of the test uses butyrythiocholine as the specific substrate for cholinesterase .Cholinesterase catalyses the hydrolysis of butyrythiocholine substrate forming butyrate and thiocholine. Thiocholine reduces hexacyanoferrate( iii).to hexacyanoferrate(ii).The decrease of absorbance is directly proportional to CHE activity in the sample. The

reference values for adults: Women (4887-10729 U/L) Men (3995-11508) U/L). Sánchez LH ,*et al*.,2015.Values below the reference ranges were considered abnormal.

### 3.7Questionnaire Survey

Data was collected using a semi- structured questionnaire (Appendix iii) which was administered to all farmers who met the inclusion criteria and had fully consented to participate in the study.

The questionnaire was in six sections:

- Socio-demographic factors (sex, age, marital status, education, and main occupation).
- Clinical History (pesticide related symptoms).
- Behavior of farmer when handling pesticides (preparing pesticide, PPE, Concentrations of pesticide).
- Knowledge of pesticide use (Route of entry, risks of using pesticide, place of storage).
- Perception of pesticide use (is agricultural occupation risk? does long exposure to pesticide cause chronic infections?).
- Blood test(Serum cholinesterase levels)

Pre-testing of questionnaire on 10 farmers from households in a neighboring sub county was done prior to the study in order to avoid ambiguity and ensure reliability.

### 3.8 Data management

#### 3.8.1 Data entry and storage

Participant's confidentiality was maintained by use of numbers and not names. Names did not appear when discussing this project and when results were discussed focus was on a big group. Questionnaires were kept in a private lockable drawer accessible only to

the principal investigator. Data was entered into a password protected database and subject consent was sought before removing blood and administering the questionnaire. Data entering, cleaning, editing and analysis were done using Epi-info software version 3.5.3 and SPSS software version 20. Data was entered into a password protected Epi-info database using a double entry screen to eliminate errors. Questionnaires were checked at the end of the day for completeness. Data obtained of serum cholinesterase levels was entered into the computer indicating the normal and abnormal values. The principal researcher's laptop was used to store data for analysis and backed up by a CD disc.

### 3.8.2 Data analysis

Descriptive analysis was done for the demographic variables, using means, standard deviations, frequencies and 95% confidence interval to get the general view of the study participants. Bivariate analysis was done to determine potential factors using odds ratio as a measure of association and the statistical significance was checked using 95% confidence interval and chi square test (P-value <0.05).All potential associated factors were subjected to logistic regression model. Stepwise backward elimination logistic regression was used to come up with the final model for statistical significant factors.

## 3.9 Ethical Considerations

Approval to conduct the study was granted by the Board of Postgraduate studies of the Jomo Kenyatta University of Agriculture and Technology. Ethical clearance was obtained from the Kenya Medical Research Institute Scientific Steering Committee (KEMRI SSC) and KEMRI National Ethics Review Committee. (ERC) Appendix iv. Clearance to carry out the study was also sought from Keiyo District Agricultural officer. (Appendix v) and Keiyo District MOH (Appendix vi).

### 3.10 Dissemination and Application of Results

The findings of this study were disseminated through a final report that was shared with the management of Iten Referral Hospital, policy makers and program managers from the Ministry of Health and Agriculture Keiyo North Sub- County. It was also published in the Prime Journal of Social Science (PJSS).ISSN.2315-5051, Vol.4 (2) pp. 978-986 February 2015. The results will form a basis for policies and regulations aimed at promoting safer farm practices for farmers

# CHAPTER FOUR

# RESULTS

## 4.1 Social Demographic Characteristics of Farmers in Keiyo North Sub County

The demographic characteristics of the farmers enrolled and interviewed during the study period showed majority of the farmers were male 222 (57 %).Figure 4.1

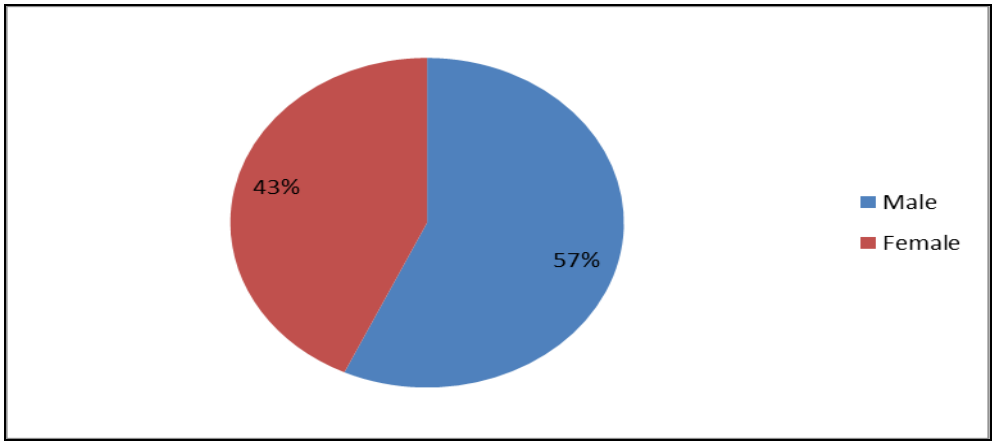


**Figure 4.1: Gender Distributions of the Study Participants in Keiyo North Sub-County, 2013**

The age of the participants ranged from 18 to 65 years with a mean age of 35. Farmers in the age group 18-25 were 85 (21.8%), those in 26-35 category were 137 (34.1%) while age groups 36-45, 46-55, and 56-65 had 99 (25.4%), 58 (14.9%) and 11(2.8%) respectively. The level of education of the farmers ranged from no formal education with 26 (6.7%), those with primary education were 227 (71.0%) while those with secondary and tertiary education were 79(20.3%) and 8 (2.1%) respectively. Most of the farmers were married 326 (83.6%), 61(15.6%) single, 2 (0.5%) divorced/separated and 1(0.3%) widowed. Majority of the farmers 327 (84.1) were earning less than 10,000 Ksh (Table 4.1).

**Table 4.1: Social Demographic Characteristics of farmers in Keiyo North Sub-County, Kenya 2013**

| Demographic Characteristics | Farmers n=390 Frequency (%) | 95%CI |
|---|---|---|
| **Sex** | | |
| Male | 222(56.9) | 51.9-61.9 |
| Female | 168(43.1) | 38.1-48.2 |
| **Age group(years)** | | |
| <17 | 0(0) | |
| 18-25 | 85(21.8) | 17.9-26.3 |
| 26- 35 | 137(35.1) | 30.4-40.1 |
| 36-45 | 99(25.4) | 21.2-30.1 |
| 46-55 | 58(14.9) | 11.6-18.9 |
| 56-65 | 11(2.8) | 1.5-5.1 |
| **Education** | | |
| No formal education | 26 (6.7) | 4.5-9.7 |
| Primary | 277 (71.0) | 66.2-75.4 |
| Secondary | 79 (20.3) | 16.4-24.7 |
| Tertiary | 8 (2.0) | 1.0-4.2 |
| **Marital Status** | | |
| Married | 326(83.6) | 79.5-87.1 |
| Single | 61(15.6) | 12.3-19.7 |
| Divorced/Separated | 2(0.5) | 0.1-2.0 |
| Widowed | 1(0.3) | 0.0-1.6 |
| **Family Monthly Income** | | |
| Less than Ksh.10,000 | 328(84.1) | 80.1-87.6 |
| Ksh.10,001-20,000 | 57(14.6) | 11.3-18.6 |
| More than Ksh.20,000 | 5(1.3) | 0.5-3.1 |

### 4.2 The Profiles of Serum Cholinesterase levels and related Symptoms among Keiyo Farmers

The low Serum Cholinesterase levels(abnormal) among Keiyo farmers was 13.1% representing 51 farmers out of a total population of 390 farmers ( Figure 4.2).The most common related symptoms as experienced by Keiyo North Sub-County farmers with abnormal SChE after spraying were as follows; headache 84.4%, dizziness 76.2%, skin irritation 67.7%, weakness 66.9%, chest pain 66.4%, burning sensation on the skin 64.9%, eye irritation 62.6%, excess sweating 59.5%, nausea/vomiting 55.1%, fever 43.6% and finally abdominal pain / diarrhea 41.5%.

