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ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR EVIRONMENT AND DEVELOPMENT

PESTICIDE USE AND BEEKEEPING: EVEDENCES FROM GUDEYA BILA WOREDA OF EAST WOLLEGA ZONE IN OROMIA REGIONAL STATE, ETHIOPIA

BY

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ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USE AND APPLICATION PRACTICE ITS ON BEEKEEPING: EVEDENCE FROM GUDEYA BILA WOREDA OF EAST WOLLEGA ZONE IN OROMIA REGIONAL STATE, ETHIOPIA.

A THESIS SUBMITTED TO THE COLLEGE OF DEVELOPMENT STUDIES OF ADDISABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN ENVIRONMENT AND DEVELOPMENT STUDIES.

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This is to certify that the senior essay by Abaya Alemu Gadissa,entitled;'pesticide use and beekeeping: Evidence from Gudeya Bila woreda,East Wollega Zone,Oromia Region,Ethiopia and submitted in partial fulfillment of the requirements for Masters Degree in Center for Environment and Development studies complies with the regulations of the university and meets the accepted standards with respect to orogionality and quality.

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DECLARATION

I would like to declare that the study conducted on Environmental Implications Of Pesticide Use And Application Practice Its On Beekeeping: Evidence From Gudeya Bilaworeda, Oromia Region, Ethiopia is the original work of the investigator. The study also complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Advisor: **Shimeles Damene (PhD)** ______________________ ______________________

Signature Date

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Acronyms

BHC	β-Benzene Hexachloride
CSA	Central statistics agency
DDT	Dichlorodiphenyltrichloroethane
EPA	Environmental protection Authority
ETR	Exposure toxicity ratio
PRIMET	Pesticides Risks in the tropics to Man, Environment and Trade
FAO	World food and agriculture organization
HBRC	Holeta bee research center
KTB	Kenya top-bar
LD50	lethal dose 50%
LC50	Lethal concentration 50%
MoA	Ministry of Agriculture
OECD	The Organisation for Economic Co-operation and Development
PEC	Predicted No Effect Concentration (PNEC)
POPs	Persistent Organic Pollutants
PIC	Prior Informed Consent
SSA	Sub-Saharan Africa
WHO	World health organization
2, 4-D	Dichlorophenoxy acetic acid

Abstract

The study was conducted to analyze the pesticide use, and its implications on beekeeping in Gudeya Bila woreda. The *sampling frames for this particular study were rural farmers that found in different agroecological zone of Gudeya Bila woreda western Oromia. The survey was conducted among 312 households of which 304 were farmers and 8 were pesticide retailer. A pesticide risk assessment tool PRIMET was used to assess risks posed by pesticides. The result shown that most of respondents (66.35%) have traditional hives. Concerning pesticides use all respondents (100%) use chemical pesticides for agricultural purposes. All respondents indicated that they purchase pesticides from local dealer. Moreover, 79.5% of respondents buy pesticides without label. PRIMET based analysis revealed that ETR value of the six pesticides (Carbaryl, chlorpyrifos, diazinon, malathion, fipronil and profonefos) considered in this study were highly risky to honey bees in in-crop scenario and in possible risk range in off-crop scenario. The result showed that pesticide use and application practice of farmers were inappropriate and it needs awareness creation for farmers and retailer and reminding farmers to remove or cover beehives during application and flowering/ Use only after sunset. Farmer's awareness on protecting the environment and application of pesticides considering protection of bees is found to be minimum. Proper risk communication strategy and awareness creation is important to curb the present danger to bees posed from dangerous pesticide application in the area.*

Key words: Pesticides, Risk Assessment, PRIMET, bees

CHAPTER ONE
INTRODUCTION

1.1. Background

It is projected that the world population will increase by 50 percent over the next 50 years to 9 billion and the global food demand is expected to double by 2050 (WHO, 2004). In connection to this use of major agricultural inputs such as inorganic fertilizers and pesticides will dramatically increase so as to increases agricultural production and productivity (Berhanu, 2012).

Several current studies have shown a clear causal correlation between the use of agro-chemicals and crop yields, a strong causal association between the use of modern agricultural inputs and crop yields and, consequently, yields and economic growth is found in the recent panel data review (McArthur & McCord ,2014). Pesticide use has risen in developing countries, particularly to be used on high value export and industrial crops that generate foreign exchange; the fastest growing markets are in Africa, Asia, and South and Central America (UNEP, 2012).The considerable increase in food production obtained from the identical area of land with the help of fertilizers, more efficient machinery, intensive irrigation and simpler pest management (UNEP, 2003).

Pesticides and agrochemicals, in general, became an important component of worldwide agriculture systems during the last century, allowing for a noticeable increase in crop yields and food production (Alexandratos & Bruinsma 2012).

Pesticide use definitely improves crop productivity and quality if right type of pesticide is used at right time with the right dose (Khan et al., 2010). Cai,(2008) indicated that the loss of fruits, vegetables and cereals from pest injury can hit 78%, 54% and 32%, respectively in absence of pesticide use. In the USA, 80% of fruit and vegetable crops are fungicides. It was projected that the production of the apple will be raised by US$1223 million using fungicides (Guo et al., 2007). Exports of cotton, wheat and soybeans in the United States will fall by 27% without the use of pesticides (Zhang et al., 2011). Farmers in Africa have long adapted to climatic and other risks by diversifying their farming activities (Ebi et al., 2011).As insect pests are one of the world's main crop production constraints, in Ethiopia more than 68 insect and mite pests have been reported. In Ethiopia and elsewhere in Africa, crop yield losses due to pests and diseases account about 30 to40% of the total production. As per study conducted by Amera and Abate (2008), crop yield losses in Ethiopia due to insect pests vary with crop types, where highest loss is in cereals (32 to 60%) and cotton (36% to 60%) followed by pulses (19%) to 63%), vegetables (24% to 49%) and citrus fruits (2% to 9%). In response reaction to these losses, pesticides have been widely used by Ethiopian stallholder and commercial farmers which played a significant role in rising agricultural production. In Ethiopia, pesticides in the agriculture sector were introduced in the 1960s. Different forms of pesticides have been imported for industrial use by both private and public corporations. Since then, pesticide use for crop protection has grown exponentially (Abate, 2003). Arsenic and soon Benzene hex chloride (BHC) in bran bait were accustomed to desert locust outbreaks during that stage. Since the 1960s, smallholder farmers have been introduced to the employment of agricultural inputs, including pesticides, by agricultural extension systems. Since then, the use of pesticides has seen a slight rise and, with the new growth of the flower-growing market, average pesticide imports have risen to more than 2400 tons per year (Assefa, 2010).

The key consumers of pesticides are industrial farmers, who account for around 80 percent of the pesticides imported into Ethiopia. The remaining 20% of all imports was used for small-scale agricultural, household, health and industrial uses (EPA, 2004). Out of 4128 tons of pesticides, 638 tons of insecticides were imported to Ethiopia in 2018 (FAOSTAT, 2018).

The influence of pesticides on the environment consists of the harmful effects of pesticides on non-target plants and animals. Residues of pesticides may contaminate surface water, e.g. by drainage from treated plants and soil or by spray drift during application (Konstantinou et al., 2006). This means that as amounts reach the edge thresholds within the surface water environments, marine flora and fauna are often prone to wrecking by pesticides. Global use of pesticides may have contributed to a depletion of biodiversity (Kumar et al., 2013; Zhang et al., 2011). There are 20,000 species of bees on Earth, pollinating 90 percent of the 107 main crops in the world. Bee numbers have declined dramatically in recent years. It is estimated that 75% of the world's honey has been found to have traces of bee-damaging insecticides, particularly to neonicotinoids, such acetamiprid, clothianidin, imidacloprid, thiacloprid, and thiamethoxam (Harvard School of Public Health, 2015; Sheridan et al., 2017). Beekeeping may be a long-standing tradition in Ethiopia's rural communities (Yirga &Teferi, 2010) which as significant contribution for household wealth and poverty reduction as well as to the economy of the country being an export commodity. A report by CSA, (2011) shows that Ethiopia is among the four largest beeswax producing countries, for example the honey export in 2010/2011 production years was estimated 620,101 kg from which the country an average generated 420 million Ethiopian Birr on annual base from the sale of honey. It is estimated that the overall honeybee colonies population in the country is estimated 10 million, of which 7.5 million are tamed, while the remaining are from wild colonies found in forests (SNV, 2005). However, with the introduction of pesticides in Ethiopia, the poisoning effect of the comical on honeybees has been increasing over time, where some beekeepers have even lost all their colonies due to agrochemicals (Kerealem et al., 2009). In connection to this, Melaku et al. (2008) attributed colonial death and abscondation with insecticides and herbicides. Chauzat et al. (2006) also showed that improper use of insecticides results in the demise of the honeybee. Melisie et al. (2015) underlined that reduction in honeybee products and crop production are among the major challenges of the beekeeping industry. Study conducted by Fikadu.(2020) attributed the declining of honeybees pollinators with unwise use and practices of pesticides due to lack of knowledge on pest and predators management of farmers. But this study was comes up with environmental implications of pesticide use and application practice it's on beekeeping.

