JIMMA UNIVERSITY

INSTITUTE OF HEALTH SCIENCE

FACULTY OF PUBLIC HEALTH

DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCE AND TECHNOLOGY

Assessment of Pesticides Utilization and Occupational Exposure among Small Scale Farmers in Kellem Wellega, Western Ethiopia

BY

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A THESIS SUBMITTED TO JIMMA UNIVERSITY INSTITUTE OF HEALTH SCIENCE, FACULTY OF PUBLIC HEALTH, DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCE AND TECHNOLOGY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR MASTER DEGREE IN ENVIRONMENTAL HEALTH

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Thesis Submission for External Defense Request

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I have incorporated the suggestion and modifications given during the internal thesis defense and got the approval of my advisors. Hence, I hereby kindly request the department allow me to submit my thesis for external thesis defense.

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We, the thesis advisors have verified that the student has incorporated the suggestion and modifications given during the internal thesis defense and the thesis is ready to be submitted. Hence, we recommend the thesis to be submitted for external defense.

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Decision /suggestion of the Department Graduate council (DGC)

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LISTS OF ABRIVIATIONS AND ACRONYMS

CI	Confidence Interval
DDT	Dichlorodiphenyltrichloroethane
EDHS	Ethiopia Demographic and Health Survey
HHs	House Holds
IPM	Integrated Pest Management
KW	Kellem Wellega
KWD	Kellem Wollega District
KWZ	Kellem Wellega Zone
LD	Lethal Dose
ME	Marginal Error
MoA	Ministry of Agriculture
PPE	personal Protective Equipment
SPSS	Statistical Package Software for Social Science
SSF	Small Scale Farmers
SSIF	Small Scale Irrigation Farm
WHO	World Health Organization

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Abstract

***Background:* -** *Pesticides in Ethiopia are extensively used for pest and plant disease control. Even if the amount is fluctuating across the type of pesticides the country imports 3,346.32 tons of pesticides annually. Due to pesticides over use and misuse in small scale farming occupational exposure of farmer increases from time to time in Ethiopia.*

***Methods:* -** *A community based cross sectional study was conducted by involving 249 households from Seden-Chanka, Hawa-Gelan and Seyyo districts in Kellem Wellega zone Ethiopia. Data collection was conducted by administration of a pretested standardized questionnaire in all study districts on 6% of the samples. Purposive and random sampling techniques were employed. Data was encoded by using Microsoft Excel spread sheet and analyzed by SPSS version 21 software computer package. Frequency, mean, standard error and Chi-square test were used for analysis of the data. P-value < 0.05 at 95% confidence interval was considered as statistically significant.*

Objective*: - The general objective of this study is to assess pesticides utilization and occupational exposure of small scale farmers in Kellem Wellega, Western Ethiopia 2019.*

***Result:* -** *The finding of the present study revealed that, farmers pesticide utilization was 87.15%. The types of pesticides commonly used by small scale farmers were 2, 4-D, Glyphosate, Malathion, Mancozeb, Diazinon and DDT. Organophosphate and Organochlorine were the major reported chemicals used by farmers. The mean amount of pesticide used was 3.45 liter (95 % CI 3.27-3.63) and the mean exposure time was11.43 hour (95 % CI 10.83-12.03) per year respectively. Only 8 (3.2%)of the respondents followed labeling instruction and 40 (16%) of the farmers attended training. 39 (15.6%) of the farmers mix pesticides on the farm field. 48 (19.2%) of the farmers stored pesticides in separate places, while 209 (84%) of the farmers did not use any type of PPE. There was significant association between amounts of pesticides used (χ^2=15341.1, P=0.0011), frequency of use (χ^2=147.797, P=0.001), duration of use on pesticides (χ^2=153.132, P=0.001) and training of farmers on pesticides (χ^2=8.474, P=0.004) and the occupational exposure of farmers.*

Conclusion: *in conclusion, the present study found a wide utilization and high potential for pesticide exposure due to use and misuse of pesticide. Therefore, significant levels of pesticide exposure among farmers can be concluded. Due to pesticides exposure different symptoms were seen on farmers and there was significant association between the use of pesticides as risk factors and the occupational exposure of farmers. A strong coordination between Ministry of Agriculture, Ministry of Health and Environmental Protection Authority of Ethiopia and pesticide sellers is very important for the safety of farmers.*

Keywords: *Small scale, Farmers, Prevalence, Exposure, Kellem, Wellega.*

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Ethiopia is one of the fastest growing African countries both in terms of economy and population. It is estimated that 96.6 million (85%) of population in the country living in rural areas and depends on agriculture to full fill their basic needs. Accounts for about 47% of gross developmental production (GDP) and 85% of export revenue is generating from agriculture sector. The sector greatly contributes to the overall food needs of the country and delivers the national industry with agricultural raw materials. In Ethiopia there has been a great growth in agricultural production on small scale and large scale farms to ensure food security, eradicate poverty and increase national income through exporting agricultural commodities (Negatu *et al.*, 2018). The sector also continues to dominate the economy for a long time in the future. It is thus, obvious that productivity of agricultural sector, especially small holder agriculture largely depends on substantial inputs of chemical pesticides.

Pesticides are any chemicals or their mixture that are used for prevention, destruction or controlling of pests including vectors of either human or animal diseases and unwanted plant or animal species that may interfere with the production, processing, storage or transport of food. It helps to increase crop yields and improve agricultural product quality. Pesticides are produced through very strict regulation processes to function with reasonable certainty and minimal impact on human health, thoughtful concerns have been raised about health risks resulting from occupational exposure and from residues in drinking water and food (Hamilton, 2004).

Numerous pesticides including organochloride, organophosphate, carbamate, and Pyrethroid are used for the purpose of controlling insect, fungus, weed and for other purpose. Organochlorine pesticides 2, 4-D and organophosphate pesticide, Glyphosate was the most commonly used pesticides which were used in liquid form. Diazinon and Malathion were an organophosphate pesticide which used in liquid form. Dichlorodiphenyltrichloroethane (DDT) was an organochlorine pesticide which was used in powder form to control insects after crop harvest by the farmers. Pesticides are commonly used in vegetable, citrus, cereal and other crop-growing areas to maximize agricultural productivity. Though, most of the pesticides are not only specifically targeting the pest, but also they affect non-target plants and animals including human being during their application

(Hiluf and Abebe, 2015). The governments of most developing countries strongly encouraging the use of different types of Pesticides in order to control pests and plant and animal disease to increase agricultural production. Pesticides are one of the vigorous inputs in agriculture to protect loss of production, (Negatu *et al.*, 2018).

In Ethiopia pesticides use to control pests starts since 1960's, even if the amount is fluctuating across the type of pesticides the country imports 3,346.32 tons of pesticides annually (Begna, 2014). Utilization of pesticides is highly increased following modern agriculture and areas with high crop farming parts of Ethiopia are annually receiving different types and amounts of pesticides (Amera and Abate, 2008).

Farmers usually handle pesticides without following the instructions on the label, and are involved in loading, mixing or spraying the pesticides without the use of personal protective equipment (PPE). In addition there is a discrepancy between perceptions of safe pesticides use and agricultural productivity (Lu, 2017).

Occupational pesticide exposure can occur either directly or indirectly. It occurs directly during loading, mixing and pesticide application and indirectly while accomplishing re-entry tasks in pesticide treated crops or by take home exposure. Pesticide exposure can occur through the mouth (ingestion), via the skin contact (dermal uptake) and the respiratory system (inhalation). Pesticide exposure may result in health effects such as respiratory effects, endocrine disruption, ocular, dermal, cardiovascular, gastrointestinal, carcinogenic, developmental and neurological (Amera and Abate, 2008).

In Ethiopia, little is known about the chronic effects of pesticides on rural communities. Repeated application of pesticide brings damage of biodiversity. Many pesticides are not easily degradable, they persist in soil, leach to groundwater and surface water and contaminate wide environment. Depending on their chemical properties they can enter the organism, bioaccumulation in food chains and therefore influence also human health. In our country, occupational exposure of farmers increases in the case of not giving attention to the instructions on how to use the pesticides due to the fact that labels on pesticide containers were in a language which cannot be understood by the users and mostly when they ignore basic safety guidelines on the use of personal protective equipment (PEP) and fundamental sanitation practices such as washing hands after pesticide handling or before eating, washing body, changing cloths after application. Repeated application of pesticide brings damage of biodiversity. Many pesticides are not easily degradable, they persist in soil, leach to groundwater and surface water and contaminate wide environment. Depending on their chemical properties they can enter the organism, bioaccumulation in food chains and therefore influence also human health. It is important to assess the effect of increasing utilization of pesticides and to identify and predict mitigation measures. Little is known about the chronic effects of pesticides on rural communities (*Hiluf and Abebe, 2015).*

1.2. Statement of the Problem

Ethiopia's frequently food insecure population, is increasing from time to time. The increments, which is estimated to be about five million, has continued to rise as the annual population growth of 2.9% exceeds the average annual 2.4% increase in agricultural production. Usually during good years with normal rainfall, an average of about five million people is food insecure (Amera and Abate, 2008).

The challenge of providing adequate food will remain one of the most pressing and critical problems in Ethiopia. This is an alarming situation calling for an integrated approach towards increasing food production, yield, and protection both in the field and after harvest. On the contrary, the efforts to increase food production and protection should be in a way that does not upset public health and the environment harmfully. WHO had estimated that a million people were being poisoned by pesticides every year with 20,000 cases resulting in death (Idayu *et al.*, 2014). According to a survey of self-reported minor poisoning from pesticides, there could be as many as 25 million agricultural workers in the developing world suffering an incident of pesticide poisoning each year (Begna, 2014) and it results in 300,000 deaths annually by acute poisoning of pesticide (Bagheri *et al.*, 2018). However, in Ethiopia impact of pesticides to a given locality (environment) has not been clearly identified, assessed and compiled. Moreover there is no system for risk monitoring and communication.

According to a study held, in the rift valley of Ethiopia 94.3% of the farmers used pesticides as part of their agriculture input and 28.7 % of the farmers use banned pesticides like dichlorodiphenyltrichloroethane (DDT) for Agriculture. In addition organochlorides like endosulfan is used in small scale irrigation farms in Ethiopia on vegetables albeit illegal (Negatu *et al.*, 2018).

A study conducted in Ethiopia shows, that farmers and farm workers had limited knowledge on pesticide hazards and inadequate awareness about safe pesticide management (Negatu *et al.*, 2018). Only about 25% of the small scale irrigation farming (SSIF) workers usually read the pesticide label and none of them use scaled measuring equipment that are important as to adhere to the recommended dose of pesticides, which can result in very high exposures if used over the recommended amount. About 31% of the farmers stored pesticides anywhere in the house and about 6% of them stored pesticides even in the kitchen. About 50% of the farmers used empty pesticide containers for water and/food storage and about 7% of them indicated that they sell empty containers for others to use. Generally they experienced poor hygienic and sanitation practices that lead them highly exposed to pesticides (Negatu *et al.*, 2018); alongside which the occurrence of illness after spraying pesticide and within the family of a health related pesticide incident is 31% and 14.2% respectively (Amera and Abate, 2008).

Majority of the farmers in Ethiopia do not properly look for protective measures and there is a negligible use of protective equipment, among small-scale farmers. Except for the use of some sort of head covering, hand kerchiefs, eye goggles (5%) and respirators (10%), there was no complete PPE use by any of applicators in small scale irrigation farming (SSIF), mostly exposing their face, hands, palms and their fingers (Negatu *et al.*, 2018). It is therefore essential to make the affected community members could understand the impact of pesticides to human health and the surrounding environment as well as mechanisms by which affected community exposed to pesticides.

Therefore, the aim of this study is, to assess farmers pesticide utilization and occupational exposure of small scale farmers in Kellem Wellega, Western Ethiopia.

1.3. Significance of the Study

This study brings information on the pesticide use, occupational exposure of small scale farmers and, Socio-demographic and exposure risk factors. The study helps the society, the government, different levels of stockholders and other researchers as a baseline for the evaluation of activities performed and for next intervention plan for the Kellem Wellega western Ethiopia. The study is useful to improve farmer’s knowledge on safe use of pesticide. The knowledge may be useful to guide the design alternative pest management strategies like IPM program in the Ministry of Agriculture (MoA), and any organization that intends to design intervention program in Kellem Wellega.

CHAPTER TWO

LITERATURE REVIEW

2.1. Farmers Pesticides Utilization

In Ethiopia pesticides use to control pests starts since 1960's, even if the amount is fluctuating across the type of pesticides the country imports 3,346.32 tons of pesticides annually (Begna, 2014). Utilization of pesticides is highly increased following modern agriculture and areas with high crop farming parts of Ethiopia are annually receiving different types and amounts of pesticides (Amera and Abate, 2008). Farmers usually handle pesticides without following label instructions, and are involved in loading, mixing or spraying the pesticides without the use of personal protective equipment (PPE). In addition there is a discrepancy between perceptions of safe pesticides use and agricultural productivity (Lu, 2017).

Numerous pesticides including organochloride, organophosphate, carbamate, and Pyrethroid are commonly used in Ethiopia on vegetable, citrus, cereal and other crop-growing areas to maximize agricultural productivity. Though, most of the pesticides are not only specifically targeting the pest, but also they affect non-target plants and animals including human being during their application (Hiluf and Abebe, 2015).

According to a study held in the rift valley of Ethiopia 94.3% of the farmers used pesticides as part of their agriculture input and 28.7 % of the farmers use DDT for Agriculture (Amera and Abate, 2008). The types of pesticides used by the farmers in Ethiopia are insecticides (37.6%), fungicides (17.8%) and herbicides (31.5%) with the remaining 3.1% being rodenticides. From the pesticides used by farmers in Ethiopia 93.26% used for weed control, 89.93% used for insect pest control, 37.50% used for fungi/molds/rust control, 13.544% used for rodent control, 24.31% used for veterinary uses and 1.74% indicated that they use it for other purposes. The findings of different studies showed that the overall prevalence of pesticide utilization is highly increasing in our country and around the world. The previous findings of (Hiluf and Abebe, 2015; Tahir *et al.*,2006) reported that, the prevalence of pesticides utilization was 100% and 93% in studies conducted in Amhara region Shoa zone and in Pakistan respectively. The previous finding of (Mengistie *et al*., 2017; Amera and Abate, 2008) showed that, the prevalence of pesticides utilization was 94.3% and 94.3% in studies conducted in central rift valley of Ethiopia and Ziway and Arsie Negele woredas respectively. The prevalence of pesticides utilization was 83.3 % and 82 % in studies conducted in Jimma zone and Bulehora Borena zone respectively (Gesesew *et al.*, 2016; Ligani, 2016).

2.2. Common Pesticides used in Ethiopia

According to its chemical structure, pesticides are classified into different families, ranging from organochlorine, organophosphorus, Carbamates and Pyrethroids (WHO, 2009).