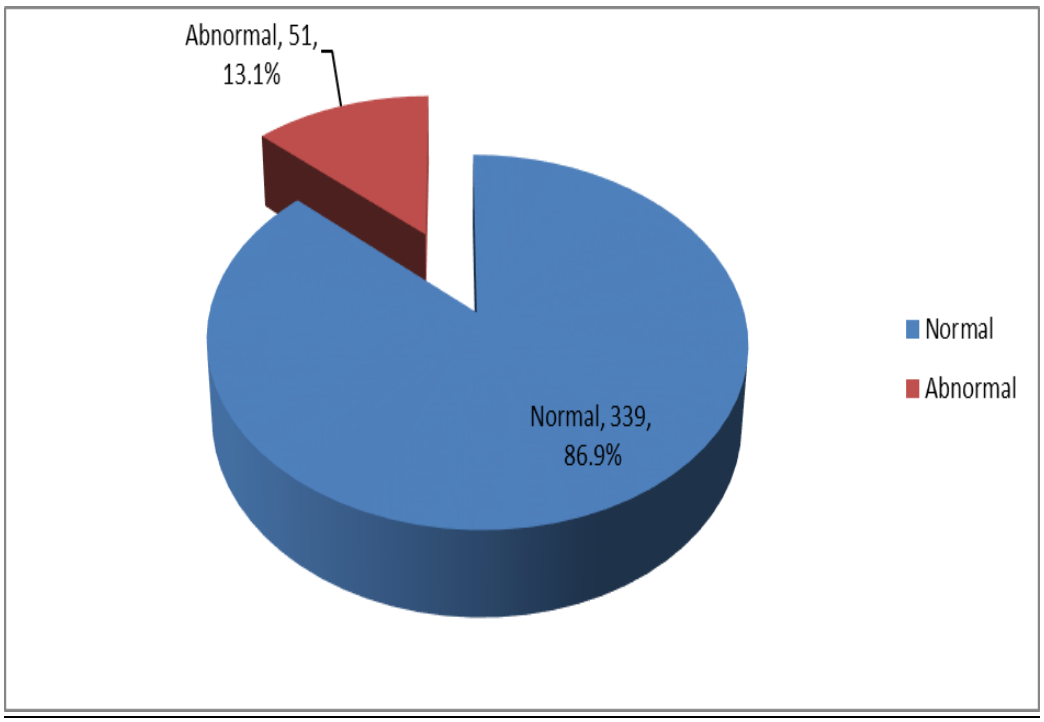


**Figure 4.2: Distribution of Serum Cholinesterase among farmers in Keiyo North Sub-County, 2013**

Farmers with abnormal SChE levels had more symptoms than those with normal levels.

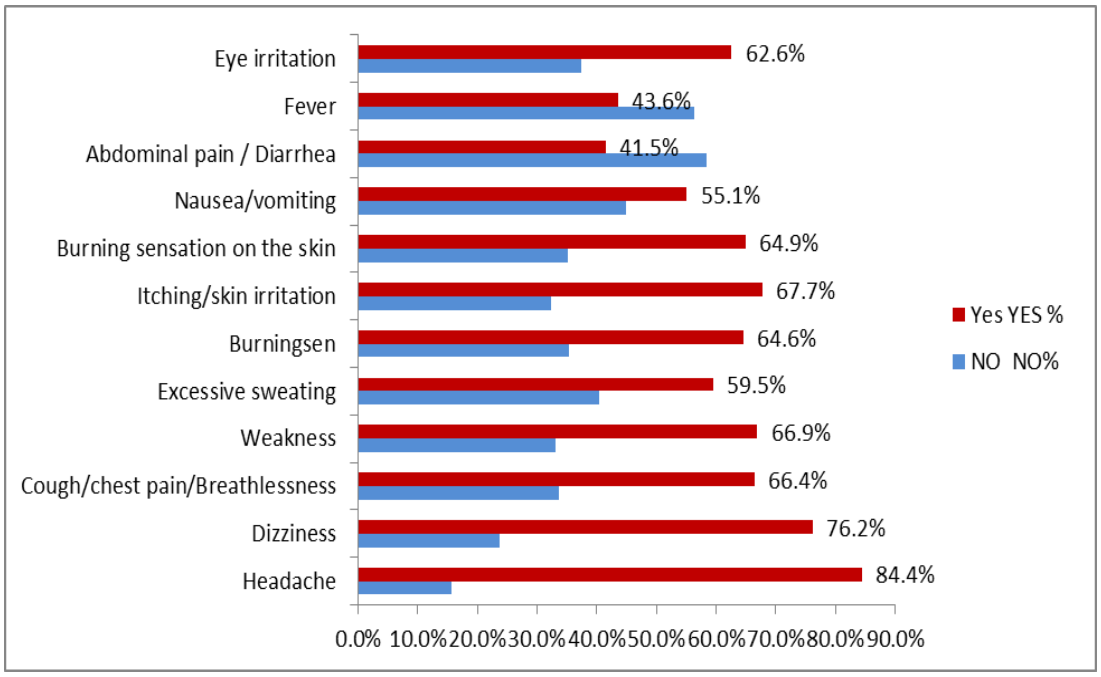


**Figure 4.3: Distribution of Self reported symptoms among farmers in Keiyo North Sub-County, 2013**

### 4.3 Knowledge of Pesticide use among Keiyo farmers

The respondents who knew that pesticides enter into the body by inhalation were 93.1%. The correct responses for other routes of entry were mouth (79.2%), skin (88.5 %.). The four most common symptoms known by respondents were burning sensation on the skin (74%), eye irritation (73.4%), headache (73.1%) and itching/skin irritation (72.1%) and the least being nausea/vomiting (34.7%), memory loss (33.6%), abdominal pains/diarrhea (29.7%).Skin diseases(77.7%) and respiratory diseases (73.1%) were the reported risks of long term exposure to pesticides. Over 75% knew that pesticides remain in the soil, ground water, fruits, seeds and leaves of vegetables. Less than 26% of the farmers knew alternative pest control other than chemical ways while 86.3% stored chemical cans in specific store far away from children and pets (Table 4.2).

**Table 4.2: Knowledge of Pesticide use among 390 Farmers in Keiyo North Sub-County by item %**

| Variables | n=390 Yes (%) | No (%) |
|---|---|---|
| **Route of entry into the body** | | |
| Mouth | 309 (79.2 ) | 81(20.8) |
| Skin | 345 (88.8 ) | 45(11.2) |
| Inhalation | 363 (93.1) | 27(6.9) |
| **Pesticide-related symptoms** | | |
| Headache | 285 (73.1) | 105 (26.9) |
| Excessive sweating | 192 (49.2) | 198 (50.8) |
| Cough / Chest pain / Breathlessness | 229(58.7) | 161(41.3) |
| Weakness | 275 (70.5) | 115 (29.5) |
| Itching / Skin irritation | 281 (72.1) | 109 (27.9) |
| Burning sensation on the skin | 287 (74.0) | 103 (26.0) |
| Nausea / vomiting | 135 (34.7) | 255 (65.3) |
| Abdominal pain / Diarrhea | 116 (29.7) | 274 (70.3) |
| Fever | 169 (43.3) | 221 (56.7) |
| Memory loss | 131 (33.6) | 259 (76.4) |
| Eye irritation | 283 (73.3) | 107 (26.7) |
| **Risks of long term exposure to Pesticides** | | |
| Cancer | 272 (69.9) | 118 (30.1) |
| Respiratory disease | 285 (73.1) | 105 (26.9) |
| Neurological system disease | 265 (67.7) | 125 (32.3) |
| Skin diseases | 303 (77.7) | 87 (22.3) |
| **Places of Pesticide residue** | | |
| Air | 332 (85.1) | 58 (14.9) |
| Soil | 327 (83.8) | 63 (16.2) |
| Ground water | 292 (74.9) | 98 (25.1) |
| Fruits, seeds and leaves of vegetables | 326 (83.6) | 64 (16.4) |
| **Alternative pest control other than chemicals** | | |
| Biological Control | 31(9.20) | 359 (91.8) |
| Natural Control | 64 (16.4) | 326 (83.6) |
| Using agricultural ways | 100 (25.7) | 290 (74.3) |
| Checking the spraying equipments in good condition before using | 28 2(72.5) | 108 (27.5) |
| For safety when using pesticides, do not spray against the wind | 293 (75.3) | 97(24.7) |
| **Storage of empty Pesticide bottles or cans** | | |
| In specific store for away from children and pets | 336 (86.2) | 54 (13.8) |
| In the home with other instruments | 125 (32.5) | 265(67.5) |

### 4.4 Perception of Pesticide use among Keiyo Farmers

At least 45% of the participants perceived that agriculturist and their family members were at high risk of exposure to pesticide toxicity while approximately 40% felt that long term exposure to pesticides may cause diseases like leukemia or the toxicity may lead to death. More than 50% had high perception that using personal protective equipment (PPE, s) and adhering to chemical use instruction can reduce the risk and dangers from chemical use while less than 10% perceived PPE's as an increasing investment cost or causing difficulty and feeling uncomfortable while working (Table 4.3).