1.2. Statement of the Problem

A healthy, diverse floral environment has always been the recipe for a healthy bumper honey production (VanEnelsdorp and Meixner,2010). There was no doubt, from the beginning that chemical insecticides could represent a serious threat to bees for the simple reason that bees are insects and, therefore, susceptible to any poison designed to kill insect pests (EFSA,2010). According to Damte and Tabor, (2015), pesticide use is widespread in developing countries, including Ethiopia. Mengistie,2015) clarified that little study has investigated the current activities of farmers, while applying a methodology focused on the philosophy of practice could enhance our understanding of these practices and the improvements in them. In a practice strategy, the core claim is that the shift to sustainability has to go beyond human behaviors and behavioral reform, and the key unit of study should be certain particular activities. This study aimed to 'blow up the black box' of the use of pesticides, implementation methods and their consequences for beekeeping practices. Ethiopia is known for its immense variety of agroclimate and biodiversity conditions that favored the life of diversified honeybee flora and large numbers of colonies of honeybees (Nuru,2007).Via research into the use of pesticides, the application practices of small-scale farmers and the effect of these practices on environmental safety on beekeeping in Gudeya Bila woreda will be evaluated. Study conducted by Fikadu, (2020) attributed the declining of honeybees pollinators with unwise use and practices of pesticides due to lack of knowledge on pest and predators management causes the misuses of pesticide. Fikadu (20200) studied on Pesticides use, practice and its effect on honeybee in Ethiopia, but his study was a review and only based on secondary data. This study employed both primary and secondary data to produce the fact. The other thing will make this finding different is it was used the software called PRIMET to analyze the possible risk of selected pesticides on honey bees. This study, therefore, assessed the pesticide use, application practice and its implications on beekeeping Gudeya Bila woreda.

1.3. Objectives of the Study

The general objective of the study was to analyze the use, application practice of pesticides and its implications on beekeeping in Gudeya Bila woreda.

1.3.1. Specific Objectives

- ✓ To assess the pesticides use and application practices of the farmers in the study area
- ✓ To analyze implications of pesticides application practices on beekeeping in the study area
- ✓ To assess the risk status of the most frequently used pesticides to bees in the study area by PRIMET software

1.3.2. Research Questions

- What are the pesticides use and application practices of the farmers in the study area
- What are the implications of pesticides use and application practices of farmers in the study area?
- In which risk categories do most frequently used pesticides are found?

1.4. Significance of the Study

Basically, the research study is undertaken for academic purpose. It is limited to a single woreda. Despite its limited area coverage, the result of the findings of the study was believed to add some insight related to pesticide use, application practice and its implications at national /country/ level in general, and in the study area in particular. Good agricultural practice has been one of the priority agendas of the Ethiopian government. Hence, the finding of the study can contribute to create awareness on pesticides uses, application practices and its implications on beekeeping and provide additional information and understanding to local conditions through providing some awareness related to pesticides misuse, application practices and its implications on beekeeping of the study area. The study would also benefit other researchers and organizations who may intend to conduct further study on related issues.

1.5. Limitations of the Study

The researcher encountered a number of problems during data collection period. The main problems the researcher faced were security and inaccessibility to contact enumerators. This makes the data collection period longer than planned for. In addition, there were lack of willingness of some of the sampled households to provide real information about their asset possessions, and production level brings some limitation to the finding.

1.6. Ethical Considerations

This study will remind the issues of research ethics such as:

The respondent's confidentiality was protected. This means without letter of consent photos and the like never is used.

To enter the study area communicating with local administrator was mandatory and respecting the local cultural aspects was considered.

CHAPTER TWO: LITERATURE REVIEW

2. REVIEW RELATED LITERATURE

2.1. Review of Basic concepts and Related Literature

A pesticide is a material or combination of substances that is meant to deter, kill, repel or mitigate harm caused by any insect (Eldridge, 2008). Insects, plant parasites, weeds, molluscs, birds, mammals, fish, nematodes (roundworms) and microbes can be pests that fight with humans for food, damage land, transmit or help bring or spread diseases or are seen as a nuisance. Insecticides, herbicides, fungicides and rodenticides are among the most popular pesticides utilized. Development inhibitors, plant defoliants, surface disinfectants and certain swimming pool chemicals are among the other less well-known pesticides. Pesticides are most widely used in the health sector and in farm crops (Yadav, 2015).

2.1.1. Pesticide regulation in Ethiopia

Plant Safety Decree No. 56 of 1971 (article 5), Pesticide Registration and Control Special Decree No. 20/1990 and the latest Pesticide Registration and Control Proclamation No. 674/2010 are the foremost appropriate policies and regulations in Ethiopia (Negaret gazeta,2010). Under the new policy, certain international commitments and conventions are integrated into national regulations (such as the Stockholm Convention on Persistent Organic Contaminants (POPs), the Rotterdam Convention on Prior Informed Consent (PIC) and the Basel Convention on the Management and Disposal of Trans boundary Movements of Hazardous Wastes). There are eight sections and 37 articles in the Pesticide Registry and Control Proclamation, which contains provisions on the registration of pesticides (requirement, application, decision on application, validity, renewal, amendment, re-registration, temporary registration, suspension and cancelation, recall, and re-evaluation), Provisions related to certificates of expertise and licenses (import authorization, marking, marking, advertisement, transport and dispose of pesticides), protective precautions (occupational safety and injury reporting), pesticide analysis (designation of official laboratory and analyst, certificate of study, analysis and supervision of residues, advisory board and inspectors on pesticides, roles and options) (prohibition, record keeping, penalties, power to issue regulations and directives, transitory provision, and repealed laws) (Mengistie, 2016).The general themes of pesticide registration and control proclamation

674/2010 was to lay down a scheme of control which would minimize the adverse effects that pesticide use might cause to human beings, animals, plants and the environment(Federal Negarit Gazeta,2010).

2.1.2. Pesticides Use and Application Practice in Ethiopia

Pesticides are agricultural technologies that help farmers to manage pests and are a key input to the development of a crop (Kateregga,2012). Ethiopia's recent agricultural development has led to a higher demand for pesticides. There are more stores that sell pesticides, and farmers have convenient access to them. There is, however, no proper record of the exact amount of pesticides used in Ethiopia's vegetable production (Mengistie et al., 2014).

Pre-harvest cereal loss figures due to insects vary from 31 percent to 61 percent, while pre-harvest losses due to diseases could range from 19 percent to 49 percent. For instance, a survey conducted in the main maize belt of western Ethiopia estimated yield losses of between 22 percent and 75 percent for both improved and native varieties due to grey leaf spot disease, while stem borers resulted in maize yield losses of 20 percent to 50 percent (Getu et al., 2002). They rely heavily on the use of pesticides, as farmers have no tolerance for insect infestation. Government extension services also promote the use of pesticides, saying that farmers have no choice (Damte and Tabor, 2015). Compared to large-scale farmers, pesticide usage habits of smallholder farmers are more complex, since they are typically resource-poor as well as risk averse. In comparison, smallholders face more health risks from pesticides than larger growers due to high dosage and hazardous application techniques (Ngowi et al., 2007; Williamson et al., 2008). Information on the methods of pesticide use includes the varieties of pesticides used, how pesticides are chosen, factors affecting the collection and use of pesticides, the ability to read available label information and professional instruction.

There is no industry in Ethiopia to supply active ingredients and just one local pesticide formulator, the Adami Tulu Pesticide Company. Imported active ingredients and solvents are used by this company to formulate some of the pesticides used in Ethiopia. Consequently, the pesticide industry in Ethiopia is primarily obsessed with imports by local agents serving foreign manufacturing/formulation firms (MoA, 2013). At present, 90 importers of pesticides are officially licensed with the Ministry of Agriculture (see appendix) and serve as dealers of pesticides to supermarkets and end-users, while some firms mix wholesale and retail imports. These industries mostly manufacture pesticides from Germany, Switzerland, France, Belgium, Israel, China, India and the USA. Some African countries, such as Kenya and African countries, import certain pesticides (MoA,2014). The increase in imports and use of agrochemical inputs accompanied the expansion of the field of crop production in Ethiopia and led to an increase in yields. During the 2014/15 production season, the gross agricultural area in which pesticides were used was 3,2 million hectares (CSA, 2014). The import of pesticides into Ethiopia is not currently a well-controlled operation. In Ethiopia, shipments of illicit pesticides appear to pose a major threat. There has been a substantial growth in the use of chemical pesticides in agricultural systems in Ethiopia over the last decade. The attitudes and practices of farmers and farm workers in Ethiopia are, sadly, bad. The most possible reasons for these hazardous uses were: lack of systematic training on industrial and environmental hazards related to pesticides; the absence of a responsible training institution; and hence the continued illegitimate use of organochlorides, particularly DDT, on food crops (Negatuetal.,2016). Much misuse (abuse and overuse) of pesticides by farmers occurs, particularly when storing, mixing (dosage) and applying them and also with regard to wearing protective gears and disposing of empty containers (Mengistie, 2017).