2.2.1. Organochlorine

Organochlorine pesticides are stable compounds are too persistent in the environment and tend to accumulate in fatty tissue. Many of these pesticides are now banned for use in the in developed countries. However, some of these insecticides are still used in other countries and are illegally brought into the developing countries. Its main use is in the eradication of disease vectors such as malaria, dengue and malaria. They are also used in cultivation and preservation of grapes, lettuce, tomato, alfalfa, corn, rice, sorghum, cotton and wood. They are also used in cultivation and preservation of grapes, lettuce, tomato, alfalfa, corn, rice, sorghum, cotton and wood.. Its way of exposure is mainly on insects by contact or by ingestion.. In general, these insecticides affect the central nervous system and, depending on the compound, can depress or stimulate the central nervous system. This pesticide family includes Aldrin, Chlordane, DDT, Dieldrin, Heptachlor, Lindane and Toxaphene. Symptoms may include mild exposure - nausea, vomiting moderate exposure - restlessness, tremors (shakes), apprehension (fear), convulsions severe exposure - coma, respiratory failure, death. (Garcia *et al.*, 2012).

2.2.2 Organophosphates

Organophosphates are esters derived from phosphoric acid. These pesticides are cholinesterase inhibitors (nerve poisons) and range in toxicity from mild to acutely toxic. For the most part, these pesticides break down rapidly in the environment. This family of pesticides includes: Chlorpyrifos (Dursban), diazinon, Malathion, methyl parathion, and triehlonfon. Symptoms may include; Mild exposure headaches, dizziness, weakness, anxiety, nervousness, impaired vision. Moderate exposure causes nausea, salivation (slobbering), watering eyes, abdominal cramps, vomiting, sweating, slow pulse, muscular tremors. Severe exposure causes diarrhea, constricted and nonreactive pupils, vision or respiratory difficulties, cyanosis (bluish color to face and hands), loss of bowel and bladder control, convulsions, coma and death (WHO, 2009).

2.2.3 Carbamates

Carbametes are esters derived from acids or dimethyl N-methyl carbamic acids are used as insecticides, herbicides, fungicides and nematicides. They are less persistent than organochlorines and organophosphates. These pesticides are also cholinesterase inhibitors (nerve poisons) and range in toxicity from low to mild toxicity. This pesticide family includes carbaryl (Sevin), dimetilan, landrin, carbofuran and methiocarb (Bay 37344). Symptoms may include mild exposure (constricted pupils, salivation or slobbering, profuse sweating); moderate exposure (fatigue, uncoordinated muscles, nausea, and vomiting) and Severe exposure (diarrhea, stomach pain, tightness in the chest) (Garcia *et al.*, 2012).

2.2.4 Pyrethroids

Pyrethroids are originated from natural insecticide derived from pyrethrum extract derived from chrysanthemum flowers, known as pyrethrins. Subsequently were obtained synthetically and are presently manufactured around 100 different commercial products (WHO, 2009).

2.3. Human Exposure to Pesticides

Exposure to pesticide and other agrochemicals constitutes a major occupational hazard accounting in some countries as much as 14% of all occupational injuries in agricultural sector and 10% of all total injuries. Hazardous occupations include pesticide mixers, loaders, flaggers for areal applications, applicators or (spray men), emergency response personnel, manufacturers and supervisors. Human exposure to pesticides may occur through occupational exposure in the case of agricultural workers in open fields and greenhouses, workers in the pesticide industry, and exterminators of house pests (Soares and Porto, 2009).

2.3.1 Sources of exposure to pesticides

The environment is a major source of exposure to pesticides from farming. Approximately 47% of the applied product is deposited at or adjacent soil and water is dispersed in the atmosphere. This situation depends on weather conditions such as rain and wind direction and intensity, of geological and soil type and the presence of water currents, and other factors such as the formula and product presentation (liquid, powder, gel, gas, etc.) and application technique (air, land, etc.). Strong winds, high temperatures and unstable terrain favor the drag of the product and the presentations powder, aerosol or smoke and, of course, aerial applications. Other phenomena that favor environmental dissemination are photo degradation and volatilization, and leaching and washing soil surface, both related to the flow of water and rain. Work activity is important as a source of pesticide exposure in agricultural workers and their families. All those who mixed, transported, loaded, stored or apply pesticides. The level of exposure and the likelihood of acute poisoning in these groups are substantially higher for continuous close contact with the chemicals. Although the period of contact with the agent are relatively short, they are still intense and repeated during the working day, causing toxic effects that vary with the type and amount of pesticide to which he was exposed, being relatively infrequent episodes of such accidental or intentional (Lu, 2009).

Occupational pesticide exposure can occur either directly or indirectly. It occurs directly during loading, mixing and pesticide application and indirectly while accomplishing re-entry tasks in pesticide treated crops or by take home exposure. Agricultural workers who mix, load, transport and apply formulated pesticides are normally considered to be the group that will receive the highest exposure because of the nature of their work and are therefore at highest risk for potential acute intoxications (Aldosari *et al*., 2018).

The exposure that affects the general population tends to be ubiquitous and crónica1. There are various types of pesticides for prolonged periods, from multiple sources and low doses penetrate the body using different routes. The main sources of exposure in the population are plant foods (fruits, vegetables, grains, legumes) or animal (beef, pork and its derivatives, fish, dairy products, eggs, etc.), and to a lesser extent water, air, soil, fauna and flora contaminated. So are the everyday industrial products that contain or are pesticides themselves and affecting directly or indirectly to human. It states that there is one segment of the general population free of exposure to these compounds and their potential adverse health effects (Barr *et al.*, 1999).

2.3.2 Common Routes of Pesticides Exposure

Pesticide exposure can occur through the mouth (ingestion), via the skin contact (dermal uptake), the respiratory system (inhalation) and Ocular (eye). The absorption depends on the properties of the formulation and the route of entry, determining cross product body barriers to reach the blood or other tissue in particular. The pathways may be multiple and simultaneous (Garcia *et al.*, 2012).

2.3.2.1 Inhalation

The inhalation of pesticide dusts, vapors, mists, and gases may represent a significant occupational hazard. Dust hazards may involve the loading, mixing, and application of insecticides in powder or granular form. The fineness and thinness of the alveolar epithelium favors gas exchange in the lung, but also allows rapid and efficient absorption of pesticides, which are captured by air quickly into the bloodstream. In the workplace the use of fumigants as gases, dusts, vapors and mists, puts the airway as the second most important (Khan and Damalas, 2015).

2.3.2.2 Dermal Exposure

Dermal exposure presents almost as great a potential for absorption as inhalation. The absorption rate through the skin is determined by the nature of the pesticide, condition of the exposed skin, and external factors such as temperature, duration of exposure, and the area exposed. Rapid absorption occurs in pesticides that are soluble both in water and in oils. The rate of absorption can be significantly high if the skin is irritated or dry or chapped from excessive washing with solvents. Other factors that may increase absorption are sweating and increased blood circulation. In the workplace the dermal route is the most important, because through it and depending on the surface of exposed skin, are absorbed significant amounts of various pesticides that vary in their level of absorption. Organochlorine (OC) passing through the skin varies widely depending on the type of substance, for example, DDT is poorly absorbed, but others such as endrin, aldrin, dieldrin and heptachlor the largest share and penetrate faster. The already absorbed soluble pesticides diffuse through the fatty components of the skin and blood, while they do soluble molecules through the intracellular protein material (Al-Haddad *et al.*, 2013)

2.3.2.3 Ingestion (Swallowing) Exposure

In the general population the most important route of absorption is the digestive system from ingestion of contaminated food and water. Accidental ingestion of chemicals can occur in several ways. Ingestion may occur through accidental splashing of chemicals in the face and mouth, eating contaminated food, using contaminated smoking materials, or by rubbing the face with contaminated hands or gloves. Personal hygiene is important when working with pesticides. The degree of hazard from ingesting pesticides is related to the toxicity of the materials, their solubility, and the specific portion of the gastrointestinal tract involved (Amera and Abate, 2008).

2.3.2.4 Ocular (Eye) Exposure

Ocular exposure is usually the result of accidental splashing or spilling a pesticide while not wearing eye protection. Acute local effects may be produced in associated eye structures such as burns to the eyelid and conjunctiva. It should be noted that sufficient material may be absorbed through the eyes to produce acute blood system effects (Hiluf and Abebe, 2015).

2.4. Factors Affecting Exposure to Pesticides

2.4.1 Types of Pesticides Used

Due to the large amount of chemicals and pesticides combinations of compounds have been classified for use in herbicides, insecticides, fungicides, miticides, nematicides, molluscicides and rodenticides. The World Health Organization proposed classification based on their health risk, based on their toxic behavior in rats and other laboratory animals by administering oral and dermal and estimating the median lethal dose (LD50) that produces death in 50% of exposed animals (WHO 1990). This ranking order from lowest to highest toxicity in numbers I through IV, being extremely toxic, highly toxic, moderately toxic, slightly toxic and respectively (Cicoplafest, 1998; WHO, 2004) (Table 1).

Table 1: A table showing classification of Pesticides based on their toxicity

Classes	**Toxicity**	**Examples**
Class IA	Extremely dangerous	Parathion, Dieldrin
Class IB	Highly dangerous	Eldrin, Dichlorvos
Class II	Moderately hazardous	DDT, Chlordane
Class III	Slightly hazardous	Malathion
Class IV	Not dangerous under normal use.	Mancozeb

Source: (Recena *et al* 2006)

2.4.2 Formulation of the Pesticides

The formulation of pesticide products may affect the degree of exposure. Liquids are susceptible to splashing and occasionally spillage, resulting in direct skin contact or indirect skin contact through contaminated clothes. Solids may produce dust while being loaded into the spraying equipment, resulting in exposure to the face and the eyes and respiratory hazards (Garcia *et al.*, 2012).

2.4.3 Type of Pesticides Packaging

The type of packaging of pesticide can also affect potential exposure. For instance, the opening of pesticide bags can cause some kind of exposure depending on the type of packaging in combination with the formulation of the active ingredient. Also, the size of liquid containers may affect the potential for spillage and splashing. Furthermore, adjuvant chemicals used in pesticide preparations to enhance their efficiency in terms of biological activity (e.g., enhance the contact between the active ingredient and its specific molecular target) and to facilitate application and reaching target species, may show toxicity themselves, thus contributing to the overall effect of exposure to a commercial pesticide product (Bagheri *et al.*, 2018).

2.4.4 The Environmental Weather Conditions

The environmental weather conditions at the time of application, such as air temperature and humidity, may affect the volatility of the pesticides, the perspiration rate of the human body and the use of personal protective equipment by the users. Wind increases significantly spray drift and resultant exposure to the applicator. The amount of pesticide that is misplaced from the target area and the distance the pesticide moves will increase as wind velocity increases, so greater wind speed generally will cause more drift and workers who avoid mixing and spraying during windy conditions can reduce the exposure. High temperature and relative humidity will cause more rapid evaporation of spray droplets between the spray nozzle and the target than low temperature and high relative humidity (Khan and Damalas, 2015).

2.4.5 Pesticide Preparation Site

Due to pesticide use in or around the home, a person can be exposed during the preparation and application of pesticides or after the applications are completed, although delayed exposure can occur through inhalation of residual air concentrations or exposure to residues found on surfaces, clothing, bedding, dust, discarded pesticide containers or spraying equipment. In addition there is a possibility of accidental pesticides exposure from pesticide use around the house or garden by pesticide spills, improper use, or poor storage as a result of use without reading the pesticide label.

2.4.6 Protective Equipment Use (PPE use)

Proper use and maintenance of protective clothing are considered important behaviors related with reduced pesticides exposures. Moreover, the frequency and duration of pesticide handling both on a seasonal and lifetime basis affects the exposure. The exposure of an individual farmer that sprays a pesticide once a year is lower than that of a commercial sprayer that normally sprays a pesticide for several consecutive days or weeks in a season. A study conducted in northern Shoa Ethiopia shows that regarding protective equipment's 90.63% of farmers were used normal clothes, 10.59% used cotton overalls, 8.15% used gloves, 8.51% used hat, and 13.54% used boots while 1.56% sprayed bare feet. 23.47% of those who spray pesticides used glasses while 5.56% used goggles for eye protection during pesticides spraying. More than 95% of farm workers do not practice safety protective equipment's during pesticide preparation and application; resulting to a great prevalence of pesticide-related illnesses in Ethiopia. Pesticide residues in different environmental samples varied greatly from below detection levels (3-5 ng) to as high as 325 ppb based on the matrix of interest, and the particular pesticide of concern (Hiluf and Abebe, 2015)

Different studies show that age and farming experience negatively affected personal protective equipment's use and safety behavior, although education had a significantly positive effect (Al Zadjali *et al.*, 2015). Uneducated Elderly and experienced farmers certainly have higher awareness of farming practices and pesticide hazard, but they sense that after many years of farming new efforts to protect their health are unnecessary (Damalas *et al.,* 2006).

2.4.7 Type and Maintenance of Spraying Equipment

Pesticides formulation, loading and application are the activities that pesticides exposure can be occurred. The majorities of Small scale farmers use old knapsack sprayers and does not follow instruction on dosage. The use of old knapsack sprayer in most cases resulted not only improper application of pesticides (at times inefficient) but also leakage of pesticides on the applicators body. Since nearly all the applicators do not use protective equipment's direct body contact with pesticide is coming up. Human health risk is a function of pesticide toxicity and exposure, a greater risk is estimated to arise from high exposure to a moderately toxic pesticide than from little exposure to a highly toxic pesticide

2.4.8 Farmers Sanitation Behavior after Holding Pesticides

Despite the fact that PPE use is a major safety behavior of farmers for preventing pesticide exposure in spraying, there are also other behaviors that can safeguard farmers during the overall process of pesticide handling. Taking a shower, changing clothes and washing the exposed clothes separately, washing hands with soap after spraying, as well as avoiding eating, drinking and smoking highly reduce occupational exposure of pesticides (Bagheri *et al.*, 2018). Generally, in developing countries including Ethiopia, where the overuse of pesticides has become a serious problem significant levels of exposure among farmers can be concluded due to pesticide misuse and careless pesticide handling (Arshad *et al*., 2009; Al-Haddad *et al.*, 2013)

2.4.9 Pesticide Storage and Empty Pesticide Container Management

A study conducted in Iran shows that 60% of farmers stored the purchased pesticides in inappropriate places, i.e., where houses and stalls, with the least care. Moreover, more than 40% of farmers also dumped the empty pesticide containers into orchards or threw it in canals (Bagheri *et al.*, 2018). A study conducted in the northern shoa Ethiopia mentioned that the majority, 42.53% of farmers store their pesticides in a separate place specified for pesticide storage but 37.50% stock their pesticides wherever in the house and 19.98% stored their pesticides in the kitchen. Concerning empty pesticide containers, 63.54% indicated that they use it for water and/or food storage, 8.17% indicated that they bury it in the soil, 27.08% indicated that they disposed to the environment and 1.23% indicated that they sell it (Hiluf and Abebe, 2015).