**Table 4.3: Perception of Pesticide use among 390 Keiyo Farmers by item %**

| | % | % | % |
|---|---|---|---|
| **Variable** | **Never** | **Sometimes** | **Always** |
| **Perceived Susceptibility** | | | |
| Agriculturalist have a chance to suffer from pesticides | 1.8 | 53.1 | 45.1 |
| Agricultural family members have a chance to suffer from pesticides toxicity | 10.3 | 50.5 | 39.7 |
| **Perceived Severity** | | | |
| Long time exposure to pesticides may cause diseases such as leukemia ,cancer | 7.7 | 50.6 | 41.7 |
| Toxicity of organophosphate may cause death | 11.3 | 51.8 | 36.9 |
| **Perceived Benefit** | | | |
| Using chemical protection equipments while spraying can protect your exposure to chemicals | 3.9 | 45.8 | 50.4 |
| Strictly adhering to chemical use instruction can reduce the risks and danger from chemical use | 6.9 | 39.2 | 53.8 |
| **Perceived Barrier** | | | |
| Using chemical protection equipments while spraying increases the investment cost | 49.5 | 39.9 | 10.6 |
| Using chemical protection equipments causes difficulty and feeling uncomfortable while working | 41.6 | 49.1 | 9.3 |

### 4.5 Practices among Farmers towards Pesticide use in Keiyo North Sub County, 2013

The majority of the farmers (62.9%) never or sometimes read and understood all the instructions before preparing pesticides. Only 8.2% mix with other pesticides while 2.6% mix with herbs. The most three worn PPE during pesticide preparation was long sleeve shirt and trouser (35%), boots (24%) and hat (10.4%) which were similar to PPE, s worn during spraying. During spraying 2.3%, 3.3%, 2.3%, 0.3%, smoke drinks, eats and chews gum respectively. The majority of the farmers wash hands with water and soap (64.9%), clean water (62.4%), shower (60.1%) while (20.5%) re-enter the field after spraying. Farmers in Keiyo North Sub-County use empty pesticide containers in different ways, 9.3% store water, 7.3%food stuff and 6.5% other chemical substances while 8.3%bury and 9.5% burn them. Only 32.8% of farmers wash fruits or vegetables after picking them from the field (Table 4.4).

**Table 4.4: Practices associated with Pesticide handling among Farmers in Keiyo North Sub-County by item %.**

| Variable | % Always | % Sometimes | % Never |
|---|---|---|---|
| Before preparing pesticides do you carefully read and understand all the instruction | 38.1 | 56.7 | 6.2 |
| **The concentration of pesticides used** | | | |
| Only one, no mixed | 71.6 | 15.5 | 12.9 |
| Mixed with other pesticides* | 8.2 | 18.0 | 73.8 |
| Mixed with herbs* | 2.6 | 19.3 | 78.0 |
| **PPE,s worn during pesticide preparation** | | | |
| Gloves | 2.8 | 13.6 | 83.6 |
| Mask | 5.4 | 22.6 | 72.0 |
| Goggles | 1.5 | 8.5 | 90.0 |
| Boots | 24 | 25.3 | 50.8 |
| Long sleeves shirt and trousers | 35 | 34.7 | 30.3 |
| Hat | 10.4 | 30.6 | 59.1 |
| Do you follow the bottle affixed label | 24.7 | 47.0 | 28.3 |
| **Practices during spraying** | | | |
| Wearing gloves | 4.9 | 15.6 | 79.5 |
| Putting on nasal masks | 4.4 | 29.5 | 66.2 |
| Using goggles | 2.6 | 10.5 | 86.9 |
| Wearing special boots | 21 | 30.8 | 48.2 |
| Wearing long sleeves shirt and trousers | 51.9 | 32.4 | 15.7 |
| Putting on hat | 7.4 | 30.0 | 62.0 |
| Smoking* | 2.3 | 11.3 | 86.4 |
| Drinking* | 3.3 | 14.9 | 81.7 |
| Eating* | 2.3 | 22.3 | 75.4 |
| Chewing* | 0.3 | 7.2 | 92.6 |
| **Practices after spraying** | | | |
| Instantly wash hands with clean water | 62.4 | 35.8 | 1.5 |
| Instantly wash hands with soap or bath | 64.9 | 33.8 | 1.3 |
| Instantly take a shower | 60.1 | 32.5 | 7.5 |
| After the field has been sprayed pesticides, do You re- enter it to work * | 20.5 | 56.1 | 23.4 |
| **Uses of empty pesticides containers** | | | |
| Store water* | 9.3 | 33.3 | 57.4 |
| Store food stuff* | 7.3 | 26.3 | 66.4 |
| Store other chemicals substances* | 6.5 | 24.8 | 68.7 |
| Throw it into the garbage sites | 7.0 | 40.4 | 52.6 |
| Bury the empty pesticides bottles/cans | 8.3 | 43.2 | 48.6 |
| Burn the empty pesticides bottles/cans* | 9.5 | 43.8 | 46.7 |
| Do you normally wash your fruits or vegetables after picking them from the field* | 32.8 | 47.0 | 20.2 |

***Negative items**

### 4.6 Social Demographic Factors Associated with Abnormal Cholinesterase levels among Keiyo Farmers

Three variables were found to be significantly associated with the occurrence of abnormal cholinesterase levels, Table 4.5. Age group 26-35 years was significantly associated with the occurrence of abnormal cholinesterase levels. The odds of occurrence is 0.7 times higher for respondents who were in age group 26-35 years as compared to respondents in age group 18-25 years ( cOR=0.65; 95% CI:1.24-7.79; p=0.04).

Marital status (divorced) and Type of work (Permanent) were also statistically associated with abnormal Cholinesterase levels. However sex, level of education and religion were not significantly associated with abnormal cholinesterase levels.

**Table 4.5: Bivariate analysis of Demographic Factors among Keiyo Farmers, 2013**

| Variable | Crude Odds Ratio | 95% CI | P value |
|---|---|---|---|
| **Sex** | | | |
| Female | 1.0 | | |
| Male | 1.9 | 0.95-3.83 | 0.07 |
| **Age** | | | |
| 18-25 years | 1.0 | | |
| 26-35 years | **1.6** | **1.24-7.79** | **0.04*** |
| 36-45 years | 0.8 | 0.31-2.45 | 0.80 |
| 46-55 years | 0.5 | 0.16-1.89 | 0.34 |
| 56-65 years | 0.3 | 0.04-3.88 | 0.42 |
| **Marital status** | | | |
| Single | 1.0 | | |
| Married | 2.7 | 0.83-8.82 | 0.10 |
| Divorced | **2.9** | **1.29-89.25** | **0.03*** |
| **Education** | | | |
| No formal | 1.0 | | |
| Primary | 0.4 | 0.14-1.26 | 0.12 |
| Secondary | 0.3 | 0.11-1.32 | 0.14 |
| Tertiary | 0.0 | 0.00-0.00 | 1.00 |
| **Type of work** | | | |
| Temporary | 1.0 | | |
| Permanent | **4.2** | **2.19-8.08** | **< 0.001*** |
| **Religion** | | | |
| Christian | 1.0 | | |
| Traditional | 1.6 | 0.15-18.97 | 0.68 |

Knowledge of pesticide use among Keiyo farmers was analyzed and results presented in Table 4.6 .Six factors were used to measure knowledge and all were found not to be significantly associated with abnormal serum cholinesterase levels.

**Table 4.6: Bivariate analysis of Knowledge of Pesticide use among Keiyo Farmers, 2013**

| Variable | cOR | 95% C.I. Lower/Upper | P Value |
|---|---|---|---|
| Knowledge of route of entry into the body | | | |
| High | 1.0 | | |
| Low | 0.9 | 0.343-2.908 | 0.999 |
| knowledge of pesticide related symptoms | | | |
| High | 1.0 | | |
| Low | 1.2 | 0.611-2.744 | 0.501 |
| Knowledge of risk of long term exposure | | | |
| High | 1.0 | | |
| Low | 0.7 | 0.337-1.717 | 0.511 |
| knowledge of places of pesticide residue | | | |
| High | 1.0 | | |
| Low | 0.5 | 0.198-1.440 | 0.215 |
| knowledge of alternative pest control | | | |
| High | 1.0 | | |
| Low | 1.3 | 0.736-2.590 | 0.315 |
| Knowledge of storage of empty pesticide bottles or cans | | | |
| High | 1.0 | | |
| Low | 1.5 | 0.440-5.515 | 0.492 |

The perception of Keiyo farmers was analyzed in terms of susceptibility, severity, benefit and use of protective gear as a barrier when handing pesticides (Table 4.7). The perception of the farmers was found not to be significantly associated with the abnormal cholinesterase levels.

**Table 4.7: Bivariate analysis of Perception of Pesticide use among Keiyo Farmers**

| Variable | | cOR | 95% C.I. Lower/Upper | P Value |
|---|---|---|---|---|
| Perceived susceptibility | | | | |
| | High | 1.0 | | |
| | Low | 1.0 | 0.514-2.101 | 0.915 |
| Perceived severity | | | | |
| | High | 1.0 | | |
| | Low | 0.6 | 0.306-1.574 | 0.382 |
| Perceived as benefit | | | | |
| | High | 1.0 | | |
| | Low | 0.8 | 0.434-1.646 | 0.621 |
| Perceived as Barrier | | | | |
| | High | 1.0 | | |
| | Low | 0.9 | 0.434-1.678 | 0.645 |

## 4.7 Bivariate analysis for the Association between Practices of Pesticide use and Abnormal Serum Cholinesterase levels

Un recommended practices when spraying were statistically associated with occurrence of abnormal serum cholinesterase levels. The odds of occurrence of abnormal serum cholinesterase levels were 1.611 times higher for respondents with high un recommended farm practices when spraying as compared to respondents with low unrecommended farm practices ( OR=1.611; CI: 1.289-6.992; p=0.048). Washing of fruits or vegetables after picking them from the field is significantly associated with occurrence of abnormal serum cholinesterase. The odds of occurrence of abnormal serum cholinesterase is 1.594 times lower for respondents with high practices of washing fruits or vegetables after picking them from the field as compared to respondents who had low practices. (OR =1.5; CI: 1.65-2.868; p=0.033).