2.1.2.1 Exposure of bees to agrochemicals

Most of the time, bees are exposed to pollutants by the ingestion of pollen and nectar residues from infected seeds, whether from crops or from weeds across the fields (Sanchez-Bayo, 2014). It is important to note that bees eat wherever they go and search for the most fitting flowers that provide ample pollen and nectar. Such crops are also more attractive than others; for example, canola (rape seed oil) yellow flowers, sunflowers, and many of the weeds that grow in and around the crops are more attractive to bees than potato plant flowers. The forager bees take pesticide residues in pollen and nectar to their colonies and live inside the beebread and honey for quite some time (Orantes-Bermejo et al., 2010). These residues are then fed to the larvae and the queen as well, who are influenced by the forager bees in comparable ways. Bees also consume water in addition to sugar, to keep their temperature under control (Schmaranzer, 2000). Pesticide compounds in the soil gradually get into the water and emerge in and above the lakes, creeks and rivers in rural areas, polluted with a combination of agrochemicals (Beldel et al., 2007). Additionally, some water pollution is due to drift from spray applications, particularly from insecticides (Woods et al.,2003). Honey bees, bumblebees and wild bees prefer to drink from puddles, drainage ditches, rivers and lakes, and they are often eaten by forager bees if these waters are polluted with pesticide residues.

Many insecticides are spread over the field canopy as sprays, but herbicide and fungicide sprays are typically applied directly to the soil prior to crop planting. In all these situations, droplets and dust from the applications will fall directly on the bees traveling through or around the treated fields and wind will bring the small droplets and soil particles several meters away from the flower (Craig etal., 1998). One insecticide droplet could also be enough to destroy a bee since the spray solutions contain concentrated doses of these compounds, which could be the most common cause behind the bee outbreaks mentioned in the literature (Marinelli et al., 2004). There is no direct application to granular pesticides introduced into soil (e.g., herbicides) to bees. As seed coatings, the so-called systemic insecticides are usually added. Using pneumatic drilling planters, the handled seeds are inserted into the soil and the rubbing of the seeds inside the equipment often creates dust particles that are highly filled with insecticides. These poisonous particles can cause a decent deal of mortality among bees, if they happen to be within the atmosphere (Georgiadis et al., 2010). Systemic insecticides used in this manner haunt crop plants as they grow and their residues are completely found in areas of the treated plant, including flowers, pollen and nectar (Bonmatinet al.,2015). The weeds and bushes that emerge in the vicinity are not only impacted by crop plants (Krupke et al.,2012) because they either suck up small quantities of residues that disperse by lateral water movement through the soil (Sanchez-Bayo, 2007) or are polluted by dust/spray drift. In addition, in the first hours of the morning, certain plants may create guttation drops (e.g. corn, strawberries), and systemic insecticides occur in elevated amounts in those drops (Tapparo.et al., 2011) that are able to kill the bees.

2.1.2.2 Toxicology of pesticides

Pesticides are harmful compounds with a common mode of action, which means that they are primarily engineered to regulate a target group of species by interacting with certain biochemical pathways. Thus, insecticides and acaricides destroy insects and mites by interrupting their neuronal function, their mechanism of molding or other particular metabolism of these arthropods; herbicides and algicides kill plants and algae by interrupting their photosynthetic capacities or by inhibiting the forming of their cell membranes or by inhibiting the synthesis of essential organic compounds, and fungicides kill fungi. There are also various types, such as rodenticides that kill small rodents, repellents for birds, etc. The word biocide is used for poisons of a wide range that destroy any organism, primarily bacteria, but also large animals. However, the toxicity of each whole pesticide is not limited to the target community of organisms: other organisms that share common metabolism are often affected, but typically to a lesser extent (Chakrabarti et al,2015).

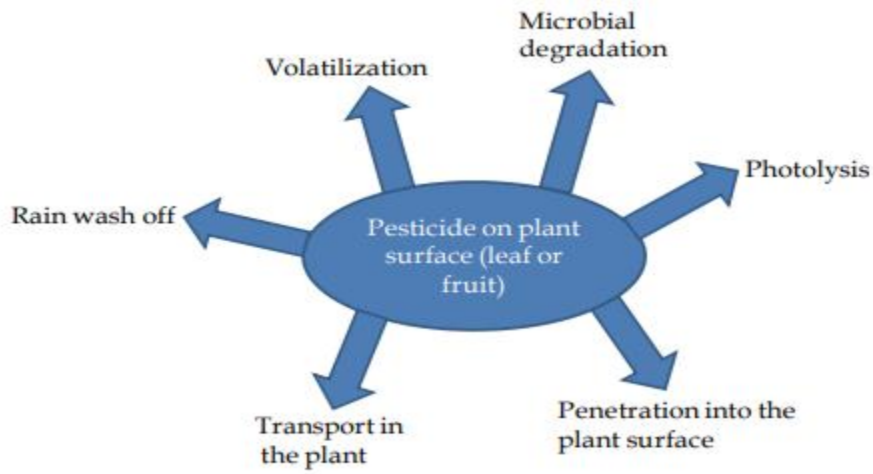
A pesticide's risk for any species is determined by the dosage of a toxic chemical that is lethal to 50 percent of the individuals of that species (LD50) and that dose ranges from species to species. Doses are considered "sublethal" under the LD50, but they may also cause death for a chosen proportion of the population of the species, i.e. 20 to 30 percent of individuals may die. Sublethal levels, in general, produce harmful effects that do not kill the cells but also impair their normal functioning and fitness. Exposure of bees to sublethal doses of neurotoxic insecticides, for example, can induce stress paralysis or irregular habits without killing the bees (Chakrabarti et al.,2015; Zaluski et al., 2015). The survival of pesticides is measured by their half-life (t1/2), defined as the time needed to extract half the quantity of the product from the medium, i.e. water, soil, air or biological tissue. Half-lives longer than 90 days suggest that the pesticide will accumulate, because after 1 year (Sanchez-Bayo, 2011) quite 5% of the amount added will stay within the atmosphere and chronic than other organophosphorus (e.g. malathion), carbamates (e.g. car-bofuran) and pyrethroids (e.g. carbofuran) (e.g. cypermethrin). Despite their high water solubility, their residues also occur in rural water sources and also in the rivers they drain into (Haladik et al., 2014). As they are frequently used as seed dressings, their residues will linger for years in the soil and are obsessed with crops and weeds, ending up in the nectar and pollen of all plants in the treated landscape (Bonmatin et al., 2015). This poses a danger to bees, not just because of its high toxicity and availability, but also because of its specific mode of operation. Both neonicotinoids and fipronil also generate honey bee immune suppression (Di Prisco et al., 2013) and thus predispose bees to Nosema infections (Pettis et al., 2012) and outbreaks of viral diseases typically spread by Varroa mites (Doublet et al., 2014). As a result, the combined effects of chemicals and diseases may succumb to colonies feeding on honey and pollen contaminated with these neurotoxic insecticides. In the presence of ergosterol-inhibiting fungicides (such as propiconazole, myclobutanil), which function as synergists, the toxicity of certain insecticides is also enhanced. Indeed, the detoxification mechanism in bees is hindered by this form of compound (Iwasa et al., 2004) because the metabolites of insecticides and acaricides do not appear to be metabolized or removed as easily as they could.

In animals, sub-lethal exposure to pesticides, including fungicides and some herbicides, also creates discomfort when species try to metabolize and acquire harmful chemicals rapidly, consuming vast quantities of energy aside from stress, bees undergo other harmful effects when exposed to sublethal doses of pesticides. As an example, under chronic exposure conditions, chomped pollen contaminated with chlorpyrifos from honey bee larvae produced only some queens (Degrandi-Hoffman et al., 2013). Wild bees (Osmia bicornis) exposed to thiamethoxam and clothianidin sublethal levels had their reproductive performance reduced by 50 percent (Sandrock et al., 2014), while honey bee queens experienced exceptionally high supersedure rates (60 percent) (Sandrock et al.,2014); colonies of bumble bees (Bombus terrestris) exposed to thiamethoxam sublethal levels did not perform and produced 85 percent (Whitehorn et al., 2012). In forager bees, sublethal doses of neonicotinoid insecticides often induce disorientation and state of mind in (Decourtye, 2009). Devillers, leading to less productivity in the collection of pollen by bumble bees (SubFeltham et al., 2014). Lethal doses of coumaphos acaricide often create irregular mobility among the exposed honey bees (Williamson and Wright, 2016). Definitely, the output of the individual bees and the colony is disrupted by those results (Desneux et al., 1999). Recent global declining on pollinators including honey bees has reported owing to several factors includes and unwise use and practices of pesticides honey bee productivity is affected by the indiscriminate use of agrochemicals, lack of knowledge, pest and predators (Fikadu, 2020).