2.4.10 Knowledge and Training of Farmers on Pesticides

Nowadays, there is an increasing body of evidence in the literature that the poor knowledge and awareness of farmers about pesticide hazards as well as the overuse of these pesticides has become a severe problem in developing countries, which threatens farmers' health in many ways Therefore, understanding farmers' behavior in pesticide handling is an important issue. Earlier studies showed that education and training were the main factors of environmentally sound behavior in pest control, in the sense that high levels of education and training seemed to discourage pesticide use, Information about pesticides also positively affected PPE use and safety behavior (Khan and Damalas, 2015).

A study conducted in northern Shoa Ethiopia shows that different training components regarding pesticides were also provided. Only 37.50% of farmers were trained on pesticide issues like on how to use pesticides, on health and safety issues, 22.40% were on integrated pest management (IPM), on disposal, on application technology and 7.81% were trained on environmental effects of pesticide (Hiluf and Abebe, 2015). Some studies in Iran shows that 83% of farmers do not have sufficient knowledge and information about the effects of unsafe pesticides spraying, as they are unaware of the pesticide risks on human health and also they often ignored typical symptoms of pesticide injuring. It should be noted, however, that most the farmers in the country do not get any advice or motivations for proper disposal of pesticide empty containers, because of lack of regulations and any governmental organization for the control of disposal of pesticide containers (Bagheri *et al.*, 2018).

Trained farmers had increased levels of knowledge of pesticides and beliefs about pesticide hazard control, were accompanied by raised safety behavior in farmers, therefore they were related with lower occupational exposure to pesticides. In addition, farmers who participated in education programs suffered significantly had more awareness on pesticide health hazard and experienced less poisoning. Awareness creation and behavioral change communication are required to change farmers' attitudes in addition to the need for training in integrated pest management practices and minimizing pesticide application. Training farmers in the safe use of pesticides is required, but training alone cannot ensure farmers' protection from health risks, because malpractices that expose farmers to pesticide risks cannot be attributed to lack of information alone, but also to other factors, e.g., cost and accessibility of proper protective items (Damalas and Koutroubas, 2017)

2.4.11 Pesticides Spraying Frequency of Farmers

The frequency and duration of pesticide handling both on a seasonal and lifetime basis affects the exposure. The exposure of an individual farmer that applies a pesticide once a year is lower than that of a farmer that normally applies a pesticide for many consecutive days or weeks in a season. These farmers sprayed pesticides for long period of time have high pesticides accumulation in their body than the others (Garcia *et al.*, 2012).

2.5. Positive Impacts of Pesticides on Human Health

In agriculture Pesticides are usually used to prevent or reduce agricultural product losses by pests and thus can improve harvest as well as quality of the yield, even in terms of ornamental appeal, increase the nutritional value of food and sometimes its safety. In addition there are also many other types of benefits that may be attributed to pesticides. Thus, from this point of view, pesticides can be considered as an economic, labor-saving, and effective tool of pest management with great popularity in most sectors of the agricultural production (Megan *et al.*, 2017).

2.6. Negative Public Health Effects of Pesticides

Even though their popularity and extensive use, pesticides serious concerns about health risks get up from the exposure of farmers when mixing, transporting and applying pesticides or working in sprayed farms or fields these activities have caused a number of accidental poisonings, and even the repetitive use of pesticides can pose major health risks to farmers both in the short and the long period of time. Repeated application of pesticide brings damage of biodiversity. Many pesticides are not easily degradable, they persist in soil, leach to groundwater and surface water and contaminate wide environment. Depending on their chemical properties they can enter the organism, bioaccumulation in food chains and therefore influence also human health (Hiluf and Abebe, 2015).

Evidently, exposure to pesticides poses a continuous health hazard, especially in the agricultural working environment. By their precise nature most pesticides show a high degree of toxicity because they are designed to kill definite organisms and thus create some risk of harm. Therefor pesticide use has raised serious concerns of potential effects on human health. Head ache, feeling of nausea, vomiting, respiratory effects, endocrine disruption, ocular, dermal, cardiovascular, gastrointestinal, carcinogenic, developmental neurological and death are some health effects come from pesticides exposure (Damalas and Eleftherohorinos, 2011).

2.7. Pesticides Registration and Safety

Registration of pesticides is a scientifically-based, legal, and administrative process, where a wide variety of effects associated with the use of a pesticide product and its potential effect on human is assessed. It is an essential phase in the management of pesticides as it enables authorities primarily to decide which pesticide products are permitted to be used and for what purposes, and also to exercise control over usage rates, quality, claims, packaging and labeling and advertising of pesticides, thus ensuring that the best interest of product users is well. The registration process is limited to the assumption that pesticides are only used for their proposed function and envisages proving that such use does not promote unreasonable effects on human health. For that reason, before any pesticide can be used commercially, several tests are conducted that determine whether a pesticide has any potential to cause adverse effects on humans health and on others (Amera and Abate, 2008).

2.8. Conceptual Frame Work

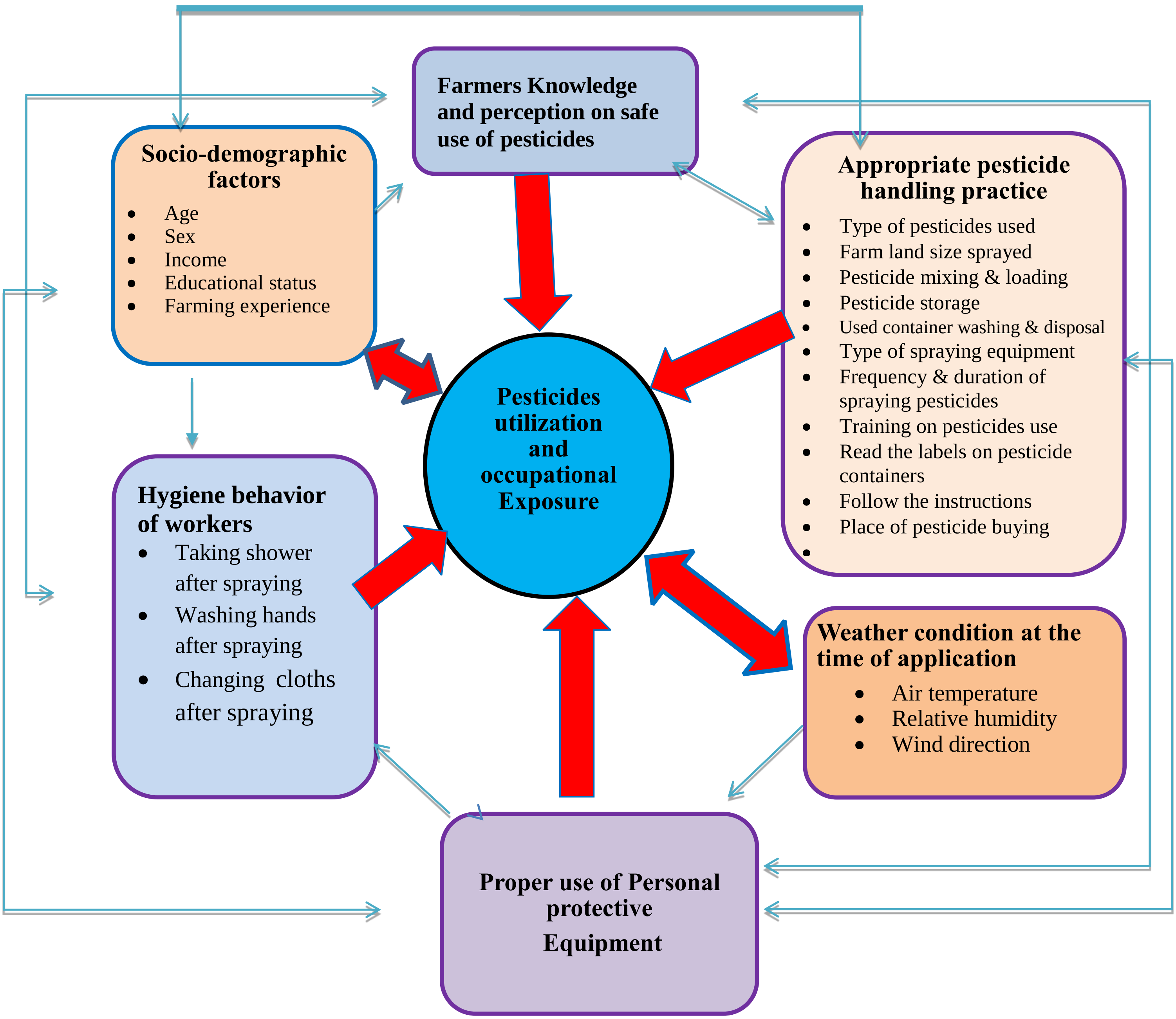

Figure 1: Conceptual Frame Work of the Study

CHAPTER THREE
OBJECTIVES

3.1. General objective

The general objective of this study is to assess pesticides utilization and occupational exposure of small scale farmers in Kellem Wellega, Western Ethiopia.

3.2. Specific Objectives

- To assess the utilization of pesticides in community of Kellem Wollega
- To assess occupational exposure of pesticides among small scale farmers
- To evaluate the associated risk factors of pesticide exposure

CHAPTER FOUR
METHODS AND MATERIALS

4.1. Description of the study area

This study was conducted in western part of Oromia region in Kellem Wellega zone. The zone is located 672 Km far from Addis Ababa which is the capital city of Ethiopia with estimated population of 965,099 (male (484,919) & female (480,180)) found in ten districts. The area is located at an elevation of 1701-1830m above sea level. The climatic condition alternates with long summer rain fall (June to September), short rainy season (March to May) and winter dry season (December to February).The minimum and maximum annual rain fall and daily temperature ranges from 800 to 1200 mm and 15 to 25^{0}C respectively. The study was conducted from March 1-15/2019.

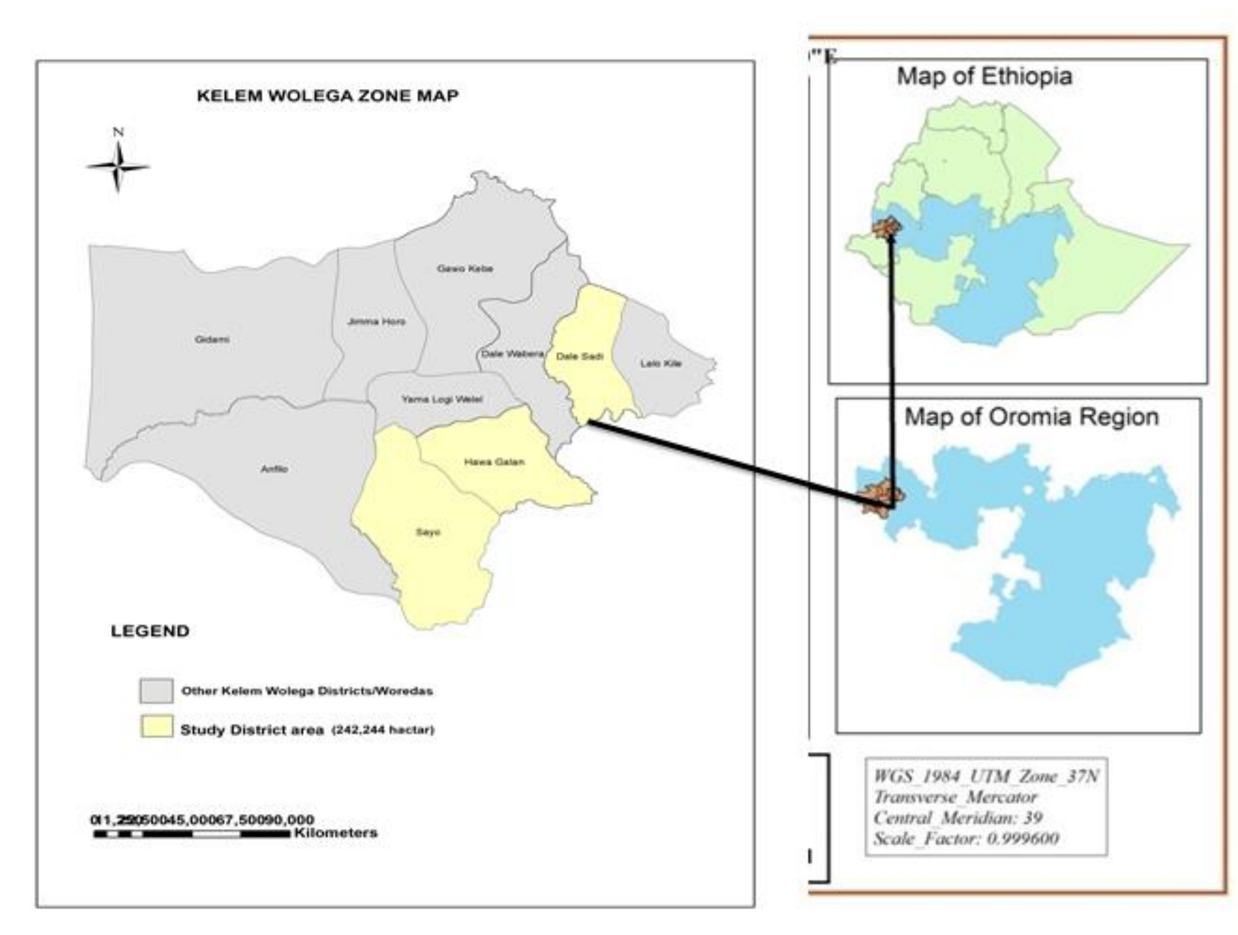

Figure 2: Study Area Map

The Kellem Wollega Zone has different types of culture like food culture. The staple foods of this zone are made mainly from “injera”, *Enjera* is a fermented sour leavened pancake like bread made from teff (*Eragrostistef*), wheat, barley, sorghum, maize or a combination of some of these cereals etc “Wot” which is mainly made from legumes plants peas and beans, Affagn which is made of meat and other spices. Anchotae, Qotchqotcha, different kinds of fruits etc are some of staples food.

The zone is highly known by extensive agricultural crop production like coffee, maize, teff, wheat, barley and sorghum. Most of the agricultural activities are under taken by small scale farmers that widely use different types of pesticides such as insecticides, herbicides and fungicides to protect pests, weeds and fungal diseases respectively in order to increase agricultural productivity.

4.2. Study Design

A community based cross-sectional study design involving 249 households was conducted in Kellem Wellega zone Oromia region Ethiopia. One person from each of the selected households, usually the head of the household, was interviewed using a pretested structured questionnaire. When the household head was not available, the interviewer was asked for consent to interview the mother and if not available first adult over 18 years meet in the household.

4.3. Source population

The source population for this study was small scale farmers in Kellem Wellega.

4.3.1. *Study Unit*

Two hundred forty nine (249) small scale farmers were randomly selected from study population and participated in this study.