**Table 4.8: Bivariate analysis of Practices of Pesticide use among Keiyo Farmers**

| Variable | | cOR | 95% C.I. Lower/Upper | P Value |
|---|---|---|---|---|
| Before preparing, do you carefully read understand all the instructions | High | 1.0 | 0.327- | |
| | Low | 0.7 | 1.951 | 0.621 |
| The concentration of pesticide used | High | 1.0 | 0.125- | |
| | Low | 1.2 | 12.333 | 0.854 |
| PPEs worn during preparation | High | 1.0 | | |
| | Low | 0.0 | 0.000 | 0.999 |
| practice after spraying | High | 1.0 | 0.373- | |
| | Low | 0.9 | 2.571 | 0.967 |
| Un recommended practice when spraying | High | 1.0 | **1.289-** | |
| | Low | **1.6** | **6.992** | **0.048** |
| uses of empty pesticides container | High | 1.0 | | |
| | Low | 0.0 | 0.000 | 0.999 |
| Un recommended uses of empty pesticides container High | | 1.0 | 0.186- | |
| | Low | 0.9 | 5.200 | 0.985 |
| Do you normally wash fruits or vegetables after picking from the farm | High | 1.0 | **1.657-** | |
| | Low | **1.5** | **2.868** | **0.033** |

## 4.8 Bivariate Analysis of Three Months most often used Pesticides by Keiyo Farmers, 2013

Dimethoate was significantly associated with the occurrence of abnormal serum cholinesterase. The odd of occurrence of abnormal serum cholinesterase was 6.8 times higher for respondents who handled Dimethoate for three months as compared to respondents who had not. (OR=6.8; CI: 1.834-20.561; p=0.004). (Table 4.9)

**Table 4.9: Bivariate analysis of Most often used Pesticides by Keiyo Farmers**

| OP Pesticide | cOR | 95% C.I. Lower/Upper | P Value |
|---|---|---|---|
| Okor(Yes) | 0.8 | 0.424-1.581 | 0.552 |
| Cyclone(Yes) | 1.0 | 0.517-2.188 | 0.868 |
| Diazinon(Yes) | 0.7 | 0.305-1.948 | 0.582 |
| Dimethoat(Yes) | 6.8 | 1.834-20.561 | 0.004 |
| Malathion(Yes) | 1.1 | 0.493-2.763 | 0.725 |
| Bulldock(Yes) | 0.7 | 0.092-6.031 | 0.775 |
| Duduthrin(Yes) | 1.1 | 0.555-2.207 | 0.774 |
| steladon(Yes) | 1.3 | 0.576-3.191 | 0.485 |
| Polythrin(Yes) | 1.7 | 0.838-3.455 | 0.142 |

Variables that were significant in bivariate analysis were subjected to multivariable analysis (Table 10), whereby three significant independent factors, Type of work (Permanent),Un recommended practice when spraying and handling Dimethoate pesticide remained to be significantly associated with abnormal serum cholinesterase levels. The findings imply that the type of work, unrecommended farm practices when spraying and handling Dimethoate pesticide determined the likelihood of having abnormal serum cholinesterase levels.

**Table4.10: Final model of logistic regression of factors Associated with Abnormal Serum Cholinesterase levels among Keiyo Farmers, 2013**

| Variable | AOR | 95% C.I. Lower | P value |
|---|---|---|---|
| Type of work(Permanent) | 5.5 | 2.326-8.511 | **0.00** |
| Un recommended practice when spraying (Low) | 1.9 | 1.343-11.333 | **0.05** |
| Dimethoate(Yes) | 9.7 | 2.676-25.829 | **0.00** |

# CHAPTER FIVE

# DISCUSSION

## 5.1 Socio-demographic characteristics of Keiyo Farmers

Exposure to pesticide is an occupational hazard among farmers in low income countries. Extensive handling of OP has health implications which include neurotoxicity, lung and liver damage, respiratory failure, cancer and aplastic anemia among others. Pesticide toxicity becomes worse when farmers practice unrecommended farm practices.

A total of 390 farmers participated in this study, of which males were 56.4% with a male to female ratio of 1.3:1 .The age of the participants ranged from 18 to 65 years categorized into different groups of between18-25 (21.8%), 26-35(34.1%), 36-45(25.4%), 46-55(14.9%) and 56-65(2.8%). Age group 26-35 (34.1%) had the highest number of participants. The level of education varied across the participants with 227(71.0%) having primary education. This reflected a group of rural agricultural area with a significant number of farmers working as subsistence farmers. The majority of farmers were married 326 (83.6%) with a quarter either being single or divorced/separated and majority of the participants 327 (84.1) were earning less than 10,000 Ksh per month.

The overall prevalence of abnormal cholinesterase activity was 13.1%.This prevalence is slightly similar to a study that was done in Bolivia of 731 farmers which showed 5-10% had decreased cholinesterase activity as a sign of exposure to organophosphate (Jors *et al.,* 2006).However the prevalence of this study was lower compared to studies done by Sriyironjan *et al.,* 2005 (24.6%) and in Zimbabwe who had 24.1% (Regis *et al.,* 2011).The high prevalence in the two studies may be attributed to the choice of the study area, some places are high risk while others are not.

The most common related symptoms as experienced by Keiyo farmers after spraying were as follows; headache 84.4%, dizziness 76.2%, skin irritation 67.7%, weakness 66.9%, chest pain 66.4%, burning sensation on the skin 64.9%, eye irritation 62.6%, excess sweating 59.5%, nausea/vomiting 55.1%, fever 43.6% and finally abdominal pain / diarrhea 41.5%.Headache and dizziness were the leading symptoms as reported by the farmers. This result is similar to those of chomthaisong *et al* and Yassin *et al* who found that dizziness and headache were the most common pesticide related symptoms. The study also realized that the prevalence of OP related symptoms among farmers with abnormal SChE levels was higher than the normal group which is similar to a study that was done in East Africa (Mbakaya *et al*., 1996) Another study found out that those farm workers and green house workers exposed to OP reported more symptoms than unexposed workers (Strong *et al.*, 2004; Pasha *et al.,* 1999).

Several potential factors associated with abnormal cholinesterase levels were noted in this study for statistical association. The initial bivariate analysis indicated that age group 26-35 and divorced/separated were more likely to suffer from organophosphate toxicity though found not statistically significant on multivariable analysis. This is similar to a study that was done in India which reported majority of the cases were in age group 21-30 years. (Dharral & Pawal, 2011). Divorced/separated farm workers were more likely to suffer from pesticide toxicity compared to married farmer workers. This could be attributed to the fact that they have no partner to encourage them to use personal protective equipment.

Generally from this study Keiyo farmers were knowledgeable and were able to answers correctly most of the questions asked except for alternative pest control methods. Less than 26% of the farmers knew alternative pest control other than chemical. Although Keiyo farmers were knowledgeable their pesticide handling and field spraying practices did not sufficiently demonstrate this level of knowledge. The level of education and knowledge of the farmers were not statistically associated with abnormal cholinesterase levels. Unrecommended farm spraying practices like not wearing PPE,s (wearing

gloves, putting on nasal masks, using goggles, wearing special boots ,wearing long sleeves shirt and trousers and putting on hat), smoking, drinking, eating and chewing was significantly associated with abnormal cholinesterase levels. . The odds of occurrence of abnormal cholinesterase levels were 1.611 times higher for participants with high un recommended farm practices when spraying as compared to participants with low (OR=1.611; CI: 1.289-6.992; p=0.048).Farmers engaged in spraying practices that inadvertently increase the risk of exposure of applicators to pesticide toxicity hoping to reduce the quantity (and hence cost) of pesticides and PPE,s. One such practice is spraying when wind speed is high as farmers perceived that the higher the wind the higher the spread of the chemical solution to a wider area of the field and 75% of the farmers knew that spraying against the wind is a bad practice. A study in northern Greece (Damalas *et al.,* 2006) showed that almost all farmers (99%) are aware that pesticides can potentially impact negatively on users, but about half of farmers interviewed (46%) did not use any special protective equipment when spraying pesticides. Similar results have also been reported among pesticide applicators in India (Mancini *et al*., 2005).