2.2. Empirical literature

2.2.1. Pesticides Fate after Application

Fate refers to the pattern of distribution in the organism, system, compartment or (sub) community of concern of an agent, its derivatives or metabolites as a result of movement, partitioning, transformation or degradation (OECD, 2003). They can communicate with plant surfaces after pesticides are added to the crops, be subjected to environmental conditions such as wind and heat, and can be washed out during rainfall. The pesticide may be absorbed from the surface of the plant (waxy cuticle and root surfaces) and enter the mechanism of transportation of the plant (systemic) or remain on the surface of the plant (contact). The pesticide will undergo volatilization, chemical photolysis and microbial degradation while still on the surface of the seed. Both these processes can decrease the concentration of the initial pesticides, but certain metabolites can also be added into the crops (Figure 1). Typically, pesticide volatilization occurs immediately after in-field deployment. The process depends on the vapor pressure of pesticides. Pesticides with high vapor pressure tend to quickly volatilize into the air, while those with low vapor pressure remain longer on the atmosphere. Environmental factors such as wind speed and temperature also depend on the rate of volatilization. Typically, pesticide volatilization occurs immediately after in-field deployment. The quicker the wind speed and the higher the temperature, the greater the evaporation of the pesticide. Photolysis occurs, resulting in pesticide oxidation, when molecules absorb energy from sunlight. The indirect reaction may also be triggered by the breaking down of some other chemicals by sunlight and their components reacting in exchange with pesticides. Microbial metabolism may destroy certain pesticides. Pesticides may be used as carbohydrates by micro-organisms to split down carbon dioxide and other elements (Holland and Sinclair, 2004). Because of the disparity in organic chemicals that exist spontaneously and pesticide systems, bacteria do not assimilate them; however they can be altered at reactive locations. The products formed may be less or more toxic than the parent chemical (Keikotlhaile and Spanoghe, 2018).



Source: B. M. Keikotlhaile, and P. Spanoghe ,2018

Figure 1: Fates of pesticides on plant surface

2.2.2. Pesticides Monitoring

The aim of the pesticide surveillance systems is to ensure that maximum government-approved residue amounts (MRLs) are not surpassed in fruits and vegetables, that there is no abuse of pesticides that may lead to unintended food residues, and that good agricultural practices (GAPs) are preserved. Owing to the demands of foreign exchange, such programmes, often in developed nations, are carried out. Regulatory authorities are now using the findings of these monitoring programmes for potential improvements in the creation of MRLs and risk management activities for public health. In most nations, a central organization appointed as the responsible authority organizes the surveillance services Based on prior evidence available from dietary intake and risk management activities or the use of pesticides in available fruits and vegetables, the Department designs a surveillance strategy. There is a structured plan in the European Union (EU) for all Member States to be followed by the European Commission and the national initiatives of the Member States. The findings are then published annually by the European Food Safety Authority as a single report (EFSA, 2016).

2.3. Conceptual Framework

2.3.1. Pesticides use and application practice

Ethiopia's recent agricultural development has led to a higher demand for pesticides. There are more stores selling chemicals, and farmers have convenient access. There is, however, no proper record of the total amount of pesticides used in the cultivation of vegetables in Ethiopia (Mengistie et al., 2014). Pre-harvest cereal losses due to insects are expected to be between 31% and 61%, while pre-harvest losses due to diseases could range from 19% to 49%. For example, a survey conducted in the main maize belt of western Ethiopia estimated yield losses of between 22 percent and 75 percent for both improved and local varieties due to grey leaf spot disease, while stem borers resulted in maize yield losses of 20 percent to 50 percent (Getu et al., 2002). They rely heavily on the use of pesticides, as farmers have no tolerance for insect infestation. Government extension services also promote the use of pesticides, claiming that farmers have no choice (MoA, 2013; Mengistie et al., 2014; Damte & Tabor, 2015). Compared with large-scale farmers, pesticide usage habits of smallholder farmers are more complex as they are typically resource-poor as well as risk-averse. In comparison, smallholders face more health risks from pesticides than larger farmers due to high dosage and hazardous application techniques (Ngowi et al., 2007; Williamson et al., 2008). Information on the methods of pesticide use includes the varieties of pesticides used, how pesticides are chosen, the reasons affecting the collection and use of pesticides, the ability to read available label information and professional instruction. There has been a substantial growth in the use of chemical pesticides in agricultural systems in Ethiopia over the last decade. The attitudes and practices of farmers and farm workers in Ethiopia are, sadly, bad. The most likely reasons for these inappropriate uses were: the lack of formal training on occupational and environmental risks related to pesticides; the absence of a responsible training institution; and the continued illegitimate use of organ chlorides, particularly DDT, in food crops (Negatu et al., 2016).

2.3.2. Why small scale farmers misuse or abuse pesticides?

In order to avoid the dangers involved with the application of pesticides, understanding of the existence of pesticides and their effects on farmers is important. The level of understanding in the population is poor about the pesticides they use. Proper use of pesticides will mitigate the effects of improper use of pesticides on the environment and public health. Further instruction on the use of protective equipment and follow-up of safety precaution is required (Shemsu, 2016). We have seen farmers literally use pesticides without relevant awareness, preparation, and the impacts of pesticides on the climate and human beings. In general, awareness, preparation, the quality of schooling, the supply of pesticides, the efficiency of regulatory bodies and spray materials can contribute to pesticide misuse.

2.3.3. Risk of pesticides to bees

An assessment of the basic threats that existing pest control products and acaricides used for the care of hives pose to honey bees is needed, having explained above the routes of exposure to pesticides and their different impacts on bees. The biggest risk comes from the immediate exposure of the compounds to the bees, resulting in short-term or short-term mortality. Other threats include sublethal consequences that, as described above, will affect hives' efficiency and also the long-term viability of the colonies. Risks are usually estimated as harm odds, and the immediate toxicity and thus the extent at which the bees may be harmed by a chemical is endorsed. Three scenarios were developed: (Van Engelsdorp & Meixner, 2010) risks arising from the spraying of chemicals over agricultural fields (EFSA, 2014) risks arising from the ingestion of agrochemical contaminants found in pollen, honey and water gathered and eaten by the forager bees and transferred to the hive, where they are processed into honey and beebread and fed to the opposite bees, larvae and forager bees.

2.3.4. Exposure and effect assessment for bees

Two exposure and effect assessment for calculating exposure to toxicity ratio was done consistent with Wipfler et al., (2014). In-crop and off-crop scenarios were considered for risk determination. In-crop scenario indicated the applying of pesticides while bee hives are present with within the sprayed field while off-crop represents application when bee hives are present away certain buffer zone off from sprayed field. In both scenarios the exposure concentration is calculated because the concentration because of one application (spraying) (Wipfler et al., 2014). The PRIMET software was used to determine risks to bees in for the two pre-determined scenarios. PRIMET calculated by combining basic data given as application rate (g/ha) the smallest value of either the oral or contact LD50 value for bees (ug/bee). Calculation was done by considering Predicted Environmental Concentration (PEC) as the application rate in kg a.i. /ha and for in and of crop scenario, where value is multiplied by a drift factor to come up with the PEC value for the off-crop scenario. The Predicted No Effect Concentration (PNEC) value was obtained by directly selectin either of the least value of an oral or contact LD50 values (ug/bees) for bees. PRIMET determine the risk using simple calculation of the ratio the PEC to PNEC values and combining the crop and drift factor values already set in the database, further explanations can be obtained in Wipfler et al., (2014).