*4.3.2. Inclusion and Exclusion Criteria**:***

The inclusion criteria was farmers living in the community for at least one year until the time of interview, and farmers who own or work in the community farm. Those who were involved in organic farming and the migrant farmers who have been in the area for less than one year were excluded

4.4. Sample Size Calculation

Sample size for estimating the prevalence of agrochemicals use among local communities was calculated by using single population proportion according to Thrusfield (2005). Sample size determination formula uses input of 95 % confidence level, 5% margin of error and expected prevalence of 82% (Shemsu, 2016) with non-response rate of 10%, becomes:

$$n = \frac{1.96^2 Pexp(1 - Pexp)}{ME^2} = \frac{(1.96)^2 0.82(1 - 0.82)}{(0.05)^2} = 226$$

10 % was added for non-response rate and n = 226 + (226 x 10 % =23) = 249

And finally 249, participants were participated at house hold level from Kellem Wellega zone.

Where

n= number of sample size

p= expected prevalence

ME= Marginal error

q=1-p

4.5. Sampling Techniques

Kellem Wellega was selected purposively due to the reason that, other studies on pesticides not conducted in the area. Study districts and Kebeles were selected randomly. Therefore from ten districts three districts (Seden Chanka, Hawa Gelan and Seyyo) and sixteen kebeles selected randomly. From the selected kebeles totally 249 samples of small scale farmers randomly selected to participate at house hold level. Lottery method used for simple random sampling.

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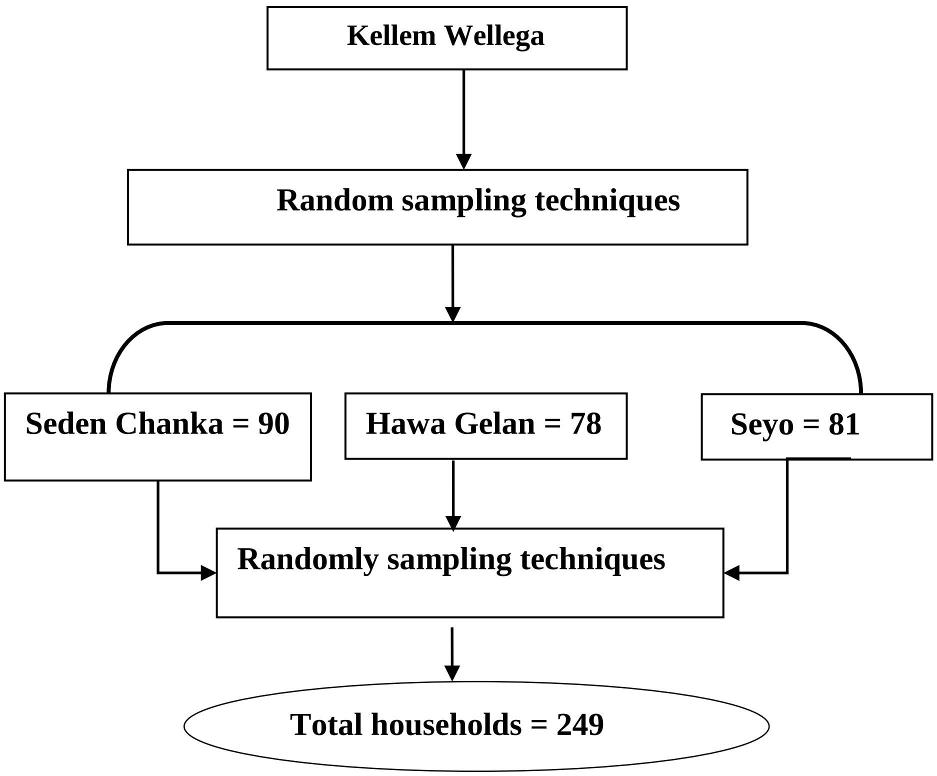

Figure 3: Sampling techniques of the study participants

4.6. Study Variables

Dependent Variables: Farmers pesticide utilization and occupational exposure level

Independent Variables: Age, educational status, income, knowledge of farmers on harmfulness of pesticides, on pesticides labeling instruction, on dose of pesticides, on common routs of exposure, having training, farmers practice on following pesticides instruction, on purpose of pesticides application, having spill of pesticides, spraying against wind direction, re-entrance to sprayed farmland, storage of pesticide, location of pesticide mixing, empty pesticide container disposal, , eating and drinking while mixing and spraying, hygiene behavior of farmers, frequency and duration of pesticide use, level of pesticide use, personal protective equipment use, weather condition, types of spraying equipment , condition of spraying equipment, farmland size and amount of pesticides used.

4.7. Data Collection

Data on the Prevalence of pesticides use and occupational exposure of small scale farmers in Kellem Wellega was collected using structured and pretested questionnaire from March 1-15/2019. A standard questionnaire with some modification was prepared in English version and it was translated to Afan-Oromo and back again to English to confirm the correctness of the translation. The questionnaire includes socio-demographic characteristics, knowledge on pesticides, pesticide use, pesticide exposure factors and farmers health. Four agricultural extension workers were trained for two days and assigned for data collector in selected districts. Two supervisors were trained for two days before data collection and after the pretest also there was continuous supervision.

4.8. Data Analysis and Interpretation

All data collected were entered into Microsoft excel spread sheet, transferred to software SPSS version 21 and processed for analysis. Descriptive analysis was carried out to summarize data. Frequency, mean, standard error and Chi-square test were used to analyze the prevalence of pesticide utilization, pesticides exposure and to check the presence of association between risk factors and pesticide exposure. Only variables with $p < 0.05$ judged as statistically significant at 95 % confidence interval (CI).

4.9. Ethical Consideration

The study was conducted following standard ethical guidelines. Ethical clearance was obtained from institutional board of Jimma University. In addition, permission was obtained from Kellem Wellega Agriculture and Rural Development Bureau. Participation of the study subjects was entirely on voluntary basis. Written informed consent was obtained from the study subjects. Written consent was obtained after the purpose of the study, the rights of the participants, potential benefits and harms of the study were thoroughly and privately communicated.

CHAPTER FIVE
RESULTS

5.1 Socio-Demographic Characteristics

Table 2 shows result of socio-demographic characteristics of the study area. As shown in table 2 this study included 230 (92.4%) males and 19 (7.6%) females totally 249 study participants. The majority of the farmers aged between 21-40 years old (57 %), the remaining were 41-60 years old (37.8 %) and greater than 60 years old (5.2 %). All the selected 249 study participants were participated in the survey. Among the study participants, 233 (93.6 %) were married while 8 (3.2 %) were widowed and 4 (1.6 %) of them were divorced. The remaining 4 (1.6 %) were not married. The average family size was 5.35±0.084 (Table 2).

When we consider the life of study participants, 225 (90.4 %) of them work only on agriculture. While 8 (3.2 %) of the farmers practice mixed farming system and 7 (2.8 %) of the farmers work in nongovernmental organization and use crop production as support for their life. The remaining 5 (2 %) of the farmers work as daily laborer together with farming and 4 (1.6 %) of the farmers work private business together with farming. Regarding the educational level of the study participants 45.4 %, 38.6 %, 12 %, 3.6 % and 0.4 % of the study participants were illiterate, primary level, secondary level, vocational/certificate level and diploma or degree level respectively. Regarding the income of the farmers, 4.6 %, 26.5 %, 45.4 % and 23.3 % of them got monthly income of less than 600 birr, 600-1000 birr, 1000-2000 birr and greater than 2000 birr respectively (Table 2).

Table 2: Results of socio-demographic characteristics

Variables	Frequency	Percentage
Respondents sex		
Male	230	92.4
Female	19	7.6
Respondents age		
21-40	142	57
41-60	94	37.8
>61	13	5.2
Head of the family		
Yes	232	93.2
No	17	6.8
Respondents occupation		
Farmers	225	90.4
Farmer and daily laborers	5	2.0
Farmer and privately business	4	1.6
Farmer and Non-Government organization worker	7	2.8
Others	8	3.2
Respondents marital status		
Married	233	93.6
Divorced	4	1.6
Widowed	8	3.2
Unmarried	4	1.6
Levels of education		
Illiterates	113	45.4
Primary	96	38.6
Secondary	30	12.0
vocational certificate	9	3.6
Diploma or degree and above	1	0.4
Respondents income/ month		
< 600 Birr	12	4.8
600-1000 Birr	66	26.5
1000 - 2000 Birr	113	45.4
>2000 Birr	58	23.3
Total	**249**	**100**

5.2 Farmers Pesticides Utilization

The utilization of pesticide in Seden Chanka, Hawa Gelan and Seyyo were 90%, 83.3% and 87.7% respectively. The overall current utilization of pesticides was 87.15% (Table 3).

Table 3: Current utilization of pesticides (n=249)

Area	No. respondent	No. users (%)
Seden Chanka	90	81 (90)
Hawa Galan	78	65 (83.3)
Seyo	81	71 (87.7)
Total (Overall prevalence)	**249**	**217 (87.15)**

Among common chemicals used as pesticides in the area, 2, 4 dichlorophenoxyacetic acid (2, 4-D) and Glyphosate (Round up) were used to control weed. Malathion, Dichlorodiphenyltrichloroethane (DDT) and Diazinon were commonly used to control insects. In addition, Mancozeb was used to control fungal diseases. From all study participants 172 (69.1%) of the participants used 2, 4-D, 103 (41.5 %) of the participants used Round up, 138 (55.4%) of the participants used Malathion, 21 (8.4 %) of the participants used DDT, 64 (25.7%) of participants used Mancozeb and 66 (26.5%) of participants used Diazinon (Table 4).

Table 4: Types of Pesticides used by farmers in study area

Types of Pesticide	Number of farmer by area district (%)			Total (n=249)
	Seden Chanka (n=90)	Hawa Gelan (n=78)	Seyyo (n=81)	
2, 4-D*	69 (76.7)	45 (57.7)	58 (71.6)	172 (69.1)
DDT**	4 (4.4)	11 (14.3)	6 (7.4)	21 (8.4)
Glyphosate	34 (37.8)	27 (35.1)	42 (51.9)	103 (41.5)
Diazinon	29 (32.2)	12 (15.4)	25 (30.7)	66 (26.5)
Malathion	59 (65.6)	37 (47.4)	42 (51.9)	138 (55.4)
Mancozeb	27 (30.0)	13 (16.7)	24 (29.6)	64 (25.7)

*2, 4 dichlorophenoxyacetic acid; **Dichlorodiphenyltrichloroethane

5.3 Pesticide Exposure of Farmers

Table 5 shows that the total average exposure of farmers to the most commonly used pesticides. Total exposure to pesticides can be expressed in terms of amount of pesticide used per spray season or year, average of total application time per season or per year and frequency of cropping season per year (Lu, 2009). The mean amount of pesticides sprayed by farmers per season was 2.55±0.05 liter; average of total application time (in hour) per season was 8.21±0.14 hours and the average crop seasons per year was 1.41±0.03. Therefore the total pesticide exposure of the farmers in the study area was 3.51±0.09 liter per year for total application time of 11.43±0.31 hour.

Table 5: Mean pesticide exposure among small scale farmers in study area

Variables	Mean	Std. Error	S.E mean
Amount of pesticide (Liters) sprayed per season per farmer	2.55±0.05	0.047	0.05
Average of total application time (hours) per season	8.21±0.14	0.137	0.14
Frequency (Cropping seasons per year)	1.41±0.03	0.031	0.03
Average of total application time (Hours) per year	11.43±0.31	0.303	0.31
Total pesticide exposure per year (Liters)	3.51±0.09	0.092	0.09

The assessment showed that, the majority (87.15%) of the study participants used chemical pesticides at different levels to increase agricultural productivity and for other purposes. Chemical pesticides such as Dichlorophenoxyacetic acid (2-4-D), Glyphosate, Malathion, Dichlorodiphenyltrichloroethane (DDT), Mancozeb and Diazinon were commonly used to control weeds, insects, fungal diseases and other harmful organisms in the study area (Table 4).

About two third of the study participants used 2, 4-D, about two fifth of the study participants used Glyphosate, about half of the study participants used Malathion, about one fourth of the study participants used Mancozeb, about one fourth of the study participants used Diazinon and about one tenth of the study participants used DDT (Table 5). Dichlorophenoxyacetic acid (2, 4-D) and Dichlorodiphenyltrichloroethane (DDT) are an organochlorine type of chemical pesticide; Glyphosate, Malathion and Diazinon are categorized under organophosphate chemical pesticides and Mancozeb is a carbamate type of pesticides. The majority of the respondents used organophosphate pesticides 297 (100 %) in their agricultural work followed by organochlorine pesticides 193 (77.5 %) and carbamate pesticides 64 (25.7%) respectively (Table 6).

Table 6: Frequency distribution of active ingredients of pesticides used

Pesticide classification	Active ingredient	WHO classification	Frequency	Percentage
Organophosphate	Glyphosate	II	103	41.5
	Malathion	III	138	55.4
	Diazinon	II	66	26.4
Organochlorine	2, 4-D	II	172	49.2
	DDT	II	21	8.5
Carbamate	Mancozeb	IV	64	25.6

NB: II=moderately dangerous, III=slightly dangerous, IV,=not dangerous under normal use.

Organophosphate pesticides were the most frequently used pesticide that consisted the largest amount of exposure among farmers at 1077.577 liters, followed by Organochlorine 677.43 liters and Carbamate 224.64 liters for the entire one year.

A pesticide's formulation is a significant factor for human exposure to chemical pesticides. From the chemical pesticides used by farmers 2, 4-D, Glyphosate, Malathion, Diazinon and Mancozeb were used in liquid form, whereas DDT was used in powder form. Therefore the predominant form of farmer's exposure to chemical pesticides in the study area was liquid mist (91.6 %).

From those farmers interviewed, 198 (79.5 %) informed that, they sense some discomforts (illness) during and after application of pesticides. 79 (31.7 %), 57 (22.9 %), 46 (18.5 %), 44 (17.7 %), 42 (16.9 %), 39 (15.7 %), 10 (4 %) and 4 (1.6 %) said that they sense headache, eye irritation, skin irritation, cough, abdominal pain, vomiting, asthma and other discomforts during and after pesticide application respectively.

5.4 Risk Factors Associated with Pesticide Exposure

In this study, area was not significantly associated with occupational exposure of farmers to pesticides (χ^2=1.052, P=0.591). From 90 respondents who were interviewed in Seden Chanka district 73 (81.1%) of them exposed to pesticides; from 78 respondents who were interviewed in Hawa Gelan district 59 (75.6%) of them exposed to pesticide and among 81 respondents who were interviewed in Seyyo district 66 (81.5%) of them exposed to chemical pesticides (Table 7).

Table 4: Association between study area districts and exposure of farmers to pesticides

Area	No. Participants	No. Exposed (%)	χ^2	P-value
Seden Chanka	90	73(81.1)	1.052	0.591
Hawa Gelan	78	59(75.6)		
Seyyo	81	66(81.5)		
Total	**249**	**198 (79.5)**		

The result of our study showed that, there was no significant association between the age of the respondents and the occupational exposure of the farmers to chemical pesticides **(χ^2=1.849, P=0.397).** From 142 study participants who were 21-40 years old, 108 (76.1%) of them exposed to pesticides. from 94 study participants who were 40-60 years old, 78(83 %) of them exposed to pesticides and from 13 study participants who were greater than 61 years old, 12 (92.3 %) of them exposed to pesticides (Table 8).