At least 45% of the participants perceived that agriculturist and their family members were at high risk of exposure to pesticide toxicity while approximately 40% felt that long term exposure to pesticide may cause diseases like leukemia or the toxicity may lead to death. Statistically the perception of the farmers was not associated with abnormal cholinesterase levels. A 2002 study examined take-home Organophosphorus pesticide exposure among agricultural workers and found pesticides in dust samples from 85% of farm workers‟ homes and 87% of farm workers had pesticides in dust samples in their vehicles. In addition, 88% of farm worker children had organophosphate metabolites in their urine. The study also demonstrated that agriculturist families have a chance of suffering from organophosphate toxicity. (Curl *et al*., 2002),

From this study permanent farm workers were more likely to have abnormal cholinesterase levels than temporary farm workers, this could be due to the fact that permanent workers spent more times and years exposed to pesticides in their farms as compared to temporary farmers. This corresponds to a study which found that decrease in levels of serum cholinesterase were higher in workers with prolonged exposure than those with shorter exposures (Karabay *et al.*, 2004; Bhalli, *et al.*, 2006).However this findings were inconsistent with findings from Quinlin, Mayhew and Bohle (2001) who found, temporary or day time laborers were more likely to have decreased SChE.

This study established an indiscriminate availability and use of banned pesticides or restricted in Kenya like Dimethoate organophosphate which is significantly associated with depressed levels SChE of among Keiyo farmers. The odds of occurrence of abnormal cholinesterase levels were 6.8 times higher for respondents who handled Dimethoate for three months as compared to participants who had not. (OR=6.8; CI: 1.834-20.561; p=0.004).A similar case was found to exist in East Africa (Tanzania) and other countries in Africa, including Malawi (Hillocks *et al,.* 1999).

**5.2 Study Limitations**

Limitations of this study were pesticide related symptoms relied on self reports by the farmer without clinical review thus other underlying issues could not be ruled out.

Only one test was performed to determine abnormal cholinesterase levels. Ideally a baseline test should be done to determine the body's normal cholinesterase level and another test after the spraying period.

Although measures were taken to ensure that questions in all interview forms were clear and understood the possibility for questions not being fully understood cannot be ruled out.

# CHAPTER SIX

# CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusion

The major conclusions derived from this study are:-

- There was high prevalence of abnormal serum cholinesterase (13.1%) among farmers in Keiyo North Sub- County.
- The prevalence of abnormal serum cholinesterase related symptoms among farmers with abnormal SChE levels was higher than the normal SChE group.
- Keiyo farmers were knowledgeable and were able to answers correctly most of the questions asked except for alternative pest control methods. Less than 26% of the farmers knew alternative pest control other than chemical
- Farmers handling Dimethoate, permanent farm workers and un recommended practices when spraying were significantly associated with abnormal serum cholinesterase levels.

## 6.2 Recommendations

- The government of Kenya should put more resources into helping Farmers in Keiyo Sub-county understand the concerns of negative health effects due to abnormal serum cholinesterase levels.
- The two ministries of health and agriculture should integrate health education and trainings on recommended farm practices, provision of PPE,s and periodically monitoring the SChE levels of exposed farm workers .
- The government should give regulations which promulgate to control the use of banned pesticides. The Regulations should cover farmer's exposure to pesticide toxicity as well as its potential release to the air.

## REFERENCES


Alarcon, W.A., Calvert, G.M., Blondell, J.M., Mehler, L.N., Sievert, J, & Propeck, M. (2005). Acute illnesses associated with pesticide exposure at school. *Journal of the American Medical Association,* 294, 455-65.

Amitai, G., Moorad, D., Adani, R., & Doctor, B.P. (1998). Inhibition of acetylcholinesterase and butyl cholinesterase by chloropyrifos – Oxon. *Biochem. Pharmacol*. *International Journal of Occupational Environmental Health, 7*, 90-7.

Arcury, T.A., Quandt, S.A., & Mellen, B.G.,( 2003). An exploratory analysis of occupational skin disease among Latino migrant and seasonal farmworkers in North Carolina. *Journal of Agricultural Safety and Health, 9*(3), 221–32.

Atreya, K. (2008). Health costs from short-term exposure to pesticides in Nepal. *Social Science Medicine, 67*, 511-519.

Attia, M. A. (2006). Risk assessment of occupational exposure to pesticides. Earth. *Environmental Science, 3*, 349-62.

Azmi, M. A., Naqvi, S. N., Azmi, M. A., & Aslam, M., (2009). Effect of pesticide residues on health and different enzyme levels in the blood of farm workers from Gadap (rural area) Karachi-Pakistan. *Chemosphere, 64*(10), 1739-44.

Beshwari, M. M. M.; Bener, A.; Amer, A.; Mehdi, A.M.; Onda, H.Z. & Pasha, M. A. H. (1999). Pesticide related health problems and diseases among farmers in the United Arab Emirates. *International Journal of Environmental Health Research; 9,* 213-222.

Bhalli, J.A.; Khan, Q. M., Hag, M.A.; Khalid. & Nasim, A. (2006). Cryptogenic analysis ofPakistani individuals occupationally exposed to pesticides in a pesticidesproduction industry. *Mutagenic, 21*, 143-148.

Brandt, V.A., Moon, S., Ehlers, J., Methner, M.M., & Struttmann, T. (2001). Exposure to endosulfan in farmers: two case studies. *American Journal of Industrial Med*icine, *39*, 643-9.

Bronstein, AC, Spyker, DA, Cantilena, LR Jr, Green, JL, Rumack, BH, & Heard, SE. (2007). Annual Report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 25th Annual Report. *Clinical Toxicology (Phila), 46*(10), 927-1057.

Calvert, G.M., Plate, D, K., Das, R., Rosales, R., Shafey, O., & Thomsen, C.,(2004) Acute occupational pesticide-related illness in the US, 1998-1999: surveillance findings from the SENSOR-pesticides program. *American Journal of Industrial Med*icine, *45*, 14-23.

Centers for Disease Control and Prevention. (2006). Worker Illness Related To Ground Application of Pesticide-Kern County, California, 2005. *Morbidity and Mortality Weekly Report*, *55*(17).

Chan, T.Y.K. & Critchley, J.A.J.H. (1998). Insecticides poisoning with Organophosphates and carbamates. Hong Kong. *Journal of Emergency Medicine 20*(11), 604-13.

Chaudhry, R., Lall, S,B., Mishra, B., & Dhawan, B. A.,(1998) foodborne outbreak of organophosphate poisoning. *British Medical Journal, 317*, 268–9.

Choi, S., Yoo, S., & Lee, B., (2004). Toxicological characteristics of endocrine-disrupting chemicals: Developmental toxicity, carcinogenicity, and

mutagenicity. *Journal of Toxicology and Environmental Health Part B: Critical Reviews 7,* 1-24.

Chomthaisong, C., Nathapindhu, G., & Setheetham, D., (2010). Occupational health impact on tomato growers in Kutchap District and Nonwuaso District Udon Thani Province: A comparison of impact between production for seed and production for consumption. *KKU Resj.(GS), 7,*74-82(in Thai).

Cochran, W G., (1977). *Sampling techniques*. (3rd ed.) New York: John Wiley and Sons.

Coronado, G.D., Thompson, B., Strong, L., Griffith, W.C., & Islas, I. (2004). Agricultural task and exposure to organophosphate pesticides among farm workers. *Environmental. Health Perspectives*, *18*,(112), 142-147.

Coye, M.J., Lowe, J.A., & Maddy, K.J., (1986). Biological monitoring of agricultural workers exposed to pesticides: I. *Cholinesterase activity determinations, 28*, 619–627.

Curl, H. (2002). Evaluation of Take-Home Organophosphorus Pesticide Exposure among Agricultural Workers and Their Children, *Environmental Health Perspectives*, *110*(12), 787-792.

Damalas, C.A. & Hashemi, S. M., (2010). *Pesticide risk perception and use of personal protective equipment among young and old cotton growers in northern Greece.* Greece: Academic press.

De Groote, H., Kimenju, S. C., Likhayo, P., Kanampiu, F., Tefera, T., & Hellin, J. (2013). Effectiveness of hermetic systems in controlling maize storage pests in Kenya. *Journal of Stored Products Research, 53,* 27–36. doi:10.1016/j.jspr.2013.01.001

El-Demerdash, F. M.; Yousaf, M.I. & Elagamy, E.I. (2001). Influence of paraquat, glyphosphate and cadmium on the activity electrophoretic behavior (in vitro) *Journal of.Environmental Sience Health*. *Part B., 36*, 29-42.

FAO. (1986). *Food and agricultural organization of the United Nation. International code of conduct on the distribution and use of pesticides*, Rome: FAO.

Gertrudis, C., Mario, V., Arnaldo, V., Viviana, D., Isolde, R., Nicolas, H. & Gloria, C. (2001).A rat mammary tumor model induced by the organophosphorus pesticidesparathion and Malathion, possibly through acetyl cholinesterase inhibition. *Environmental. Health. Perspective, 109*(5), 211-221.