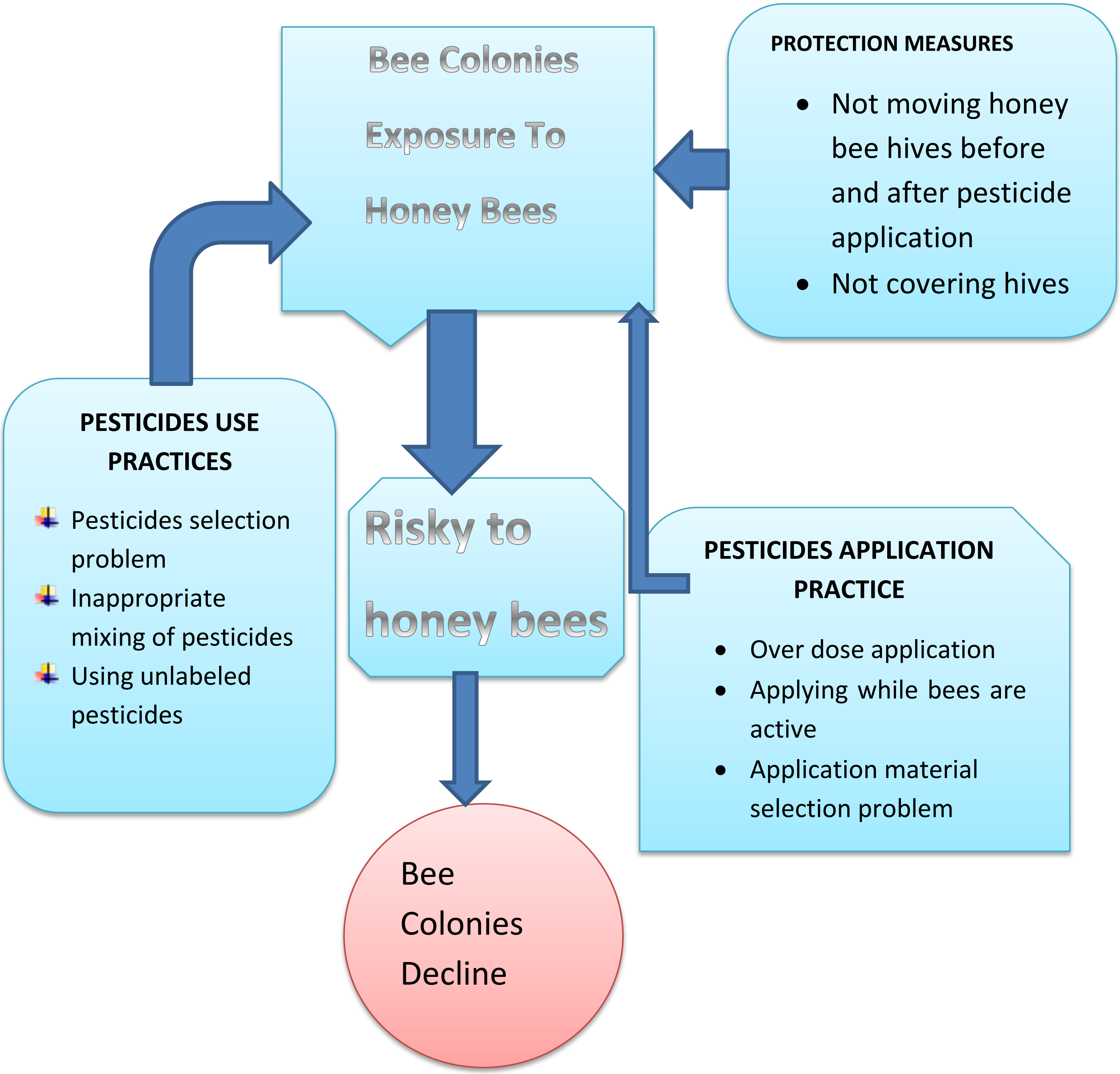


Figure 2: Conceptual framework of pesticide use and its implication on beekeeping

CHAPTER THREE

3. DESCRIPTION OF STUDY AREA AND RESEARCH METHODOLOGY

3.1. Description of the Study Area

Gudeya Bila is among in the East Wollega zone in Oromiya the region, Ethiopia. It was found 274 km far from Addis Ababa and 105 km east to Zonal Administration called Nekemte. The woreda is bordered by the Horo Guduru Wollega district of Jima Genati in the east, the Bako Tibe district of West Shoa in the south-east, the Gobu Sayo and Sibu Sire districts of East Wollega in the west, and the Horo Guduru Wollega district of Abe Dongoro in the north. The woreda has 13 farmer associations (kebeles) and 2 local councils (Bila and Jare). The woreda has two rainy seasons, where the main rainy season occurs between June and September and the second occur between October and May, The average rain fall of the area was between 1900 mm and 2400 mm annually. There are water resources which are flow either perennially or annually. The soil types of the district were clay soil 80%, sandy loam 10% black soil 5% and others were 5% (Gudeya Bila District Agricultural office,2020). The total area of the district is estimated to be 70,181.76 hectare and its altitude is between 1600 m and 2600 m above sea level. The minimum and maximum average daily temperatures range between 18.5°C and 27.5°C, respectively.. The vegetation cover was comprises wood forest, bushes and shrubs and dense forests. The total area of vegetation is estimated to be 10,000 hectares and the total population of the District was 30,924 male, 32,136 female totals 63,060 in rural areas and 3,623 male and 3,896 female totals 7519 in urban areas (GudeyaBila District Agricultural office,2020). The main economic activity of the area Agricultural based. The farming type was mixed which comprises crop production and animal rearing. Major crops grown in the woreda are maize, teff, beans and some kinds of fruit and vegetables.

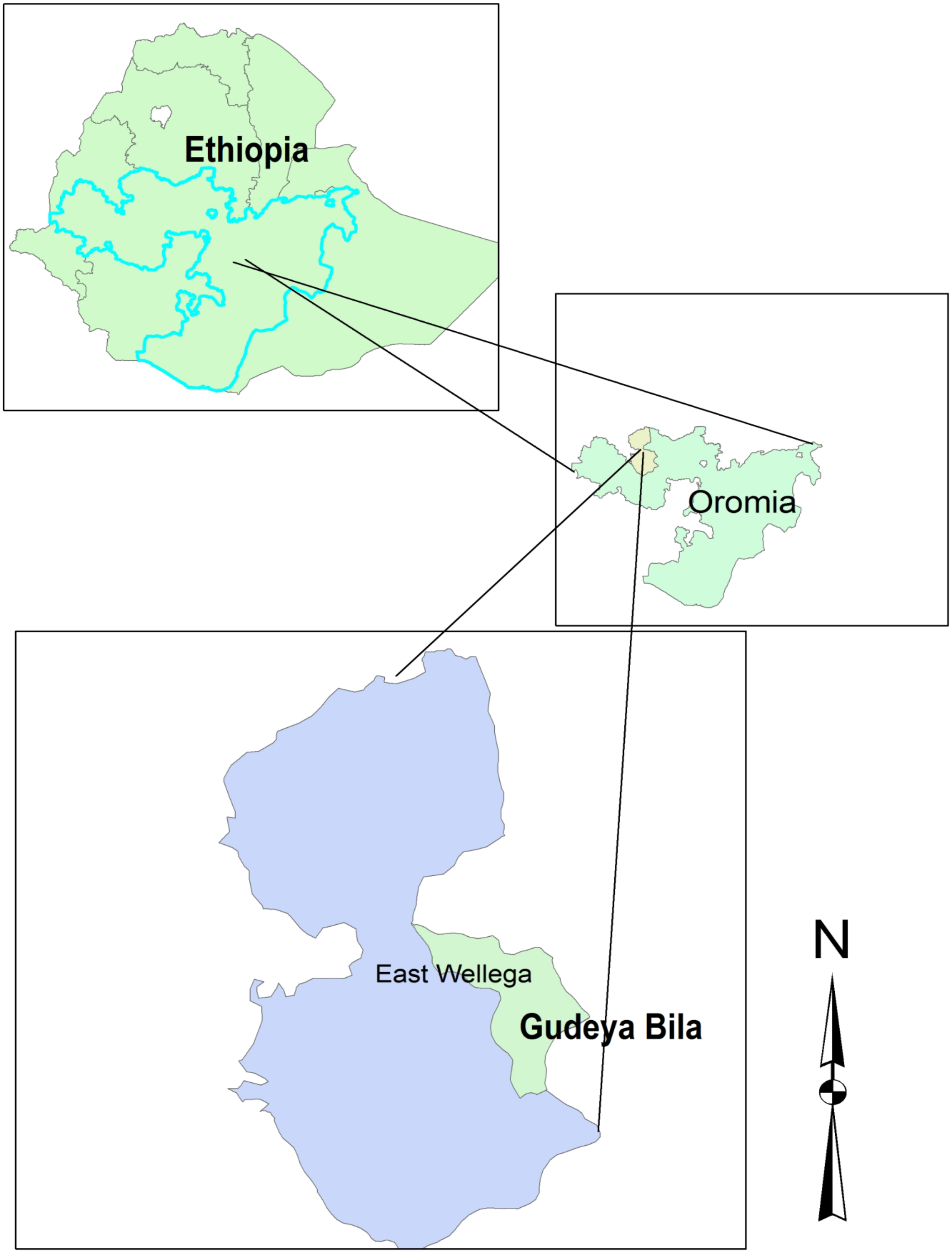


Figure 3: Study area (Gudeya Bila) wereda map

3.2. Research Design and Approach

This section enlightens how the data were collected and analyzed and offers reasons for the suitability of the choice of method so as to answer the research questions and fulfill the objectives of the study. Foremost important guiding principle for selecting study methodology is the research problem or the character of the study (Bryman, 2003). This study followed a quantitative and qualitative (mixed) research design. Survey designs are procedures in quantitative research within which you administer a survey or questionnaire to a little group of individuals (called the sample) to spot trends in attitudes, opinions, behaviors, or characteristics of an oversized group of individuals (called the population). The data were gathered during this study by questionnaires provided by the investigator to the participants. A descriptive survey was chosen because it offers a reliable description or account of the characteristics of one person, circumstance or community, like actions, opinions, skills, values, and expertise. This design was selected to fulfill the objectives of the research, namely to assess the awareness and opinions of patients and family members with regard to pesticides uses, applications procedures and its effects on beekeeping.