Table 5: Association between age and occupational exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Age			**1.849**	0.397
21-40 year	142	108(76.1)		
40-60 year	94	78(83)		
>60 year	13	12 (92.3)		
Total	**249**	**198 (79.5)**		

The result of the study showed that, educational status of the respondents was significantly associated with pesticide exposure (χ^2=23.316, P<0.001). Pesticide exposure was high on illiterate farmers 85% (97/113) followed by primary school level (81.3%), secondary school level (60.0%) and vocational school (55.6 %) (Table 9).

Table 6: Association between educational level and exposure of farmers to pesticides

Educational level	No. Participants	No. Exposed (%)	χ^2	p-value
Not read and write	113	96(85.0)	14.040	0.007
Primary school	96	78(81.3)		
Secondary school	30	19(63.3)		
Vocation school and above	9	5(55.6)		
Collage	1	0(00)		
Total	**249**	**198 (79.5%)**		

From the total 249 study participants, 131 (52.6%) of the study participants used chemical pesticides for weed control, 10 (4.0%) of the study participants used chemical pesticides for insect control, 7 (2.8%) of the study participants used chemical pesticides for other purposes, 2 (0.8%) of the study participants used chemical pesticides for fungi control and the remaining 67 (26.9%) of the study participants used chemical pesticides for mixed purpose. There was significant association between purpose of pesticides application and the occupational exposure of farmers (χ^2=146.340, P<0.001). From those farmers sprayed pesticides for weed control, for mixed purpose, for insect control, for other purposes and for fungal control 126 (96.2%), 57 (85.1%), 9(90%), 5 (71.4%) and 1(50%) were occupationally exposed to pesticides respectively. Those farmers who sprayed pesticides for weed control (96.2%) and insect control (90%) had more pesticides exposure than the others (Table 10).

Table 7: Association between purpose of pesticide use and exposure of farmers to pesticides

Variable	No. Participants	No. Exposed (%)	χ^2	p-value
Purpose of using pesticides			146.340	0.001
Fungi control	2	1(50)		
Weed control	131	126(96.2)		
Pest control	10	9(90)		
Mixed use	67	57(85.1)		
Other purpose	7	5(71.4)		
I did not use pesticides	32	0 (00)		
Total	**249**	**198 (100)**		

Regarding the knowledge and practice of farmers on pesticides labeling instructions, even if 136 (54.6 %) study participants could read and write only, 24 (9.6%) and 8 (3.6%) of the study participants could understand and follow the labeling instruction which was found on chemical pesticides containers respectively. In this study there was significant association between knowledge of farmers on pesticides instruction, practice of farmers on following pesticides instruction and occupational exposure of farmers to pesticides was observed (χ^2=89.039, P<0.001) and (χ^2=8.960, P<0.001) respectively. From 24 farmers who had knowledge on the pesticides instruction and 225 farmers who hadn't knowledge on pesticides instruction 8(33.3) and 190 (84.4%) of the farmers were exposed to pesticides respectively. From 8 study participants who followed labeling instruction and 241 study participants who did not follow labeling instruction, 3 (37.5%) and 195 (80.9%) of the farmers were occupationally exposed to pesticides respectively (Table 11).

Table 8: Association between farmer's knowledge and practice on pesticide labeling and exposure of farmers to pesticides

Variable	No. Participants	No. Exposed (%)	χ^2	p-value
Knowledge on labeling instruction			89.039	0.001
Yes	24	8(33.3)		
No	225	190(84.4)		
Following pesticide labeling instruction			8.960	0.003
Yes	8	3(37.5)		
No	241	195(80.9)		
Total	**249**	**198 (79.5%)**		

From the total 249 study participants, 37 (14.9%) of the study participants know the dose of chemical pesticides they used for agriculture, whereas 212 (85.1%) of the study participants did not know the dose of chemical pesticides they used and they apply by guessing which leads harm to their health and the environment. There was significant association between farmers knowledge on pesticide dose and the occupational exposure of farmers (χ^2=3.811, P<0.041). Those farmers who did not know the dose of chemical pesticides used for agriculture were highly exposed 173(81.6%) to pesticides than those farmers who know the dose of chemical pesticides they used for agriculture 25(67.6%) (Table 12).

Table 9: Association between farmer's knowledge on dose of pesticides and exposure of farmers

Variable	No. Participants	No. Exposed (%)	χ^2	p-value
Do you know dose of pesticides			3.811	0.041
Yes	37	25(67.6)		
No	212	173(81.6)		
Total	**249**	**198 (79.5%)**		

There was significant association between the knowledge of the farmers on the common routs of exposure to chemical pesticides and the occupational exposure of the farmers (χ^2=39.540, P<0.001). From 125, 29, 46, 3 and 46 study participants who said inhalation, ingestion, skin contact, all of the above routs of exposure and I don't know respectively, 105 (84.0%), 23 (79.3%), 29 (63.0%), 1(33.3%) and 40(87%) were poisoned by chemical pesticides respectively (Table 13).

Table 10: Association between knowledge of farmers on the common routs of pesticides exposure and exposure of farmers to pesticides

Variables	No. of respondents	No. of exposed	χ²	p-value
Knowledge on Common routs of exposure			39.540	0.001
Ingestion	29	23 (79.3)		
Inhalation	125	105 (84.0)		
Skin contact	46	29 (63.0)		
All of the above routes	3	1(33.3)		
I don't know	46	40 (87)		
Total	**249**	**198(79.5)**		

From the total 249 study participants 190(76.3%) of the study participants said that chemical pesticides are always useful, 19(7.6%) said that chemical pesticides are always harmful and 40(16%) said that chemical pesticides are sometimes useful and sometimes harmful. There was significant association between knowledge of the farmers on usefulness and harmfulness of chemical pesticides and the occupational exposure of farmers (χ^2=6.529, P=0.038). From those farmers who said chemical pesticides are always useful, always harmful and sometimes useful and sometimes harmful 158(83.2%), 12(63.2%) and 28(70.0%) were exposed to pesticides respectively. Therefore, those farmers said chemical pesticides are always useful more likely exposed to pesticides (83.2%) than the others (Table 14).

Table 11: Association between farmer's knowledge on usefulness of pesticide and the exposure of farmers to pesticides

Variable	No. of respondents	No. exposed (%)	χ²	P-value
Knowledge on usefulness of pesticide			6.529	0.038
Pesticides are always useful	190	158(83.2)		
Pesticides are always harmful	19	12(63.2)		
Pesticides are useful or harmful	40	28(70.0)		
Total	**249 (100)**	**198(100)**		

From the total 249 study participants, 125 (50.2%) of the study participants were re-entered in a recently sprayed farmland, 95 (38.2%) were not re-entered recently sprayed farmland and 32 (12.8%) said that, I did not use pesticides. There was significant association between re-entrance to recently sprayed farmland and the occupational exposure of farmers. From those farmers who re-entered, not re-entered in a recently sprayed farmland and not use pesticides for agriculture 116 (92.8%), 74 (86.3%) and 8 (25%) of the farmers exposed to chemical pesticides respectively. The sources of exposure for those farmers not used pesticides, but exposed to pesticides were from the farm land of their neighbor during re-entrance to sprayed farm. Regarding pesticides spill 177 (96.6%) of the participants had pesticides spill during mixing and applying chemical pesticides, whereas, 40 (16%) of the participants hadn't pesticides spill during mixing and applying pesticides. There was significant association between re-entrance to recently sprayed farmland and the occupational exposure of farmers (χ^2=142.626, P<.001). From those farmers who had pesticides spills and who hadn't pesticides spill during mixing and applying pesticides 171(95.0%) and 27(67.5%) of the farmers were exposed to chemical pesticides respectively. Spraying chemical pesticides against the wind is one reason for the occupational exposure of farmers. In this study about 106 (42.6%) and 111 (44.6 %) of the study participants were sprayed against the wind direction and not sprayed pesticides against the wind direction respectively. There was significant association between re-entrance to recently sprayed farmland and the occupational exposure of farmers (χ^2=71.346, P<.001). From those farmers sprayed pesticides against the wind direction 101 (95.3%) of the farmers were exposed to chemical pesticides and from those farmers not sprayed chemical pesticides against the wind 97(87.4%) of the farmers were exposed to chemical pesticides respectively (Table 15).

Table 12: Association between re-enter to sprayed farm, spraying against wind, having pesticides spill and exposure of farmers to pesticides.

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Re-entrance to sprayed farm land			128.823	.001
It is possible to re-enter	125	116(92.8)		
Not possible to re-enter	95	74(86.3)		
I didn't use pesticides	32	8(3.2)		
Spraying against the wind			71.346	.001
No	111	97(87.4)		
Yes	106	101(95.3)		
I didn't use pesticides	32	0(00)		
Having pesticides spill			142.626	.001
No	40	27(67.5)		
Yes	177	171(96.6)		
I didn't use pesticides	32	0(00)		
Total	**249**	**198 (79.5)**		

From 249 study participants 216 (86.7%) and 1 (0.4% of the study participants were use a backpack and handholding spraying equipment to spray chemical pesticides. There was significant association between the type of the spraying equipment and the occupational exposure of farmers (χ^2=142.603, P<.001). From the farmers who used backpack and hand holding spraying equipment 198 (100%) and 0(00 %) of the farmers were exposed to chemical pesticides respectively. From the total 249 study participants 39(15.7%)) of the farmers used damaged backpack spraying equipment that increase the occupational exposure of farmers, but the remaining 178 (71.9 %) of the farmers used safe spraying equipment. There was significant association between the condition of the spraying and the occupational exposure of farmers (χ^2=142.589, P<.001). From those farmers used damaged and non-damaged spraying equipment 36(92.3%) and 162(91.0%) of the farmers were exposed to chemical pesticides respectively (Table 16).

Table 13: Association between types and condition of pesticides praying equipment and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Type of spraying equipment				
Back pack	216	198(100)	142.603	0.001
Hand hold	1	0(00)		
I didn't use pesticides	32	0(0.0)		
Condition of spraying equipment			142.589	.001
Damaged	39	36(92.3)		
Not damaged	178	162(91.0)		
I didn't use pesticides	32	0(0.0)		
Total	**249**	**198 (79.5)**		

The result of this study showed that there was significant association between the use of PPE and occupational exposure of farmers in the study area; regarding personal protective equipment use, only 40 (16 %) of the study participants were use PPE to protect occupational exposure of pesticides during working on chemical pesticides. From those farmers who used PPE only 9 (3.6 %) of the farmers were use full PPE and the remaining 31 (12.4 %) were use one or more (use some) PPE as explained below. 40 (16 %) were use boot, 28 (11.2 %) were use hat/cape, 10 (4 %) were use goggle, 10 (4 %) were use local mask, 9 (3.6 %) were use glove and 9 (3.6 %) were use coverall. From 240 study participants who were not use full PPE 92, (36.9 %), 83 (33.3 %), 33 (13.2 %) said that they were not use PPE due to the luck of access, expensiveness and uncomfortableness respectively.

From 40 study participants who used PPE 21(52.5 %) exposed to chemical pesticides and from 209 study participants who didn't use PPE 177(84.7 %) exposed to chemical pesticides (Table 17).

Table 14: Association between farmers PPE use and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ²	p-value
PPE use			18.712	.001
Yes	40	21 (52.5)		
No	209	177 (84.7)		
Total	**249**	**198 (79.5)**		

There was significant association between activities performed by farmers during pesticide handling and occupational exposure of farmers**;** from the total 249 study participants, 85(34.1%) were eat and drank, 40 (16.0 %) were chewing Khat, 17 (6.8%) were smoked cigarettes, 67(26.9 %) were perform mixed activities and 29(11.6 %) were not performed any activities during handing pesticides. From 64(25.7%) of the respondents ate and drank, 40(16.0%) of the respondents chewed khat, 17(6.8 %) of the respondents smoked cigarettes, 67(26.9 %) of the respondents performed mixed activities and 28(11.2%) of the respondents not performed any activities, 64(98.5%), 38(95.0), 17(100%), 60(89.6) and 19(67.9) of the participants were occupationally exposed to pesticides respectively (Table 18).

Table 15: Association between activities performed during pesticide handling and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ²	p-value
Activities			155.997	.001
Eat and drink	85	64(98.5)		
Chewing Chat	40	38 (95.0)		
Smoking	17	17 (100)		
Mixed activities	67	60(89.6)		
Nothing	28	19(67.9)		
I didn't spray pesticides	32	0 (0.0)		
Total	**249**	**198 (79.5)**		

To protect occupational exposure of farmers personal sanitation behavior of farmers was very important as a safety measure. Regarding this 143 (65 %) of the farmers washed only their hands, 57(22.9%) of the farmers took shower, 17 (6.8 %) of the farmers changed their cloths. There was significant association between sanitation practices performed by farmers and the occupational exposure to pesticides (χ^2=148.123, P<0.001). From 143 study participants who washed only their hands, 57 study participants who took shower, 17 study participants who changed their cloths

137(95.8%) 46(80.7%) and 15(88.2%) of study participants were exposed to chemical pesticides respectively**.** Those farmers washed only their hands had higher pesticide exposure than the other (Table 19).

Table 16: Association between sanitation behavior of farmers and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Sanitation behavior			148.123	.001
Washing only hands	143	137(95.8)		
Bathing	57	46(80.7)		
Changing clothes	17	15(88.2)		
I didn't spray pesticides	32	0(0.0)		
Total	**249**	**198 (79.5)**		

Pesticide storage was one of the major factors which affect the occupational exposure of farmers. From the total 249 study participants 103(41.4%) of the study participants stored pesticides everywhere in the house, 53(21.2%) the study participants stored pesticides in the kitchen, 48(19.2%) of the study participants stored pesticides in separate places and the rest 13(5.2%) of the study participants stored pesticides in mixed places. There was significant association between pesticide storage and the occupational exposure of farmers to pesticides (χ^2=106.810, P<0.001). from 103, 53, 48 and 13 farmers who stored chemical pesticides everywhere in the house, in the kitchen, in separate places and in mixed places respectively, 99(96.1%), 49(92.5%), 39(81.3%) and 11(84.6%) were occupationally exposed to chemical pesticides respectively. Those farmers' stored pesticides in the house had higher pesticides exposure (96.1%) than the others. (Table 20).

Table 17: Association between farmer's pesticides storage and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Pesticide Storage			106.810	.001
Stored everywhere in the house	103	99(96.1)		
Stored in the kitchen	53	49(92.5)		
Stored in mixed places	13	11(84.6)		
Stored in separate places	48	39(81.3)		
I didn't spray pesticides	32	0(0.0)		
Total	**249**	**198 (79.5)**		

Regarding location of pesticide mixing and container washing 60 (24%), 65 (26.1%), 53 (21.3 %) and 39(15.6%) of the study participants mixed their chemical pesticides and washed containers near the river or water canals, at home, in the farm field and in in all places respectively. Mixing chemical pesticides and washing containers near the river and around the home can cause environmental pollution and increase the vulnerability of farmers to pesticide exposure. There was significant association between farmers practice on chemical pesticide mixing and container washing and the occupational exposure of farmers in the study area (χ^2=76.244, P<0.001). Those farmers mixed chemical pesticides and washed containers in all places ((94.9%) and at home (93.8%) had higher pesticides exposure than the others (Table 21).