Harper, H.A., Rodwell, V.W. & Mayers, P.A. (1997). *Review of physiological chemistry*, (23rd Ed.). Middle East: Academic Press.

Hayes, W., & Laws, E.R., (1991). *Handbook of Pesticide Toxicology General Principles*, New York: Academic Press

Hernandez, A, F., Gomez, M., Penan. A. G., Fernandez, Gil., Lourdes, R., Villanueva, E. & Antonio, P. (2004). Effect of long term exposure to pesticides on plasma esterases from plastic green house workers. *Journal of Toxicol*ogy *Environmental. Health.* Part A., *67*(14), 1095-08.

Hernandez, F.A.; Gomez, M.A.; Perez, V.G.; Lario, V.J.; Pena, G. & Gill .F. (2006). Influence of exposure to pesticides on serum components and enzyme activities of cytotoxicity among intensive agricultural farmers, *Environmental. Research*, *102*, 70-76.

Hillocks, R.J., Phiri, N.A. & Overfield, .D. (1999). Coffee pest and disease management options for smallholders in Malawi .*Crop protection, 18*, 199-206.

Hurtig, A.K., Sebastian, M.S., Soto, A., Shingre, A., Zambrano, D. & Guerrero, W. (2003).Pesticide use among farmers in the Amazon Basin of Ecuador. *Archives of Environmental .Health, 14*(58), 223-228.

Jeyaratnam, J. (1990). Pesticide poisoning: as a major global health problem. *World Health Statistics Quarterly, 43*, 139–44.

Jors, E,; Morant, R.E.; Aguilar, G. C.; Huici, L. F.; Baelum, J. & Konradsen, F. (2006).occupational pesticides intoxications among farmers in Bolivia a cross-sectional study. *Environmental. Health. Global Science, 5*, 10.

Kamal, F. & Hoppin, J.A. (2004). Association of pesticide exposure with neurologic dysfunction and disease. *Environmental. Health. Perspective*, *112*(9), 950-58.

Karabay, N.U.; Cakmak, B.; Saym, F. & Oguz, M.G. (2004). Risk Assessment of Organophosphate Pesticide Exposure on Greenhouse Workers in Menderes Region, Develi Village (Turkey). T. Klin. Tip. Bilimleri, 24., 6-11.

Kashyap, S.K., Jam, J.P., Sayyed, H.N., & Gupta, S.K. (1984). Clinical effects and cholinesterase activity changes in workers exposed to phorate (thimet). *Journal of Environmental Science Health B, 19*, 479-489.

Keifer, M., Rivas, F., Moon, J.D., & Checkoway, H. (1996). Symptoms and cholinesterase activity among rural residents living near cotton fields in Nicaragua. *Occupational Environmental of Medicine, 53*, 726-9.

Kenya National Bureau of Statistics. (2010). The 2009 Kenya Population and Housing Census, population distribution by administrative units volume 1 A, 148-149. Nairobi: Kenya National Bureau of Statistics.

Kimani, V.N., & Mwanthi, MA. (1995). Agrochemicals exposure and health implications in Githunguri location, Kenya. *East Africa Medical Journal, 72*, 531-535.

Konradsen, F., Van der Hoek, W., Cole, D.C., Hutchinson, G., 1 Daisley, H., Singh, S. & Eddleston, M. (2003). Reducing acute poisoning in developing countries-options for restricting the availability of pesticides. *Toxicology, 192,* 249-261.

Krishna, V. (2008). *Textbook of Forensic Medicine and Toxicology – Principles and Practice*, ($4^{th}$ ed.), London: Elsevier.

Litchfield, M.H. (2005). Estimates of acute pesticide poisoning in agricultural workers in less developed countries. *Toxicology Rev.*, *24*(4), 271-278.

London, L. & Bailie, R. (2001). Challenges for improving surveillance for pesticide poisoning: policy implications for developing countries. *International Journal of Epidemiology, 30,* 564-70.

Luginbuhl, RC. (2008). Heat-Related Deaths among Crop Workers--- United States, 1992-2006. *MMWR, 57*(24), 649-653.

Mancini, F., Van Bruggen, A.H.C., Jiggins, J. L.S., Ambatipudi, A.C., & Murphy, H. (2005). Acute pesticide poisoning among female and male cotton growers in India. *International. Journal .Occupational. Environmental. Health, 11*, 221-232.

Maroni, M. and A. Fait. (1993.) Health effects in man from long-term exposure to pesticides. A review of 1975-1991 literature. *Toxicology, 78,* 1-180.

Mason, H.J. (2000). The recovery of plasma cholinesterase and erythrocyte acetylcholinesterase activity in workers after over exposure to dichlorovos. *Occupational Medecine, 50*(5), 343-37.

Mbakaya, F.L. C., Ohayo-Mitoko, G.J.A, Ngowi, V.A.F., Mbabazi, R., Simwa, J.M., Maeda, D.N., Stephens, J. & Hakuza, H. (1994). The Status of Pesticide Usage in East Africa. *African Journal of Health Sciences, 1*, 37-41.

McCauley, A.; Linda, Anger, K.W.; Keifer, M.; Langley, R. & Robson, G.M. (2006). Studying health outcomes in farm worker populations exposed to pesticide. *Environmental Health Perspective, 1*(14), 6-8.

Michalek, J.E. Ketehun, N.S. & Longneeker, M.P. (2001). Serum dioxin and hepatic abnormalities in veteran of operation Ranch Hand. *Annals Epidemiology journal, 11*(5), 304-11.

Oerke, E. (2005). Centenary review crop losses to pests. *Journal of Agricultural Science, 144*, 31-43.

Oerke, E.C. (2002). Crop losses due to pests in major crops. In *Crop protection compendium 2002: Economic impact*. Wallingford, UK: CAB International.

Ohayo-Mitoko, G.J.; Kromhout, H.; Simwa, J.M.; Boleij, J.S. & Heederik, D. (2000). Self reported symptoms and inhibition of acetylcholinesterase activity among Kenyan agricultural workers. *Occupational Environmental Medical journal, 57*(3), 195-00.

Panieri, E, Krige, JE, Bornman, PC, & Linton, DM. ( 1997). Severe necrotizing pancreatitis caused by organophosphate poisoning. *Journal of Clinical Gastroenterology, 25*, 463–5.

Peter, E. (2003). The role of oximes in the management of organophosphorus pesticides Poisoning. *Oxicologyl. Rev., 22,* 165-190.

Prasit, K.,Nopporn, H., Dusit, S., Sukhontha, S. & Nawarat, S. (2010). Serum cholinesterase levels of Thai chilli-farms workers exposed to chemicals pesticides: Prevalence estimates and Associated Factors. *Journal of occupational Health,* 52, 89-98.

Quinlan, M., Mayhew, C., & Bohle, P., (2011). The global expansion of precarious employment. Work disorganization and consequences for occupational health: Placing the debate in a comparative historical. *International .Journal of Health Service, 31,* 507-36.

Regis, M., Bigboy, M., Simbarashe, R., Anderson. C., Nqobile, N., Mufuta, T., … &, Notion, G. (2011). Health effects of agrochemicals among farm workers in commercial farms of Kwekwe district, Zimbabwe .*Pan African Medical Journal, 9,* 26.

Reigart, JR. & Roberts, JR. (1999). In: Organophosphate Insecticides. *Recognition and Management of Pesticide Poisonings, 15,* 34-48.

Salvi, R.M.; Lara, D.R.; Ghisolfi, E.S.; Portela, L.V.; Dias, R.D. & Souza, D.O. (2003).Neuropsychiatric evaluation in subjects chronically exposed to organophosphate pesticides. *Toxicology Science, 72,* 267-71.

Sánchez, LH, Medina, OM., & Gómez, G., (2015). Laboratory genetic-based reference values for cholinesterase activity in a Colombian population. *Biomédica, 35*(Supl.2), 20-9 doi*: http://dx.doi.org/10.7705/biomedica.v35i0.2422*

Senanayake, N. (1998). Organophosphorus insecticide poisoning. *Ceylon Medical Journal, 43,* 22–9.

Singh, S. & Sharma, N. (2000). Neurological syndromes following organophosphate poisoning. *Neurol. India*., *48*, 308-13.

Smit, L.A.; Van-Wandel-de-Jodi, B.N. & Heedrik, D. (2003). Neurological symptoms among Srilankan farmers occupationally exposed to acetylcholinesterase-inhibiting insecticides. *American Journal of Industrial Medicine*, *44*, 254-64.