3.3. Target Population, Sampling Design and Sample Size

The sampling frames for this particular study were rural farmers that found in different agro-ecological zone of Gudeya Bila woreda and the study area was selected purposefully. Mainly, the familiarity of the researcher with the study area and distribution of beekeeping caused to select purposively. Moreover, multi- stage sampling technique was used to select the representative samples. At the first stage, rural kebeles were stratified by agro-ecology (*dega*, *woina dega*, and *kolla*) and then rural *kebeles* of Gudeya Bila *woreda* were selected randomly, i.e., one *kebele* from each agro-ecological zone by lottery method. Households or respondents were selected randomly. In addition to this pesticide retailers were included in the sampling to get information on pesticides selection and use status. Hence, it was appropriate techniques to have a deep understanding of the pesticides use practice, application practice and beekeeping status of the study area.

The sample size of this study was determined or calculated using Taro Yamane sample size determination formulas, as given below (Eq.1)

$$n = \frac{N}{1+N(e)2} \qquad \text{(Eq.1)}$$

$$\frac{1439}{1+1439(0.05)2} = 312$$

n = 312 household heads were used for this study

Where, n- Sample size

N-is the whole population under study

e- The precision or sampling error which is 0.05.

As the proportion of respondent household to be food secure are not known, hence, 0.5 was used as p-value to obtain the sample size (n).

3.4. Methods of Data Collection

Data were generated from both primary and secondary sources to achieve the objective of the study. The primary data were collected through various data collection methods such as household surveys, focus group discussion (FGD), key informants interview (KII) and field observation as detailed herunder.

- **Household survey**

To generate quantitative data about pesticides use, application practices and its implications on beekeeping, household survey was undertaken by developing structured questionnaires. The developed structured questionnaire was translated into the local language, 'Afan Oromo' for the convenience of data collection during the survey. To achieve the objective of the study, enumerator's were employed based on their ability in communicating with local language, educational background and experiences in similar works. A questionnaire was a printed form designed to elicit information that can be obtained through the written responses of the subjects. The data obtained through a questionnaire was similar to that obtained by an interview, but the questions tend to have less depth (Burns & Grove, 1993). Data was collected with the aid of questionnaires to evaluate the status of pesticides use, application practices and its implications on beekeeping trends.

Focus Group Discussion

Focus groups discussions were undertaken to get qualitative information from beekeepers, crop growers and pesticide retailers. The three FGDs have eight members selected from beekeepers, crop, vegetable growers and pesticide retailers from each *kebele*. Detail information's were collected on pesticide use, application practice and its implications on beekeeping.

Key Informant Interview

Key informant interviews resemble a conversation among acquaintances, allowing a free flow of ideas and information. Interviewers frame questions spontaneously, probe for information and takes notes. The interview was conducted to investigate their practice regarding pesticides use, application practices and its implications on beekeeping to particular and supplement the findings obtained through household survey. The informant interview was conducted for selected small scale farmers, beekeepers, extension experts and *woreda* agricultural extension officers.

Field Observation

Observation of the study *kebeles* was carried out prior to collecting data; different sites were visited to know the status of pesticides use, application practices, beekeeping and topography of the study area. Information regarding people's attitude, pesticides use, application practices and beekeeping trends were obtained from personal observation and by talking with peoples in their site. Field observation has contributed to substantiate some of the findings of the study.

Sources of secondary

Secondary source of data were reviewed to supplement the primary sources of data. Various documents available at *wereda* and *kebele* were reviewed and used to generate secondary source of information. Moreover, books, journal, articles, different GOs and NGOs documents and publications, and academic research papers could be reviewed to understand pesticides use, application practices and implications on beekeeping to the findings.

3.5. Method of Data Analysis

Data for this study were generated through qualitative and quantitative method. Hence, qualitative and quantitative techniques were used to analyze data. Information's that were generated from key informant interview, focus group discussion and personal observation were analyzed qualitatively. The SPSS software version 20 was used to analyze the quantitative data such as frequencies, percentages and cross tabulation was applied to generated quantitative data from household survey entered into computer for analysis. A pesticide risk assessment tool is already developed for an Ethiopian situation PRIMET (Pesticide Risks In the Tropics for Man, Environment and Trade) in collaboration with Wageningen University of the Netherlands. This tool is developed considering specific scenarios in Ethiopia and can be taken as a pioneer in Africa. Thus, this tool was used to assess risks posed by pesticides. It can estimate risks of pesticides currently registered or to be registered in Ethiopia for none target organisms including bees. To analyze data the software package called PRIMET was used to indicate the risk status of the applied pesticides to honey bees. Input data were collected by survey on pesticides use, chemical name of pesticides, frequency of application, dosage, crop type and stage of application and other all data required such as LC50,LD50 and ADI were organized and enter into the software and processed. Then the software calculates the ETR for each chemical pesticides for both off-crop and in-crop scenarios. The software indicates whether the pesticides are high risk, possible risk or low risk to bees depending on the data entered. PRIMET calculates the ETR (exposure toxicity ratio) of pesticide applied on target crop and pest. There were threshold levels set scientifically to show risk categories as low risk, possible risk and high risk. Thus, if the output ETR value of a given pesticide to be greater or equal to 400, that pesticide could be taken it was highly risky to honey either in-crop or off-crop scenario. In addition to this if the value of ETR became in a range between 50 and 400 that pesticide could be classified as under the categories of possible risk in both off-crop and in-crop scenario. Depending on the values of ETR decision could be given regarding the pesticide used or to be used. This PRIMET software help us weather a given chemical was or will be risky to honey bee. Hence, quantitative data was analyzed using Statistical Package for Social Sciences (SPSS). Among most frequently used pesticides, insecticides and herbicides were widely used. Insecticides are the more damaging types of pesticides to honey bees (Harvard School of Public Health, 2015; Sheridan et al., 2017). Therefore, six types of insecticides which are most frequently used in the study area were selected and their risks were analyzed by using PRIMET Ethiopia 1.1.1. Version.

Pesticides Environmental Risk Assessment on Honey Bees Using PRIMET/Pesticides Risks in the tropics to Man, Environment and Trade/

The environmental risk assessment contains six protection goals being aquatic ecosystem, terrestrial ecosystem, bees, non-target arthropods, birds and non-target plants. These protection goals are discussed in the next sections. The risk assessment focuses on the protection of beehives and honeybees at the treated crop and outside the treated crop. The *Apis mellifera* of honey bee species is taken as a representative species for all bees so that LD50 values for this species were used for risk determination.