Table 18: Association between location of pesticide mixing, container washing and exposure of farmers to pesticides

Variables	No. of respondents	No, exposed (%)	χ^2	P-value
Location of pesticide mixing			76.244	0.001
Mix and wash at home	65	61 (93.8)		
Mix and wash near the river	60	53 (88.3)		
Mix and wash in the farm field	53	39(73.6)		
Mix and wash in all places	39	37(94.9)		
I didn’t use pesticides	32	8(25.0)		
Total	**249 (100)**	**198 (100)**		

Regarding the fate of empty pesticide containers, the farmers used different disposal methods. The majority of the farmers disposed empty containers in unsafe ways which expose them for chemical pesticides. from the total 249 study participants 133 (53.4%), 31 (12.5%), 22 (8.8%), 19 (7.6 %), 7 (2.8%) and 5 (2.0%) of the study participants used empty containers for domestic purpose, disposed to the field, sold to others, disposed to water streams, buried and burnt respectively. Although it was not significant those farmers used empty pesticide containers for domestic purpose (96.2%), disposed to water stream (96.2%) were highly exposed to pesticide than the others (χ^2=12.230, P=0.057) (Table 22).

Table 19: Association between empty pesticide container disposal and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Empty container disposal			12.230	.057
Used for home use	133	128(96.2)		
disposed in the field	31	26 (83.9)		
Sold to others	22	20 (90.0)		
Disposed to water Streams	19	18 (94.7)		
Buried	7	4 (57.1)		
Burned	5	2 (40)		
I didn't use pesticides	32	0(00)		
Total	**249**	**198 (79.5)**		

The result of the study showed that, there was significant association between training of farmers on chemical pesticides and occupational exposure of farmers in the study area. From the total 249 study participants only 40 (16 %) study participants trained on chemical pesticides related issues, whereas the remaining 209 study participants not trained on chemical pesticides related issues The finding of the survey showed that farmers not trained on pesticide are more likely exposed to pesticide 173 (82.9 %) than farmers who had training 25 (62.5 %) (Table 23).

Table 20: Association between farmers training on pesticide and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Farmers training			8.474	.004
Trained farmers	40	25(62.5)		
Farmers not trained	209	173 (82.9)		
Total	**249**	**198 (79.5)**		

There was significant association between pesticides use duration and the occupational exposure of farmers in the study area. Regarding pesticide use duration 33 (13.2 %), 113 (45.4%), 61 (24.5 %) and 9 (3.6 %) of the farmers were use chemical pesticides for less than three years, for three to ten years, for greater than ten years and not know their chemical pesticides use duration respectively. Working on chemical pesticides for long period increases the accumulation of chemical pesticides in the human body. The result of this study showed that, those farmers didn't know the duration they work on chemical pesticides highly exposed to chemical pesticides 9 (100 %) followed by those farmers worked on chemical pesticides for greater than ten years 60 (98.4 %), those farmers worked on pesticides from three years to ten years 103 (91.2 %) and those farmers worked on pesticides for less than three years 26 (78.8 %) respectively (Table 24).

Table 21: Association between farmer's pesticides uses duration and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Pesticide use duration			153.132	0.001
Less than 3 years	33	26 (78.8)		
3-10 years	113	103 (91.2)		
Greater than 10 years	61	60 (98.4)		
I don't know	9	9 (100.0)		
I didn't use pesticides	32	0		
Total	**249**	**198 (79.5)**		

The result of this study showed that there was significant association between the weather condition of farmers chemical pesticides spraying season and the occupational exposure of farmers in the study area. The weather condition of the environment determines the occupational exposure of farmers. Spraying in relatively high humid and relatively high cold season was recommended to reduce chemical pesticides exposure. The majority of the respondents 193 (77.5%) sprayed chemical pesticides during relatively high humid and relatively high cold season (March - September) and the remaining 24 (9.6 %) of the respondents sprayed chemical pesticides during relatively dry and relatively hot season (October – February) and 32 (12.8) did not use pesticides for agriculture. The result of the survey showed that, farmers who sprayed chemical pesticides during dry and hot season were highly exposed 24 (100%) to chemical pesticides than those sprayed during humid and cold season 174 (90.6%). Regarding spraying time about four fifth of the respondents sprayed pesticides during a day when the temperature is relatively hot and the rest one fifth of the respondents sprayed chemical pesticides during a day when the temperature is relatively cold (Table 25).

Table 22: Association between the weather condition of pesticides spraying season and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Weather condition			148.897	0.001
Humid and Cold season	193	174 (90.6)		
Dry and hot season	24	24 (100)		
I did not use pesticides	32	0(0.0)		
Total	**249**	**198 (79.5)**		

The result of the study showed that, there was significant association between the farmland size, the frequency of chemical pesticides spraying and the occupational exposure of farmers in the study area. Regarding the farmland size that chemical pesticides sprayed 203 (81.5 %), 37 (14.9 %), 9(3.6 %) of the farmers sprayed 0.5 – 2 hectare, 2.-4 hectare and greater than 4 hectare of farmland respectively. From those farmers sprayed 0.5-2 hectares, 2-4 hectares and greater than 4 hectares 165 (81, 3%), 27 (73.0 %) and 6 (66.7%) of the farmers were exposed to pesticides respectively.

From the total 249 respondents 130 (52.2%) of the respondents cultivated agricultural crops once a year, 78 (31.3%) of the respondents cultivated agricultural crops twice a year and 9 (3.6 %) of the respondents cultivated agricultural crops three times a year. From the total 249 respondents 56 (22.5%), 115 (46.2 %) and 46 (18.5 %) of study participants sprayed 0.5-2 liters, 2-4 liters and greater than 4 liters respectively. From those respondents who sprayed 0.5-2 liters, 2-4 liters and greater than 4 liters 45 (80.4 %), 107 (93.04 %) and 46 (100%) of respondents were exposed to pesticides respectively. From those farmers cultivated agricultural crops once a year, twice a year and three times a year 118 (90.8 %), 71 (92.1 %) and 9 (100 %) of the farmers were exposed to pesticides respectively (Table 26).

Table 23: Association between amounts of pesticides, farm land size sprayed and exposure of farmers to pesticides

Variables	No. Participants	No. Exposed (%)	χ^2	p-value
Amount sprayed per year			**15341.121**	**0.001**
0-2 liters	56	45 (80.4)		
2-4 liters	115	107 (93.04)		
Greater than 4 liters	46	46 (100)		
I didn't use pesticides	32	0 (0)		
Spraying frequency per year			**147.797**	**0.001**
Once a year	130	118 (90.8)		
Twice a year	78	71 (92.1)		
Three times a year	9	9(100)		
I didn't use pesticides	32	0(0)		
Total	**249**	**198 (79.5)**		

CHAPTER SIX
DISCUSSION

6.1 Farmers pesticides utilization

Today, there is a growing body of evidence in the literature that high utilization of pesticides has become a serious problem in developing countries, which threatens farmers' health in many ways (Damalas and Eleftherohorinos, 2011; Lekei et al., 2014). But such evident literatures are scanty in Kellem Wellega zone. Therefore, it was necessary and crucial to assess the prevalence of pesticide utilization and different factors that favors pesticide utilization. In the 10 districts of Kellem Wellega above 85% were fully dependent on farming, from the total 249 study participants 217 (87.15 %) use at least one or more chemical pesticides for agricultural purpose. Therefore, the current study revealed that the overall pesticides utilization was 87.15 %. The result of the present finding is almost similar with the previous findings of the (Gesesew *et al.*, 2016 ; Ligani, 2016) who reported the prevalence rate of 83.3% and 82% in Jimma zone and Bulehora Borena zone respectively. In contrast, the finding of the present study is lower than the previous finding of (Mengistie *et al*., 2017; Amera and Abate, 2008; Hiluf and Abebe, 2014; Tahir *et al.,* 2006) who reported 100 %, 94.3 %, 94.3 %, 93 % in studies conducted in central rift valley of Ethiopia, Ziway and Arsi Negele woredas, in Amhara region Shoa zone and in Pakistan respectively. The difference in prevalence might be due to the difference on awareness of farmers on the effect of chemical pesticides to human and environmental health, on coverage of farmers training on integrated pest management (IPM) and on some socio-economic factors.

6.2 Farmers Exposure to pesticide

Exposure can be defined as human contact with chemicals with the potential for absorption (Krieger, 2002). According to (Lu, 2009) exposure to pesticides can be confirmed with the symptoms showed on the exposed person. Occupational pesticide exposure can occur either directly or indirectly. It occurs directly during loading, mixing and pesticide application and indirectly while accomplishing re-entry tasks in pesticide treated crops or by take home exposure. Agricultural workers who mix, load, transport and apply formulated pesticides are normally considered to be the group that will receive the highest exposure because of the nature of their work and are therefore at highest risk for potential acute intoxications (Aldosari *et al*., 2018).

The level of exposure in these groups is substantially higher for continuous close contact with the chemicals. Although the period of contact with the agent are relatively short, they are still intense and repeated during the working day, causing toxic effects that vary with the type and amount of pesticide to which he was exposed, being relatively infrequent incidents of such accidental or intentional (Garcia *et al.*, 2012).

In the present study, the mean amount of pesticides (in liter) sprayed by farmers per season was 2.48 liter (mean=2.55±0.05). Average of total application time (in hour) per season was 8.21(mean= 8.21±0.14) and the average crop season per year was 1.55 (mean=1.41±0.03) respectively. Therefore, the total pesticide exposure of the farmers in the study area was 2.48 liter per season for application time of 8.21 hour and 3.45 liter per year (mean=3.51±0.09) for the total application time of 11.43 hours (mean=11.43±0.31). The result of the present study is lower in terms of the total pesticides exposure, but higher in terms of pesticide exposure time than the previous finding of (Lu, 2009). The difference may be due to economic factor and utilization of advanced pesticide spraying technology in Philippine. The number of spray operations per week has been proven to have significant association with the likelihood of experiencing neurobehavioral, respiratory, or intestinal symptoms in a study among Indonesian farmers (Kishi *et al.* 1995), in a study among North Carolina growers and agents (Rao *et al.*, 2004).

The assessment showed that, the majority (87.15 %) of the study participants used chemical pesticides at different levels to increase agricultural productivity and for other purposes. Chemical pesticides such as Dichlorophenoxyacetic acid (2, 4-D), Glyphosate, Malathion, Dichlorodiphenyltrichloroethane (DDT), Mancozeb and Diazinon were commonly used to control weeds, insects, fungal diseases and other harmful organisms in the study area. The finding of the present study is similar with the previous finding of (Gesesew *et al.*, 2016; Amera and Abate, 2008) who reported the utilization of 2, 4-D, Glyphosate, Malathion, Mancozeb and DDT in a study conducted in Jimma zone and in Ziway and Arsi Negele. 69.1% of the study participants used 2, 4-D. The finding of the present study is higher than the previous finding of Gesesew *et al.*, 2016 who reported 6.1 % in a study conducted in Jimma zone. The finding of the present study is lower than the previous finding of(Amera and Abate, 2008) who reported 93.4 % in a study conducted Ziway and Arsi Negele. The difference might be due to the difference in the presence of amount of weed in the study areas, the difference on the availability of human force labor to control weeds and the difference in distance from towns. 41.5 % of the study participants used Glyphosate. The finding of the present study is higher than the previous finding of Gesesew *et al.*, 2016 who reported 9.2 % in a study conducted in Jimma zone., about 55.4% of the study participants used malathion. The finding of the present study higher than the previous finding of (Gesesew *et al.*, 2016; Amera and Abate, 2008) who reported 9.9 % and 9.7 % in a study conducted in Jimma zone and Ziway and Arsi Negele respectively. 25.7% of the study participants used Mancozeb. The finding of the present study is similar with the previous finding of (Amera and Abate, 2008) in a study conducted in Ziway and Arsi Negele. 26.5% of the study participants used Diazinon and about 8.4% of the study participants used DDT. The finding of the present study is almost similar with the previous finding of (Gesesew *et al.*, 2016; Amera and Abate, 2008) who reported the utilization of DDT 21 % and 28.7 % in a study conducted in Jimma zone as well as Ziway and Arsi Negele respectively. The difference might be due to the difference on the amount of pests that occurred in these study areas.

The occupational exposure of pesticides and the toxicity of the pesticides can depends on type of chemicals used by the farmers (Lu, 2009). The commonly used pesticides in the study area can be categorized as follows. Dichlorophenoxyacetic acid (2, 4-D) and Dichlorodiphenyltrichloroethane (DDT) were an organochlorine type of chemical pesticide; Glyphosate, Malathion and Diazinon were categorized under organophosphate chemical pesticides and Mancozeb was a carbamate type of pesticides. In terms of organophosphate and carbamates use the finding of the present study is similar with the previous finding of Nigatu *et al*., 2016 in a study conducted in Oromia region. In terms of Organochlorine and organophosphate pesticides the finding of the present study is similar with the previous finding of (Gesesew *et al.*, 2016; Dan and Rachel, 2015) in a study conducted in Jimma and Uganda. According to the WHO classification, most of the pesticides used by the farmers in our study area (2, 4-D, Glyphosate, Diazinon and DDT) were class II pesticides which are moderately hazardous. The rest of the pesticides (Malathion) and (Mancozeb) were class III and Class IV which are slightly hazardous and not hazardous under normal use respectively. In our study area extremely hazardous (class Ia) and highly hazardous (class Ib) pesticides not used by farmers. DDT which is banned globally for all agricultural purposes under the Stockholm Convention (WHO, 2009) used by some farmers for the purpose of insect control. In terms of the level of toxicity of the pesticides the finding of the present study is similar with the previous finding of (Gesesew *et al.*, 2016; Amera and Abate, 2008) who reported the utilization of 2, 4-D, Glyphosate, Malathion, Mancozeb and DDT in a study conducted in Jimma zone and in Ziway and Arsi Negele respectively

The majority of the respondents 307(100%) used organophosphate pesticides in their agricultural work followed by organochlorine pesticides 193(77.5%) and carbamate pesticides 64(25.7%) respectively. Organophosphate pesticides were the most frequently used pesticide that involved the largest amount of pesticides exposure among farmers at 1077.57 liters, followed by Organochlorine 606.95 liters and Carbamate 224.64 liters for the entire one year.

In our study the rate of pesticides exposure was 198(79.5%). From the total pesticide exposed farmers 190(76.3%) were from those farmers use pesticides for agriculture and the remaining 8(3.2%) were from those farmers not use pesticides for agriculture, their exposure is as a result of re-entrance to pesticides sprayed farmland of their neighbor. All of the exposed farmers reported that, they applied pesticides before symptoms of exposure occurred to them. The most prevalent health symptoms were headache (31.7 %), skin irritation (49 %), eye irritation (22.9 %) and abdominal pain (16.9 %). In terms of the pesticides exposure occurrence rate, the result of the present study is higher than the previous finding of (Nigatu *et al*., 2016; Zhang *et al.*, 2011; WJ *et al.*, 2012) who reported 12%, 8.8 % and 24.7 % in Oromia region Ethiopia, China and in a national survey of male farmers in South Korea respectively. The difference might be due to farmer's knowledge and practice on pesticides use (mainly PPE use during pesticides handling) as a result of lack of training.