Srivirojana, N., Thepetepa,T., & Punppuing, S., (2005). Population pressure, utilization of chemicals in agriculture, health outcomes and solid waste management Proceedings: *International conference on integrated solid waste management in South East Asia Cities* Retrieved from: http://www.sea-uema.ait.ac/th/ARL/conf_July05_ISWM/ProcceedingsPg .html

Strong, L., (2008). Factors Associated With Pesticide Safety Practices in Farmworkers. *American Journal of Industrial Medicine, 51. p. 69-81.*

U.S. Environmental Protection Agency. (2008). Agriculture: Pesticides. Retrieved from: *http://www.epa.gov/agriculture/tpes.html*

United States Environmental Protection Agency (US EPA). (200). Organophosphate pesticide information: overview of Malathion risk assessment. Retrieved from: http://www.epa.gov/pesticides/op/malathion.htm.

Wesseling, C.; Aragon, A.; Castillo, L.; Corriols, M.; Chaverri, F.; de la Cruz, E., …& van Wendel de Joode, B. (2001). Hazardous pesticides in Central America *International Journal of Occupational Environmental Health, 7*, 287-294.

Yassin, M.M., Abu Mourad, T.A., & Safi, J.M., (2002). Knowledge, attitude, practise and toxicity Symptoms associated with pesticide used among farm workers in the Gaza strip. *Occupational Environmental medicine*, *59*, 387-93.

## APPENDICES

### Appendix 1: Questionaire

Factors Associated with Serum Cholinesterase Levels among Farmers in Keiyo District

**Identifying information**

Questionnaire Number……

Interviewer (a) Name …….

(b) Mobile Number…….

Date of the interview……DD/MM/YY

**Part I. Socio-Demographic Factors**

---

1.0 Sex

□ 1 Male (*Sang*) □ 2 Female (*Ko*)

1.1. Age……years (*Kenyisiek)*

1.2 Residence (*Mengisiet)*

□1 Division----------

□ 2 Location----------

□ 3 Village ----------

1.3. Marital status (*Katunisiet*)

□ 1.Single □ 2 Married

□ 3Widowed □ 4 Divorce/separated

1.4. Highest level of formal education (*Somanet)*

□ 1.No formal education □ 2 Primary school

□ 3.Secondary school □ 4 Tertiary

1.5 Religion (*Kayanet)*

□1.Christian □2.Muslim □3 Hindu

□ 4 Traditional African □5.others, specify……..

1.6 Occupation (*Boisiet)*

□ 1 Farmer □ 2 Causal Laborer

□ 3.Business □ 4.Government officer

□ 5. Salaried Employee □ 6Housewife

□ 7.Student □ 8.Unemployed

□ 9 other, specify……..

1.7 Please state the family's average monthly income in shillings (*Kaikai onyoru chepkondok ata eng arawet?)*

□ 1 Less than 10,000 □ 2 . 10,001 – 20,000 □ 3 More than 20,000

1.8 During the past 3 months, have you been exposed to pesticides? (*Eng arawek somok che kikosirto tos kiboisien kerichek alak tukul?)*

□ Yes □ No

1.9 If yes, how? (*Ngo wei,kiboisiete ano?)*

□ 1 .loading pesticides (*Loisiet)* □ 2 Spraying pesticides (*Kesut)*

□ 3 visiting the farms after spraying(*Kiwe mbaret ne kikesut)* □ 4 Mixing pesticides*(Kiburuch kerichek)*

□ 5 other, specify……..

1.10. During the past 3 months, have you experienced the following symptoms after exposure to pesticides? (multiple response) (*Eng arawet somok chotok tos kiimyande ano?)*

1. 10.0 Headache (*kiamin metit)* □ 1. Yes □ 2. No

1.10. 1 Dizziness ( *kenyalul)* □ 1. Yes □ 2. No

1.10. 2 Cough / Breathlessness / Chest pain □ 1. Yes □ 2. No

*(kiilal /kiitikis/kiamin teket)*

1.10.3 Weakness *(kiichas)* □ 1. Yes □ 2. No

1.10.4 Excessive sweating (*kiot missing)* □ 1. Yes □ 2. No

1.10.5 Burning sensation in face *(kilal toket)* □ 1. Yes □ 2. No

1.10.6 Itching / Skin irritation *(kiikutkei)* □ 1. Yes □ 2. No

1.10.7 Burning sensation in skin *( kiikut makatet)* □ 1. Yes □ 2. No

1.10.8 Nausea and vomiting *(kimilamilin ak king'ung'u)* □ 1. Yes□ 2. No

1.10.9 Abdominal pain / Diarrhea *(kiamin moet/kimandaenen)* □ 1. Yes□ 2. No

1.10.10 Fever (*kiet mat)* □ 1. Yes □ 2. No

1.10.11 Eye irritation (*kiamin konyek)* □ 1. Yes □ 2. No

1.10.12 other, specify (*Alak)*…….....

1.11. If reply to Q.11 is yes, where did you go for medical services? (Multiple responses) *Ngo kiimyan,kinyorchi ano kanyaet)*

□ 1 Non □ 2 Health centre

□ 3 Private clinic □ 4.Public / private hospital

□ 5.Other, specify……

1.12. Outcome of the treatment?(*Tos kiwalak borto)*

□ 1 Better (*kararan)* □ 2 same (*mawalak)*

□ 3.Getting worse (*kiyaiit)* □ 4.Other, specify……

**Part II Pesticide use behaviors**

2.0. Type of your work regarding pesticide use? (*Nee boisingung eng boisietab kerichek chu)*

□ 1.Permanent □ 2.Temporary

□ 3 ever, but now quit using pesticides

2.1. How long have your been using pesticides……..……..years…….……months

*(Kongete auyo iboisie keriche chu?..…….. kenyisiek ……..... araosiek)*

2.2. Frequency of pesticide use per month……..time(s).(Mara ata eng arawa)

2.3. Please specify the trade name of three months most often used pesticides?

*(Kerichek ngorcho che ibosie eng arawek somok)*

( Please tick √ in the item as appropriate)

| Number | Trade name |
|---|---|
| | Okor |
| | Cyclone |
| | Diazinon |
| | Dimethoate |
| | Malathion |
| | Bulldock |
| | Duduthrin |
| | Polythrin |
| | Steladon |
| | |
| | |
| | |
| | |
| | |

**Practices towards pesticides: preparing, spraying and re-entry interval**

| Item | Always | Sometimes | Never |
|---|---|---|---|
| 2.4. Before preparing pesticides do you carefully read and understand all the instructions(*Tos isomani ng'alekab kerichek kotomo ibosien)* | | | |
| 2.5. The concentration of pesticides use are*:(kimnatet ab kerichek)* | | | |
| 2.5.1 Only one, no mixed(*Agenge,mokiburchi)* | | | |
| 2.5.2 Mixed with other pesticides(*kiburuchi ak kerichek alak)* | | | |
| 2.5.3 Mixed with herbs *(kiburktoi kerich kab gaa)* | | | |
| 2.6 Which of the following do you wear during Preparation of pesticides? (*Ilochi nee ye iburuchi kerichek ab kutik)* | | | |
| 2.6.1 Gloves | | | |
| 2.6.2 Mask | | | |
| 2.6.3 Goggles | | | |
| 2.6.4 Boots | | | |
| 2.6.5 Long sleeves shirt and trousers | | | |
| 2.6.6 Hat | | | |

| | | | |
|---|---|---|---|
| 2.7. Do you strictly follow the bottle - affixed label of pesticides use(*Tos isubi kaororetab kerichek chekikigon)* | | | |
| 2.8. Your practices during spraying pesticides? (*Boisionik ye isutishe kerichek)*<br>2.8.1 Wearing gloves | | | |
| 2.8.2 Putting on nasal masks | | | |
| 2.8.3 Using goggles | | | |
| 2.8.4 Wearing special boots | | | |
| 2.8.5 Wearing long sleeves shirt and trousers | | | |
| 2.8.6 Putting on hat | | | |
| 2.8.7 Smoking | | | |
| 2.8.8 Drinking | | | |
| 2.8.9 Eating | | | |
| 2.8.10 Chewing gum | | | |

| Item | Always | Sometimes | Never |
|---|---|---|---|
| 2.9. What do you do after spraying? (Iaenee yaitar ipitisiei)<br>2.9.1 Instantly wash hands by clean water(*Tos iunee eunek beeg eng chokchinet)* | | | |
| 2.9.2 Instantly wash hands by soap or bath Cream(*Tos iune subunit ak krimet*) | | | |
| 2.9.3 Instantly take a shower (*iunikei eng chakchinet)* | | | |
| | | | |
| 2.10. After the field has been sprayed pesticides, do You re- enter it to work? (*Tos iwendi mbar ko kakesut)* | | | |
| 2.11. What do you do with the empty pesticides Bottles or cans? *(iitaine chuboisiek che kakobek kerichek)*<br>2.11.1 Store water (*indai beek)* | | | |
| 2.11.2 Store food stuff *(indai amitwokkik*) | | | |
| 2.11.3 Store other chemical substance (i*ndei kerichek alak)* | | | |
| 2.11.4 Throw it into the garbage sites(*iwirchini kab takataka)* | | | |
| 2.11.5 Bury the empty pesticides bottles or Cans *(itupe)* | | | |
| 2.11.6 Burn the empty pesticides bottles or Cans *(ibele)* | | | |
| 2.12. Do you normally wash your fruits or vegetables after picking them from the field? *(Tos iuni lokoek anan ingwek yekakibut eng imbar)* | | | |