The risk, expressed in Exposure Toxicity Ratio (ETR bee, in-crop) as a result of applications is:

ETR bee, in crop =PEC bee, in crop / PNEC bee

With,

ETR bee, in-crop = In-crop Exposure Toxicity Ratio due to application (-)

PEC bee, in-crop = In-crop exposure concentration to bees, i.e. the individual dose applied (gha-1)

PNEC bee = Predicted No effect concentration for bees (g ha-1) PNEC value = LD50 value (the lowest of either the oral or contact LD50 values)

ETR bee, in-crop < 50 No Risk (indicated by a green colour)

50 ≤ ETR bee, in-crop ≤ 400 possible risk (indicated by an orange colour)

ETR bee, in-crop > 400 High Risk (indicated by a red colour)

Risk assessment for bees, off-crop

The risk, expressed in Exposure Toxicity Ratio (ETR bee, off-crop) as a result of applications is:

ETR bee, off-crop =PEC bee, off-crop / PNEC bee

With,

ETR bee, off-crop = Off-crop Exposure Toxicity Ratio due to application (-)

PEC bee, off-crop = Off-crop exposure concentration to bees, i.e. the individual dose applied (g ha-1)

PNEC bee = Predicted No effect concentration for bees (g ha-1) where PNEC value = LD50 value (the lowest of either the oral or contact LD50 values)

ETR bee, off-crop < 50 No Risk (indicated by a green colour)

50 ≤ ETR bee, off-crop ≤ 400Possible risk (indicated by an orange colour) ETR bee, off-crop > 400 High Risk (indicated by a red colour)

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1. Characteristics of Study Population

The survey was conducted on 312 households, where 304 were farmers and 8 were pesticide retailers. Age distributions of the household members were varied. The age of great majority (63.7%) respondents were between 20 and 30, which followed by the age group between 31 and 40 that account 17.94%, and age ranges from 41-50 were 8.7% from total respondents. Concerning marital status, 88.8% of respondents were married and 11.2% of them were divorced. Like most rural areas of the country, the major (91.7%) households types of respondents were male headed and 8.3% were female headed. Educational status of respondents showed that 4.5% are illiterate, 8.6% can read and write, 61.5% attended grade one up to six, 10.3% attended grade seven to twelve and the rest 5.6% were attended college level education. Concerning occupational status of respondents, 97.4 % of respondents were engaged in farming activities and 2.6% of respondents were merchants.

Table 1: Socio-economic and demographic status of the survey households population

Variables	Category	Number	No. (%)
Age group	20-30	199	63.7%
	31-40	56	17.94%
	41-50	27	8.7%
	Total	312	100%
Marital status	Married	277	88.8
	Divorced	35	11.2%
	Widowed	0	0%
	Widower	0	0%
Education level of survey household head	Illiterate	14	4.5%
	Read and write	58	18.6%
	Grades 1-6	192	61.5%
	Grades 7-12	32	10.3%
	College	16	5.1%

4.1.1. Beekeeping status of survey households

The study area communities have been using different type of beehives (see figure 4), where most of the survey households (68%) have traditional hives (Figure 5). As per FGD and KII, there were two forms of traditional beekeeping in the study area, which are forest and backyard based beekeeping. The communities have been practicing forest beekeeping by hanging traditional beehives on trees. This production method is marked by terribly low honey production. Commonly the average amount of crude honey produced from conventional (traditional) beehives is estimated about 8 to 15 kg/beehive/year (Beyene and David, 2007). Traditional husbandry is practiced with many fixed comb beehives, particularly in remote areas. The traditional beekeeping carried out with minimum expense and labor input, thus farmers consider it as beneficial particularly for individuals who leading a marginal life (Tessega, 2009). The second most widely used hives in the study area is transitional hives as reported by 22.8% households. A transitional framework type beehive is an intermediate form, which is characterized between conventional and modern beehive type. Kenyan Top-Bar (KTB) is well known and commonly used hive in the study area. Nearly 8.3% have three types of hives, while the rest 2.6% respondents did not engage in the bee keepings, who were pesticide retailers.

Figure 4: Honey bee hives in Gudeya Bila woreda

In this regard Tessega, (2009) reported that with minimum expense and labor, honey harvest is accomplished, and it is beneficial for individuals living a marginal life. Of the studied households 23% have transitional hives, which is somehow improved as compared to traditional hives. A transitional framework may be an intermediate form of beekeeping between conventional and modern styles of beekeeping. KTB is well known and commonly used in the study area. The rest 9% have three types of hives.

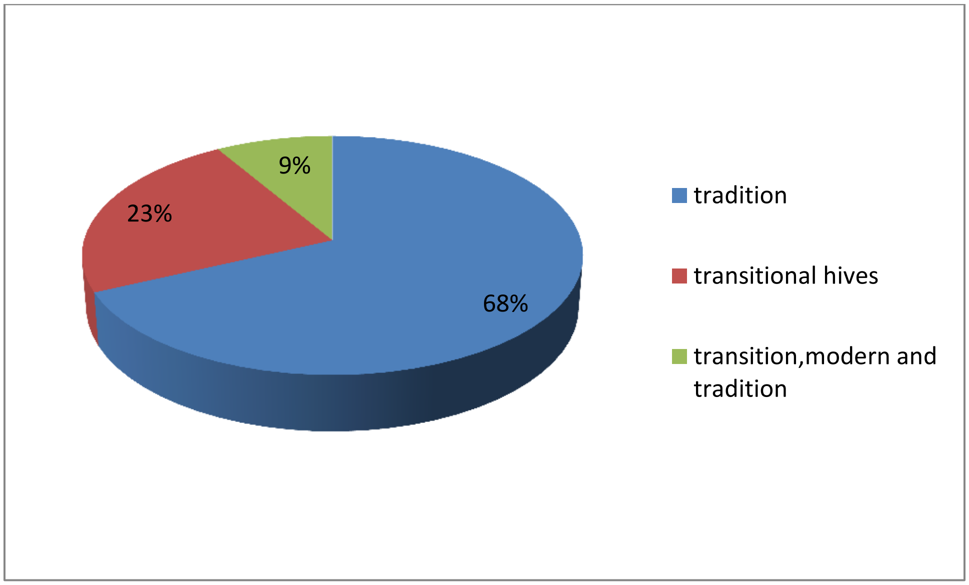


Figure 5: Types of hives owned by farmers

4.1.3. Income Obtained From Beekeeping

Honey bee could be produced two times within a year. As shown in table 2, the survey revealed that the households obtain some income from beekeeping by selling the produced honey. Considerably larger proportion (68.6%) respondents reported that they earn over 5,000 birr in one production season, while the reaming earn below this amount, i.e.,13.5%, 5.1% and 10.3% respondents reported that they earn 2001 to 3000 birr, 3001-4000 birr and 4000 – 5000 birr, respectively. This idea was supported by research conducted in Ethiopia which says Economic and ecological importance of bee and bee products in Ethiopia (Ajebush, 2018).

Beekeeping activity has important contribution economically and ecologically (Ajebush, 2018). Potential to contribute to employment generation, local and global market, livelihood improvement, and biodiversity conservation and helps ensuring economic advantages of girls, youths & Ethiopia's geographical position poor households. Development of the Beekeeping practices could significantly enhance crop production, food security, maintenance of plant diversity and ecosystem stability (Apimondia international symposium, 2018).

Table 2: Income obtained from Honey production at one trip

Income range in one production season	Frequency	Percent
2001-3000	42	13.5
3001-4000	16	5.1
4001-5000	32	10.3
>5000	214	68.6
Total	304	97.4
Missing System	8	2.6
Total	312	100.0

4.2. Pesticides Use and Application Practices

Smallholder farmers relate to two practices when addressing pesticides; pesticide use (handling) practices and pesticide-buying (selecting) practices (Belay, 2016). Concerning pesticides use all respondents (100%) replied that they use chemical pesticides for agricultural purposes. Among all respondents only 10.6% knew illegal pesticides, most of respondents (89.4%) didn't know illegal pesticides means (Figure 6). Those who reported that they knew the illegal pesticides they have wrong perception on how to identify the illegal pesticides.

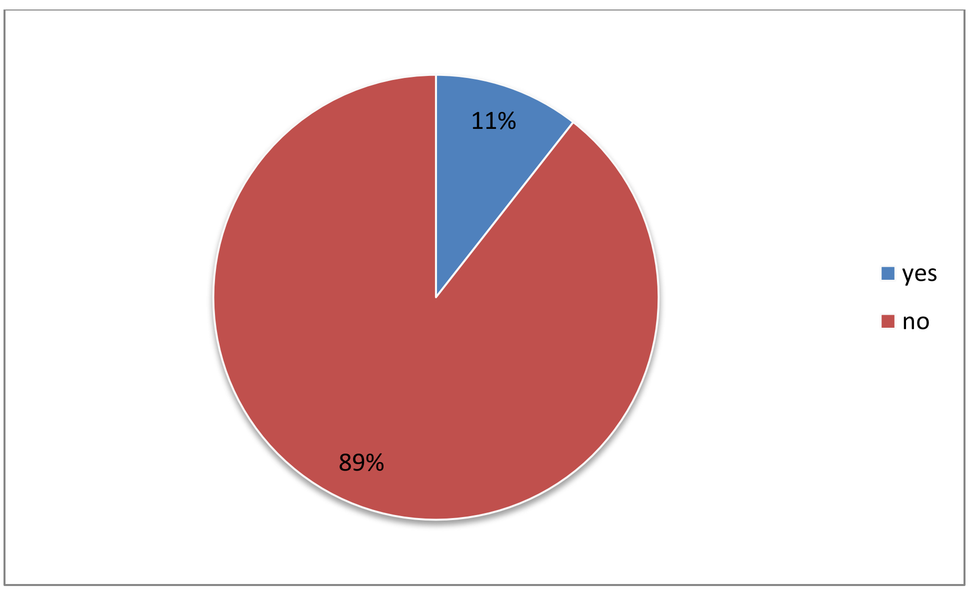


Figure 6: Knowledge of respondents on illegal pesticides

Most respondents (74%) indicated that they never read the label during purchasing and applying the pesticides, while about 24% respondents read the label while purchasing. All respondents reported that the source of pesticides for them to purchase were local dealers, but they don't know whether they are legal or not. In addition, about 79.5% respondents indicated that they bought pesticides without label and only 20.5% buy pesticides with labels (Figure 7). This means, majority farmers are purchasing pesticides without any instruction or information. In pesticide registration and control proclamation number 674/2010 part four (b) a pesticide importer or dealer have to prominently display a legible label in Amharic and in English, which has been approved and cannot easily be detached (Negaret gazeta,2010). Therefore this indicates the legally registered pesticide always have labels in both Amharic and English and approved by Ministry of Agriculture (regulatory body). This means without any instruction found on the container of pesticides they bought pesticides and only 20.5% buy pesticides with labels. This finding much lesser than study conducted in Southwest Ethiopia which in revealed around 63.2% of farmers usually followed the instructions/labels written on the containers of the pesticides (Gesesew et al. 2016).