6.3 Risk factors associated with occupational pesticides exposure

Pesticide exposure has been recorded to occur most frequently in developing countries; due to lack of attention to safety precautions, poor spraying techniques, laxity of care of the chemicals, carless disposal of empty pesticides containers, eating and drinking while working, lack of personal hygiene, weakness of occupational legislation and inadequate personal protection (PPE use) during their use. Therefore, it is very important to identify these associate risk factors and to focus on preventive measures to reduce this problem such as applying legislations for their use; farmer education, and establishment of personal and family protection programs (Abbas and El-atta, 2018).

The survey of the present study showed that the occupational exposure of the farmers in the study area was significantly associated with risk factors that determines the occupational exposure included PPE use during pesticide handling, having training on pesticides, pesticides storage, pesticide preparation site, activities done during spraying, hygiene practices after pesticide application, following labeling instructions, re-entrance to sprayed farm land, spraying against wind direction, having spill while mixing and applying pesticides and preparation of pesticide. Level of farmer's knowledge, weather condition, size of farmland sprayed, amount of pesticides used, frequency of spraying, pesticides use duration, pesticides application purpose, type and condition of spraying equipment and some socio demographic factors are also key factors in occupational exposure of farmers to pesticides.

The finding of the present study showed that, study area and age were not significantly associate with occupational exposure of farmers to pesticides (χ^2=1.849, P=0.397) and (χ^2=1.052, P=0.591) respectively. Although, it was not significant, older farmers who were greater than 61 years old 12 (92.3%) were highly exposed to pesticides than the others. The proportion of farmers exposed to pesticide was higher among illiterate farmers (85.0%) which is significant (**χ^2**=14.040**,** P=0.007).

From the total 249 study participants 190 (76.3%) of the study participants said that chemical pesticides are always useful, 19(7.6%) said that chemical pesticides are always harmful and the remaining 40(16%) said that chemical pesticides are sometimes useful and sometimes harmful. The result of the study showed that, above 76% of the study participants hadn't awareness on the harmful effect of pesticides on human and environmental health. The finding of the present study is higher than the previous finding of (Mengistie *et al*., 2017; Amera and Abate, 2008) who reported as 17 % and 35.1 % of the study participants hadn't awareness on the harmful effect of pesticide. In contrast the result of the present study is lower than the previous finding of Ligani, 2016 who reported 93.8% of the study participants hadn't awareness on the harmful effect of pesticides on human and environmental health in a study conducted in Bulehora Borena zone. The difference might be due to farmer's awareness and perception on the harmful effect of pesticides to human and environmental health as a result of lack of training in our study area and in a study conducted in Bulehora. There was significant association between the knowledge of the farmers on the harmfulness of pesticides and the occupational exposure to pesticides (χ^2=6.529, P<0.038). Those farmers said, chemical pesticides are always useful were highly exposed (83.2%) to pesticides than the others.

A pesticide's formulation is a significant factor for human exposure to chemical pesticides. From the chemical pesticides used by farmers 2, 4-D, Glyphosate, Malathion, Diazinon and Mancozeb used in liquid form, whereas DDT used in powder form. The predominant form of farmer's exposure to chemical pesticides in the study area was liquid mist (91.6 %). The remaining 8.4 % was in powder form. The farmers in the study area apply DDT in powder form to protect insects from cereals like maize after harvesting in the store without using PPE. Therefore, the misuse practice of farmers increased their occupational exposure of pesticide through inhalation (Garcia *et al.,* 2012).

Therefore, skin contact is the most common rout of pesticides exposure in our study area followed by inhalation. Using liquid concentrates have greater risks of occupational exposure; because pesticides may undergo activation processes suddenly and may be broken down to simple and mobile toxic compounds posing a greater hazard to farmers (Wolfe, 1993) and it impairs the protective function of chemically protective gloves (Canning *et al.*, 1998). There was significant association between the knowledge of the farmers on the common routs of exposure to chemical pesticides and the occupational exposure of the farmers (χ^2=39.540, P<0.001) those farmers said skin contact is the rout of exposure for pesticide had less pesticides exposure (33.3%) than the others (87%).

Most of the farmers (52.6%) used pesticides for weed control, 4% used for pest control, 0.8% used for fungi (mold) control, 2.8% used pesticides for other purpose like rodents control and for veterinary use and 26.9% used for mixed purpose. The result of the present study is lower than the previous finding of (Hiluf and Abebe, 2015) who reported for weed control 93.2 %, for insect control 89 % and for fungi control 37.5 % in a study conducted in Amhara region Shoa zone except utilization of pesticides for other purpose. In terms of insect and fungi control the result of the present study is lower than the previous finding of Mengistie *et al*., 2017 who reported 58% and 42% for insect and fungal control respectively, but, in terms of weed control and for other purpose the result of the present study is higher than the previous finding of Mengistie *et al*., 2017 who reported 0.00%. The difference might be due to the presence of different types of pests in the study area. The result of the present study is lower than the previous finding of Miah *et al.*, 2014 who reported the utilization of pesticide for pest control (100 %), for weed control (64.2 %) and Fungi control (84.2 %). The difference might be due to the different in types and amount of pests in the study areas. There was significant association between purpose of pesticides application and the occupational exposure of farmers (**χ^2=**146.340, P<0.001). Those farmers who sprayed pesticides for weed control (96.2%) and insect control (90%) had more pesticides exposure than the others.

From the total 249 study participants 24 (9.6%) and 8 (3.6%) of study participants could understand and follow labeling instruction which is found on pesticide container. The result of the present finding is lower than the previous finding of (Hiluf and Abebe, 2015; Ligani, 2016; Miah *et al.*, 2014) in a study conducted in Amhara region, Bulehora and Bangladesh respectively. The deference might be due to farmer's awareness, practice and perception on pesticide instruction as a result of lack of training on pesticides. There was significant association between farmer's knowledge on pesticides instruction, following pesticides labeling instruction and occupational exposure of farmers to pesticides (χ^2=89.039, P<0.001) and (χ^2=8.960, P<0.003) respectively. Those farmers not understood pesticides labeling instruction and not followed pesticides labeling instruction had more pesticides exposure (84.4%) and (80.9%) than those farmers not understand and not follow pesticides labeling instruction respectively.

Regarding the dose of pesticides 81.6 % of the study participants not knew the dose of pesticides they used and they apply by guessing in the way that aggravated the harmful effect to their health. The result of the previous finding is higher than the previous finding of (Nigatu *et al*., 2018). This may be due to the difference on the coverage of training to farmers. There was significant association between farmer's knowledge on pesticides dose and occupational exposure of farmers to pesticides (χ^2=3.811, P<0.041). Those farmers not had knowledge on pesticides dose were more exposed to pesticides (81.6%) than the others.

The environmental weather conditions such as air temperature and humidity, may affect the volatility of the pesticides, the perspiration rate of the human body and the use of personal protective equipment by the users. High temperature and low relative humidity will cause more rapid evaporation of spray droplets between the spray nozzle and the target than low temperature and high relative humidity (Bagheri *et al.*, 2018). More than three forth (77.5 %) of the respondents sprayed pesticides during relative high humid and cold season (March - September) which is due to the chance that their crop production season is in line with humid and cold season, above 80 % of the respondents sprayed pesticides during a day time when the temperature was relatively very hot. According to (Bagheri *et al.*, 2018) the weather condition of the season in which the majority of the farmers sprayed the pesticides was relatively high humid and cold which is good to reduce pesticide exposure of farmers. Within the safe season in terms of pesticide spraying time in a day most of the farmers (80 %) were spray pesticides at the time when the environment temperature was relatively hot which might be due to lack of awareness as a consequence of low training coverage. There was significant association between the weather condition of the spraying season and the occupational exposure of farmers to pesticides (χ^2=148.897, P<0.001). From those farmers sprayed pesticides in relatively hot and dry season all of them (100 %) were exposed to pesticides Therefore to increase farmer's knowledge and perception on the appropriate season and time of pesticides spraying awareness creation through training and extension service education should have to get great emphasis to reduce occupational exposure of farmers.

From the total 249 study participants only 16.1 % of the farmers trained on chemical pesticides related issues. From this the 14.9 % of farmers trained by government. Regarding the topic they trained on, all 16.1 % of the farmers trained on how to use chemical pesticides and spraying technology, 8.8 % trained on their effect to human health, 8.4 % trained on IPM and 2.8 % trained on disposal of pesticides and their effect to the environment. The finding of our study showed that the overall coverage of farmers training was very low; which was less than 20 %. Moreover, the coverage of the training on the effect of pesticides to human health, proper disposal methods of pesticides, IPM and effect of pesticides to the environment was very low (less than half of the trained farmers) relative to other training topics. This might be due to the reason that, the agriculture office experts focused more on how to increase agricultural productivity (they forgot the human and environmental health effect of pesticides. On the overall coverage of the training the result of the present study is lower than the previous finding of the of (Amera and Abate, 2008; Hiluf and Abebe, 2015) who reported 33.9 % and 37.5 % in studies conducted in the Ziway and Arsie Negele and in Amhara region in Shoa zone respectively. In contrary, the result of the present study is higher than the finding of the previous study of (Mengistie *et al*., 2017) who reported 13 % in a study conducted in the central rift valley of Ethiopia. The difference may be due to the awareness, perception and commitment of both the concerning bodies and the farmers to give and participate on trainings of pesticides related issues. Farmers training on pesticides increased knowledge of farmers on harm full effect of pesticides and beliefs about pesticide hazard, and accompanied with increased safety behavior which is resulted to lower occupational exposure to pesticides (Mengistie *et al*., 2017). In our study training of farmers was significantly associate with occupational exposure of farmers (χ^2=8.474, P<0.004). Those farmers not trained on pesticides suffered significantly high pesticides exposure (82.8 %) than the others.

Pesticide storage was one of the major factors which affect the occupational exposure of farmers. From the total 249 study participants 48 (19.3 %) of the study participants stored the purchased pesticides properly in separate places. The rest of the respondents stored pesticide not appropriately with care. The result of the present study is lower than the previous findings of (Bagheri *et al.*, 2018; Amera and Abate, 2008; Hiluf and Abebe, 2015) who reported 60% in Iran, 55.2% in Zeway and Arsie Negele and 45.5% in Amhara region Shoa zone respectively. In contrast, this result was found to be higher than the finding of the previous study of (Mengistie *et al*., 2017; Lekei et *al*., 2014) who reported 11% and 9% in rift valleys of Ethiopia and in Tanzania respectively. The difference in pesticide storage practice may be due to the lack of awareness of farmers on the effect of chemical pesticides to human health due to low coverage of farmers training and educational service to farmers. Pesticide storage place of farmers was significantly associate with occupational exposure of farmers (**χ^2=**106.810, P<0.001). Those farmers who stored pesticides everywhere in the house 96.1% and in the kitchen 92.5% were more likely occupationally exposed to pesticide than the others. Therefore, awareness creation through training, agricultural service education and health service education should have to get great emphasis to overcome the problem.

Regarding location of pesticide mixing and container washing 60 (24%), 65 (26.1%), 53 (21.3 %) and 39(15.6%) of the study participants mixed their chemical pesticides and washed containers near the river or water canals, at home, in the farm field and in in all places respectively. The result showed that only 53 (21.3 %) of the participants mix their pesticides and wash pesticides containers in proper place. The result of the present study is lower than the previous findings of (Mengistie *et al*., 2017; Ligani, 2016; Amera and Abate, 2008) who reported 74 % in rift valleys of Ethiopia, 78 % in Bulehora Borena zone and 65.9 % in Zeway and Arsi Negele respectively. The difference in pesticide mixing and wash pesticides containers may be due to the lack of awareness of farmers on the effect of chemical pesticides to human health due to low coverage of farmers training and educational service to farmers. Mixing chemical pesticides and washing containers near the river and around the home can cause environmental pollution and increase the vulnerability of farmers to pesticide exposure. There was significant association between farmers practice on chemical pesticide mixing and container washing and the occupational exposure of farmers in the study area (χ^2=76.244, P<0.001). Those farmers mixed chemical pesticides and washed containers in all places (94.9%) and at home (93.8%) had higher pesticides exposure than the others. Therefore, the concerning bodies should have focused to awareness creation to solve the problem.

From the symptom reported by farmers headache 31.7 %, eye irritation 22.9 % and skin irritation 18.5 % were the most common. The result of the present study is lower than the previous finding of (Miah *et al.*, 2014) that reported headache 53%, eye irritation 55% and skin irritation 62 % in the study conducted in Bangladesh. The difference may be due to the type of chemical pesticides utilized, the use of PPE and other safety behavior of the study participants in the study area. The majority of farmers in the study area comment to the data collectors that they didn’t remember these symptoms as a result of pesticides exposure, but, they consider it as a symptom of tiredness and as a nature of the chemical. The result of this study cleared that the study participants hadn’t knowledge and awareness on the effect of unsafe use of chemical pesticides. The agriculture development agent professionals in the study area focused only on encouraging the farmers on using chemical pesticides and increasing their crop product, but they ignored the effect of pesticides on farmer's health. Therefore, they should have to focus at health issues in their agricultural extension services education.

The result of this study identifies that, the use of PPE by the farmers is almost neglected 209(84%) of the farmers did not use any type of PPE to protect occupational exposure of pesticides. 40(16%) of the farmers used PPE. Only 9(3.6 %) of the farmers used full PPE and the rest of the farmers used some PPE. Boot 40 (16 %) and hat 28 (11.2 %) are the most PPE used by the farmers; whereas the least used PPE are coveralls or special clothing for spraying 9(3.6%), glove 9 (3.6 %), local mask 10(4%) and google (4%). In terms of the overall use of PPE, the result of the present study is lower than the previous finding of (Mengistie *et al*., 2017; Gesesew *et al.*, 2016; Bagheri *et al.*, 2018) who reported 57%, 58% and 33.1% in a studies conducted in central rift valley of Ethiopia, Jimma zone and Iran respectively. In contrast the finding of the present study was higher than the previous finding of (Ligani, 2016) who reported 3.1% in a study conducted in Bulehora Borena zone**.** There was significant association between farmers practice on PPE use and the occupational exposure of farmers to pesticides (χ^2=18.712, P<0.001). Those farmers not used PPE were highly exposed to pesticide (84.7%) than the others. In our study area the reason for not using PPE is not only due to the lack of awareness but also due lack of access, expensive price of the protective devices and the problem of un-comfortability of the protective equipment. The results of other studies also showed that, not using PPE is a large problem throughout our country. Therefore, responsible bodies have not given enough attention to the issue (Amera and Abate, 2008).