**Part III Knowledge of pesticide use**

**Instruction**: Please tick (√) in the item as appropriate

| Item | Yes | No |
|---|---|---|
| 3.0. Route of entry into the body (*chuitoi anoborto kerichek* )<br>3.0.1 Inhalation *(ng'uiset)* | | |
| 3.0.2 Skin *(makatet)* | | |
| 3.0.3 Mouth (*Kutit)* | | |
| 3.1. The adverse health effects of the pesticides.(*Ngemisietab kerichekkab kutik)*<br>3.1.1 Headache / Dizziness (*metit/kenyalul)* | | |
| 3.1.2 Excessive sweating (*kiot)* | | |
| 3.1.3 Cough / Chest pain / Breathlessness*(kelal/Ngwan teket/ketikis)* | | |
| 3.1.4 Weakness(*kechas)* | | |
| 3.1.5 Itching / Skin irritation *(koutut makatet)* | | |
| 3.1.6 Burning sensation in skin *(lalet ab makatet)* | | |
| 3.1.7 Nausea / vomiting *(keulaul/king'ung')* | | |
| 3.1.8 Abdominal pain / Diarrhea *(Ngwonindoab moet/kounkeei*) | | |
| 3.1.9 Fever (*matab borto)* | | |

| | | |
|---|---|---|
| 3.1.10 Memory loss *(keutye)* | | |
| 3.1.11 Eyes irritation (*Ngwani ndab konyek)* | | |
| 3.2. Long term exposure to pesticides has a chance to get the Following diseases? (*Nge boisien kerichek koek keny kemuch kenyor)*<br>3.2.1 Cancer *(seriat)* | | |
| 3.3.2 Respiratory diseases ( *miandab kabuset)* | | |
| 3.3.3 Neurological system diseases (*miandab* | | |
| 3.3.4 Skin diseases (*miandab makatet)* | | |
| 3.3. Pesticides residue may exist in the following places? *(Imuchi konget kerichek eng)*<br>3.3.1 The air (*koristo)* | | |
| 3.3.2. The soil*(ng'ung'unyek)* | | |
| 3.3.3 Ground water *(bekab ing'ony)* | | |
| 3.3.4 Fruits, seed and leaves of vegetables (*lokoek,keswek kab sakekab ngewek)* | | |
| 3.4. Alternative pest control other than pesticide use?(T*os kimuchi keboisiek tukuk alak kou)*<br>3.4.1 Biological control | | |
| 3.4.2 Natural control | | |

| | | |
|---|---|---|
| 3.4.3 Using agricultural ways for pest control | | |
| 3.5. Checking the spraying equipments in good condition before Using (*Tos ichikili tukuk che kisutisieni kotomo iboisien*) | | |
| 3.6. For safety when using pesticides, do not spray against the wind (*ng'isute kerichek matitarchi koristo)* | | |
| 3.7. Where do you store empty pesticides bottles or cans? *(ikonortoi ano chuboisiekab kerichek)* 3.7.1 In specific store for away from children and pets *(Eng stoo ole mami lakok)* | | |
| 3.8 In the home with other instruments *(Eng gaa ole momi tukuk alak)* | | |

**Part IV. Perception of pesticide use**

**Instruction**: Please tick (√) in the appropriate box

| Item | Always | Sometimes | Never |
|---|---|---|---|
| 4.0. Agriculturalist have a chance to suffer from chemical pesticides *(kabotik komuch konyor mienwokikab ab kerichek)* | | | |
| 4.1. Agricultural family members have a chance to suffer from chemical pesticides toxicity (*Tilionutik ab kabotik komuch konyur mienwokikab kerichek)* | | | |

| | | | |
|---|---|---|---|
| 4.2. Long time exposure to pesticides may cause diseases such as leukemia, cancer (*Ngeboisisie kerichek koek keny kemuch kenyor seriatab korotik)* | | | |
| 4.3 Toxicity of pesticides may cause death *(ibu meet)* | | | |
| 4.4 Using chemical protection equipments while spraying can protect your exposure to chemicals (*Ngiboisien tukuk chekiribekei komenyorn myonwokik)* | | | |
| 4.5 Strictly adhering to chemical use instruction can reduce the risks and danger from chemical use (*Ngesub arorutikab kerichek komakinyorn myonwokik)* | | | |
| 4.6. Using chemical protection equipments while spraying increases the investment cost (*Ngeboisie tukuk chekiribekei kotesei chepkondok* | | | |
| 4.7. Using chemical protection equipments causes difficulty and feeling uncomfortable while working *(Ngeboisie tukuk che kiribeikei kesutishei kokonu kaimetabkei)* | | | |

**Part V. Blood test**

**Instruction**: Please indicate serum cholinesterase levels.

---

Serum Cholinesterase levels…….IU/L

**Appendix 2: Informed Consent form for adults over 18 years**

**Factors associated with Serum Cholinesterase Levels among Farmers in Keiyo District.**

**INTRODUCTION**

Dear Participant.

My name is Rosebella Rotich from the ministry of Health, Kenya and this is a consent form which provides information that you need to understand about this study. You are free to ask questions and to freely accept or decline to participate in this study. If you choose to be part of this study, I will take 20 minutes of your time. You are free to exit the study at any point.

1. **What you Need to Know?**

We are carrying out a study to assist us find out factors associated with Serum Cholinesterase Levels in Keiyo District. To get this information we are going to ask you some questions concerning your health and socio-economic issues. We will also carry out a laboratory test to determine the level of serum cholinesterase in your blood as an indicator of pesticide toxicity.

**2. How do you consent?**

The participant will read and understand the content of the consent form and sign or verbally agree to participate in the study.

**3. Benefits from being in this study;**

The results of this study will lead to understanding the factors that are associated with organophosphate toxicity with a view of informing the two ministries of Agriculture and

Health on mitigating measures to be adopted to reduce the adverse effects of organophosphates.

**Risks from being in this study;**

There are no risks to you being part of this study. You have the right to refuse or stop participating at any time. The facts about you or your family member from this study will be kept private. No names will be used in any study reports. If you feel like you or your family might be harmed by being in this study please contact **The Secretary Kemri National Ethics Review Board, on 0202722541 or P.O. Box 54840-00200 Nairobi or Rosebella Cheptoo Rotich, Principal Investigator on 0723894879.P.O Box 309.ITEN**

**Consent signing**

This consent form has been explained to me and I agree to take part in the study. I understand that I am free to choose not to take part in this study at any time and that saying "NO" will have no effect on me.

**Participant**

Name

_____Signature_____Date_____

**Name of person explaining Consent**_____

Signature _____Date _____

Thank you.

**Appendix 3: Consent Form for Adults over 18 years in Kalenjin**

Eng Kayanindet,

Kikureno Rosebella Rotich nebo ministi nebo tililindo.Amache asom kipagen'geigwon'g eng' somanetab kaeretet ak' kiit neae kericheck chekipite minutik, kun'gem biko chepoishe kerichek choto eng' Keiyo District. Nigo, fomit nebo kayanet nemwou agobo kekuyo akobo somanet. Inyalunot iteb teputiet ago imuchi iyan anan itaii ichut somanet.kiayan somanani asute dakikak 20 anyiit kayanutik kuk'.

1. **<u>Tuguk chemagat inai</u>**

   Kimi keae somanet ne toretech kenai kaeretet ak tuguk chenamekei ak boisionikab kerichekab minutik eng keiyo district. Sikenyor wolutik, ketepenok teputik akobo poisionikuk chebo kotugul. Kipimoni kora koratik sigenai aliteno kericheck eng' borton'gung.

2. **<u>Iyondoi Ano?</u>**

   Isomani ak iguye ngalechu, ak itep nda iyani kochut somanani?.

3. **<u>Melekto nebo somanani</u>**

   Eng' Somanani kotoreti kenai akobo tuguk cheyai kericheck kongem sopet, asi, ketoret kapkrikacha ak kaptilinto eng tuguk cheistoi kewelutikab kerichek.

4. **<u>Kewelutikap ichut somanani</u>**

   Momi kewelutik alak tugul, ako kora itinye imanit iyan anan itai eng kasarta agetugul. N'galek tugul cheguk ak chebo koingung komokishartoi. Ko ngitinye

tebut aketukul imuchi itepe. “**The Secretary Kemri National Ethics Review Board, eng’ 0202722541 anan P.O. Box 54840-00200 Nairobi anan Rosebella Cheptoo Rotich, eng’ 0723894879.P.O Box 309.ITEN”**

5. Kakemwoiwo ngalechu tugul ako kaayan achut samanet anegei amesumnjo chi.

**kayanindet:**

Kainet:_____Tepenet_____Tarikiit_____

**Kainetab chito ne inetisiei**_____

Tepenet_____Tarikiit_____

Kogoi .