Eating and/drinking food and/water, chewing khat and smoking cigarettes during the overall process of pesticides handling and sanitation behavior like washing hands, taking shower and changing cloths after spraying were another important factors for the occupational exposure of farmers to pesticides. According to this study 85 (34%) of the respondents eat and drank, 40 (16 %) of the respondents chewed Khat, 17 (6.8 %) of the respondents smoked cigarettes. 67 (26.8 %) of the respondents performed mixed activities and 28 (11.2 %) of the farmers did not perform any of the activities during pesticides spraying. The result of the present study is higher than the previous finding of (Gesesew *et al.*, 2016) who reported eat and drank 3.6 %, chewing Khat 7.6 % and smoking 2.8 %, But it is lower in terms of farmers didn't perform any activities 87.2% in a study conducted in Jimma zone. The result of the present study showed that, there was association between the activities performed by farmers during handling pesticides and the occupational exposure of farmers to pesticides (χ^2=155.997, P<0.001). Those farmers performed smoking 17(100 %), eating and drinking 64(98.5%) and chewed Khat 38(95.0) were highly exposed to pesticides than the others.

From the total 249 study participants 143(57.4 %) of the study participants washed only their hands, 17(6.8%) changed their cloths and 57(22.9 %) of the farmers taken shower. The result of the present study is lower than the previous finding of (Abbas and El-atta, 2018; Hoque *et al*., 2014) who reported 72 % of the study participants perform washed hands, took shower and changed clothes after spraying pesticide in a study conducted in Bangladesh and 69 % washed hands, 47 % changed cloths, 54 % took shower in a study conducted in Bolivia respectively. The difference may be due to awareness of farmer's on the effect of pesticides to human being as a result farmers age, educational status and farming experience of farmers. Other studies showed that age and farming experience negatively affect safety behavior, while educational level had positive effect on the safety behavior of farmers (Al Zadjali *et al*., 2015)**.** There are elderly farmers in our study; Aged and experienced farmers have higher knowledge of farming practices and pesticide risk, but they sense that after many years of farming new efforts to protect their health are unnecessary (Khan and Damalas, 2015). The result of the present study showed that, there was association between the sanitation behavior of farmers and their pesticides exposure (χ^2=148.123, P<0.001). Those farmers washed only their hands were highly exposed to pesticides (95.8%) than the others.

Generally, significant levels of exposure among farmers can be concluded due to pesticide misuse by farmers. The situation of pesticides exposure is comparable with most studies conducted in different areas of our country, where the overuse of these products has become a serious problem.

The findings of this study may have major implications for the agricultural authorities and extension agents to reorient their priorities and aim human safety in relation to pesticide use in agriculture. An intervention that enhances knowledge and practice compliance with safety behaviors should have to get a great concern to reduce occupational exposure of farmers to pesticides.

CHAPTER SEVEN:

CONCLUSION AND RECOMMENDATION

7.1 Conclusion

In this study information about pesticide utilization and occupational exposure of farmers were collected among the small scale farming communities in Kellem Wellega western Ethiopia. There was high utilization of chemical pesticides for the purpose of agriculture in the study area. The commonly used pesticides were organophosphate, organochlorine and carbamate pesticides. The pesticides used by farmers were class II, class III and class IV pesticides which are moderately hazardous, slightly hazardous and not hazardous under normal condition respectively. But the utilization of DDT which was banned in a Stockholm convention was reported by some farmers. Generally, the overall prevalence of pesticide utilization in the study area was 87.15 %.

Pesticides exposure can be expressed in terms of amount of pesticides, time of exposure to pesticides and frequency of spraying season in a year. The total average pesticide exposure of the farmers in the study area was 3.45 liter per year for the total application time of 11.43 hours per year. According to self-report of the study participants the rate of pesticides exposure was 198(79.5%) which was confirmed with health symptoms. From the total pesticide exposed farmers 190(76.3%) were those farmers used pesticides for agriculture and the remaining 8(3.2%) were those farmers not used pesticides for agriculture. They exposed as a result of re-entrance to pesticides sprayed farm.

The occupational exposure of farmers to pesticides was affected by different factors. Farmer's knowledge on pesticides had greatly contributed for their pesticides exposure. Most of the farmers not had knowledge on harmful effect of pesticides, common routs of pesticides exposure, labeling instruction of pesticides, dose of pesticides and low coverage of training on pesticides related issues. The surveyed farmers revealed much misuse of pesticides in terms of PPE use during pesticide handling, pesticides storage, pesticide mixing and container washing site, disposal of empty pesticide containers, eating and drinking activities during pesticides application, smoking during spraying, hygiene practices after pesticide application, re-entry to recently sprayed farm land, spraying pesticides against wind using damaged spraying equipment and spraying pesticides in a dry and hot season that aggravated their occupational exposure to pesticides.

In the present study the occupational exposure of farmers to pesticides was significantly associated with knowledge on harmful effect of pesticides, knowledge on common routs of pesticides exposure, knowledge on labeling instruction of pesticides, knowledge on dose of pesticides, having training on pesticides related issues, purpose of pesticides utilization, PPE use during pesticide handling, pesticides storage, pesticide mixing and container washing site, eating food, drink beverages, smoking during spraying, hygiene practices after pesticide application, re-entry to recently sprayed farm land, spraying pesticides against wind using damaged spraying equipment and spraying pesticides in a dry and hot season that aggravated their occupational exposure to pesticides. In the contrary the occupational exposure of farmers to pesticides was not significantly associated with study area districts, age of respondents and disposal of empty pesticide containers.

7.2 Recommendation

Based on this conclusion the following points are recommended:

The present study identified that, high utilization of chemical pesticides that are hazardous to human and environmental health. At the kebele level there are farmers training centers (FTC) which were established to train farmers on agricultural technologies which is not functional today, therefore, it is recommended that, training farmers on integrated pest management technique to minimize utilization of chemical pesticides.

Pesticides misuse is the second problem that identified by the present study. Most of the farmers hadn’t knowledge on routs of pesticide exposure, on harmful effect of pesticides and proper use of pesticides (storage, mixing, disposal of empty container) as a result of lack of training, those farmers had knowledge not followed pesticides labeling instructions, therefore, it is recommended that, awareness creation to increase farmers knowledge and behavioral change communication to change farmers practice on proper use of pesticides through training and extension service education.

PPE use is the most important factor to protect farmer’s exposure to pesticides. The majority of the farmers didn’t use PPE during handling pesticides. Lack of awareness was not the only reason for the problem, but also other factors, such as affordability, availability and comfortability of personal protective equipment were the major. Therefore, it is recommended that, the government, NGO’s working on agriculture and pesticides producing companies to solve the problem of affordability, availability and comfortability of personal protective equipment by providing affordable and comfortable PPE until the grassroots level.

The problem of DDT utilization that is a banned pesticide in Stockholm convention and the problem of implementation of Occupational safety measures laws were identified, therefore, it is recommend that, regulation and implementation of Stockholm convention on banned pesticides utilization and Occupational safety measures by farmers and regulatory bodies.

Although this study assessed risk factors associated with general health symptoms, therefore it is recommended that, further investigation is needed to determine association of specific pesticide exposure and health.

The main cause of this problem is believed to be due to lack of coordination between governmental sectors and non-governmental organization including pesticide sellers; especially integration of the Ministry of Agriculture and rural development, the Ministry of Health and the Environmental protection authority and pesticide sellers in raising the awareness of the grass roots and designing ways of solving occupational exposure of farmers as a consequence improper utilization of pesticides. Therefore, it is recommended that, strengthen coordination between these sectors to give training and extension services education to greatly improved awareness among farmers and thus promote proper practices for the safe use of pesticides in all stages of pesticide use.

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LISTS OF APPENDIXES

Appendix 1: Questionnaire for assessment of pesticide utilization, pesticide exposure and contributing factors for Occupational exposure to pesticide.

This questionnaire aims to increase your knowledge and awareness on pesticide utilization, damage due to pesticide exposure and risk factors that could lead to occupational exposure to pesticide It will take less than 15 minutes to complete this questionnaire. Please note that your answer is completely confidential and your name will not be included in any reports of these results. Your individual answer will not be shared with anyone. Please encircle your answer number. E.g if your answer number is 2 encircle like 2

Thank you!

No	Variables	Choices	Values	Skip
	Socio-demographic Factors			
S01	Sex of respondents	Male	1	
		Female	2	
S02	Age	10-20 years	1	
		21-40	2	
		41-60	3	
		>61	4	
S03	Are you ahead of the family?	yes	1	
		No	2	
S04	What is your occupation?	Farmer	1	
		Daily laborer	2	
		Privately business	3	
		Non-Government	4	
		If other specify	5	
S05	What is your current marital status?	Married	1	
		Divorced	2	
		Widowed	3	
		If other specify ______________	4	
S06	Number of people living in the house	__________________________		
S07	Level of education	Not write and read	1	

		Primary	2	
		Secondary	3	
		Technical / vocational certificate	4	
		Higher / university/ college	5	
		Don't know		
S08	Income/ month	< 600 Birr	1	
		600-1000 Birr	2	
		1000 - 2000 Birr	3	
		>2000 Birr	4	
Knowledge				
K01	Did you use pesticides before?	Yes	1	
		No	2	
K02	Can you write the name of the chemicals?	___________________________		
K03	Understanding pesticide labeling?	Yes	1	
		No	2	
		Don't know	3	
K04	Is the use of pesticides…?	Use full	1	1→K7
		Harm full	2	
		Use full/harm full	3	
K05	If harm full what is the effect?	To human health	1	
		To animals health	2	
		To wildlife	3	
		To water bodies	4	
		To all of the above	5	
		Others (please specify)_________	6	
K06	Do you know the doses of every pesticide you use?	Yes	1	
		No	2	
K07	The common route of exposure to pesticides	Inhalation	1	
		Ingestion	2	
		Skin	3	
		I don't know	4	
Practice of farmers on pesticides				
P01	Did you ever use pesticides?	Yes	1	
		No	2	

P02	Are you currently using pesticides?	Yes	1	
		No	2	
P03	Duration of pesticide use?	3 years and below	1	
		3–10 years	2	
		Above 10 years	3	
		Do not know	4	
P04	Did you follow the instruction on pesticides bottle's label?	Yes	1	
		No	2	
		Don't know	3	
P05	purpose of application	Insecticides	1	
		Molds	2	
		Herbs/ weeds control	3	
		Others(specify)_______________	4	
P06	Who sprays pesticides?	Father	1	
		Mother	2	
		Son	3	
		Daughter	4	
		Hired labour	5	
		Other (please specify)_________	6	
P07	Do you use PPE during pesticides spraying?	Yes	1	2→P09
		No	2	
P08	If Yes, which PPE did you use during pesticide spraying?	Locally prepared mask	1	
		Coverall	2	
		Boot	3	
		Hat/cap	4	
		Glove	5	
		Goggle	6	
		All	7	
		Some of them	8	
		Don't know	9	
P09	If no, why don't you use PPE	No access	1	
		Too expensive	2	
		Not comfortable	3	
P10	Which activities you did during spraying	Nothing	1	

	pesticides?	Chew khat	2	
		Drink/eat food	3	
		Smoke cigarette	4	
		All of them	5	
P11	Which personal hygiene practice do you perform after spraying pesticides?	Washing hands	1	
		Taking shower	2	
		Changing cloths	3	
		Never	4	
P12	Have you had training about use of pesticides?	Yes	1	
		No	2	2→P15
P13	If yes, from whom?	Government	1	
		Non-Government	2	
		Farmers unions	3	
		Owner	4	

P14	What were you trained on?	How to use them	1	
		Health and safety	2	
		Integrated pest management(IPM)	3	
		Disposal of pesticides	4	
		Application technology	5	
		Environmental effects	6	
		Others (specify)______________	7	
P15	type spraying equipment used	Backpack spray	1	
		Hand hold spray	2	
P16	condition of spraying equipment	Damaged	1	
		Not damaged	2	
P18	Where do you store pesticides?	In the kitchen	1	
		Anywhere in the house	2	
		Separate place	3	
		If others _______________	4	
P19	location of pesticides mixing and empty containers washing	Near the river	1	
		At home	2	
		In the farm land	3	
P20	Contact time to pesticides during mixing and	For mixing___________________	1	

	spraying/for one Backpack spray	For spraying _________________	2	
P21	After you use what is the fate of used pesticide containers?	Thrown into nearby streams	1	
		Used for domestic purpose	2	
		Burnet	3	
		Bury	4	
		Thrown into fields	5	
		Collect and sold	6	
P22	Have you pesticide spill	Yes	1	
		No	2	
P23	Spraying against wind?	Yes	1	
		No	2	
P24	Re- entrance immediately to pesticides sprayed farmland	Yes	1	
		No	2	
P25	Months of applying pesticides?	_____________________________(name of the months)		
P26	Time of spraying pesticides	_____________________________(time in the day)		
P27	Size (area) of the fields applied	_____________________________(area in hectare)		
P28	Amount of pesticides applied once	_____________________________(in liter or Kg)		
P29	How often do you apply the same pesticide per season?	____________________________(rounds)		
	Health problems associated with pesticide exposure			
E01	Any illness after handling pesticides	Yes	1	
		No	2	
E02	Symptoms associated with pesticide exposure	Headache	1	
		Vomiting	2	
		Skin rash and irritation	3	
		Abdominal pain	4	
		Cough	5	
		Eye irritation and redness	6	
		Asthma	7	
		Others	8	

Appendix 2: Consent form for community based house hold survey questionnaires for prevalence of pesticides use and occupational exposure of small scale farmers.

Questionnaire identification number___________

Jimma University, College of Environmental Science and Technology research, Community based house hold survey questionnaires on prevalence of pesticides use and Occupational Exposure of SSF in KellemWellega

Dear respondent

My name is ______________________Zone_____________ Address _____________.

I am working as a data collector with the college of public health and Medical sciences, Jimma University, which is conducting a study to evaluate pesticide use and Occupational exposure of small scale farmers in KellemWellega Zone of Ethiopia. The main objective is to investigate prevalence of pesticides use and occupational exposure of small scale farmers. First of all dear respondents, I would like to thanks you because of your willing in talking golden time with me today. The purpose of my visit today is to take information from you on the aforementioned topic. If you are willing to participate in the study, I will ask you questions lasting for about 20-30 minutes about perception of farmers on protecting, storages and public health effects of pesticides. Your honest answers to these questions and your continuous interest to participate the study will help us in understanding of the situation of pesticides use in your locality better, and will eventually help in designing and implementing appropriate intervention programs to alleviate the problem.

Your name and any other personal identifiers will not be recorded. All the data obtained will be kept strictly confidential by using only code numbers to be accessed only by the principal investigator. During the discussion period, if you feel inconvenient, you can interrupt and clarify inconvenience, or can refuse the discussion at any time. Your honest and genuine participation in responding to the questions prepared is very important and highly appreciated. If you agree to participate in the discussion you will join the group.

Would you be willing to participate?

If yes, proceed.

If no, thank and choose other discussant.

Signature _________________________Date_____________________ (participants).

For any further question, contact the investigator.

Name and address of the principal investigator: - MiftaheShekelifa. Mobile: +251917210003