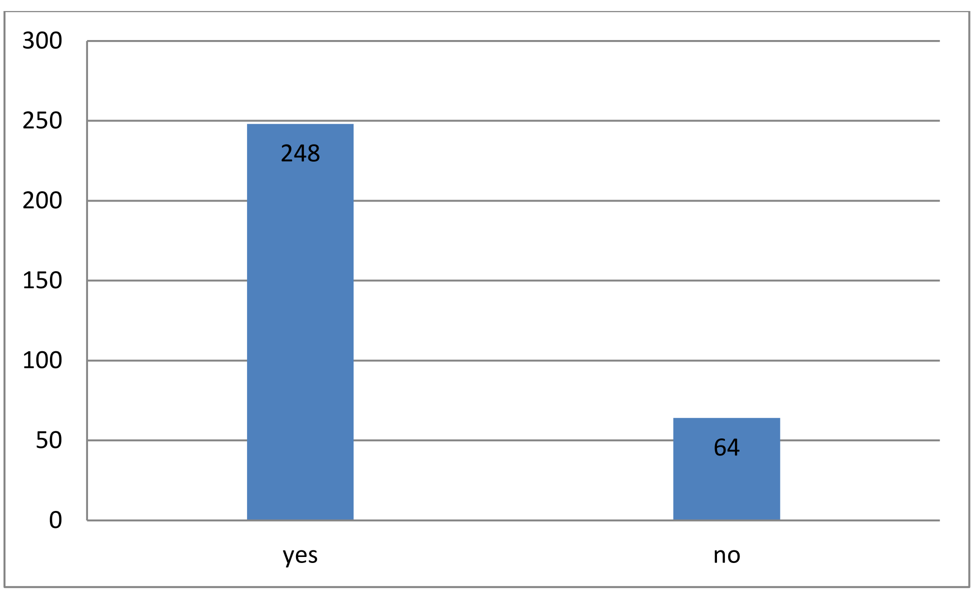


Figure 7: Pesticides use with and without labels

Results showed that those respondents that bought pesticides without label buy these chemicals from local dealers. Among farmers who reported that they purchase pesticide with label in a language they didn’t know, 63 % while 34% of them purchase chemical pesticides with label in language they understand (Figure 8).

Do you buy pesticides with a label with language you don’t understand?

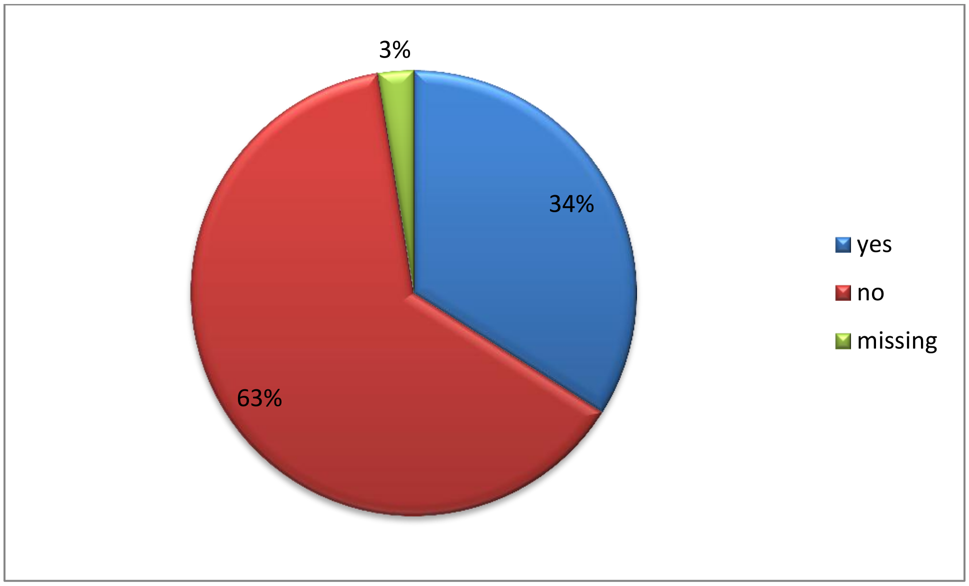


Figure 8: Respondents use status of pesticides with a label in a language they did not understand

Result in table 3 showed that 62.5% respondents reported that they buy pesticides both from registered and unregistered suppliers and 37.5% purchase from register

red suppliers. The survey respondents and FGD participants indicated that some retailers sell pesticides with material safety sheet but most retailers sell pesticides by pouring from the original containers into other container based on the customer request. This is illegal action according to pesticide registration and control proclamation number 674/2010.

The agricultural office has given little emphasis in incorporating pesticide use in agricultural extension services. Result from table 3 shows that 11.9% of respondents said that pesticides use has been included in agricultural extension package and most of respondents (88.1%) thought that pesticide use issues were never included in agricultural extension packages. The survey showed that only 16% of respondents had sufficient and appropriate information on how to use pesticides but 84 % don't have such information.

Based on the FGD and KII, there are eight pesticide retailers in the study area but only five of them had certificate of competency and other legal requirements. All pesticide dealers replied that they began pesticide market in the last two years. All of them have agricultural education background, but all don't have information and knowledge about pesticide registration and they don't have list of registered pesticides in Ethiopia. Moreover, whenever the retailers buy pesticides from wholesalers they never ask license and work permit (professional) certificate. From farmers involved in the survey, 97.4% respondents said that they never move their hives to safe place and location (distance) while spraying pesticides nearby the hives. The result of household survey and qualitative research also revealed that there were no pesticide inspectors from concerning agricultural office to control illegal pesticides and mode of application. In relation to this, all respondents said they never have seen any inspectors and nobody was punished for selling illegal pesticides. Moreover, 56.3% respondents said that they apply the chemicals (pesticide, insecticide or herbicide) whenever their farm get infested with weed, insect or disease that they spray even at blooming or flowering stage of the crop although this stage is very acute time for bee to make honey.

Table 3: Pesticides use and application practices of farmers

Questions	Responses	Frequency	Percent
Are pesticide uses included in extension service package?	Yes	37	11.9
	No	275	88.1
	Total	312	100.0
Do you have sufficient and appropriate information on how to use pesticides	Yes	50	16
	No	262	84
	Missing (System)	0	
	Total	312	100
Do you displace your hives when applying pesticides nearby hive?	No	304	97.4
	Missing (System)	8	2.6
	Total	312	100.0
Do pesticide inspectors visit pesticide shops and you in the field while applying pesticides?	Yes	0	0
	No	312	100
	Missing(system)	0	0
	Total	312	100
Do you Select time to apply pesticides?	Yes	174	56.3
	No	130	43.7
	Missing(system)	8	2.564
	Total	312	100
Fate of pesticide containers	Reuse them	257	82.3
	Dispose in the field	55	17.7
	Missing(system)	0	0
	Total	312	100

Most of farmers (72.7%) mix pesticides near the river and which are used by local residents for drinking and cooking. The rest 27.3% mix pesticides in the field where they spray but they fetch water using the materials they mix the pesticides. This show there might be contamination of water from the containers that were used to mix pesticides. This finding in line with research conducted in the central rift valley of Ethiopia (Belay, 2016) which exposed. Most farmers (74%) mix their pesticides close to a river, canal or community water source. 89.4% of respondents replied Mixing takes place in a knapsack and the rest mixes in the open headed plastic containers. Results exposed that 82.3% of respondents reuses pesticides containers without enough rinsing methods and the rest respondents dispose in the field, this result is much higher than research conducted by (Belay,2016) which exposes the mixing containers are reused by 48% of the farmers.

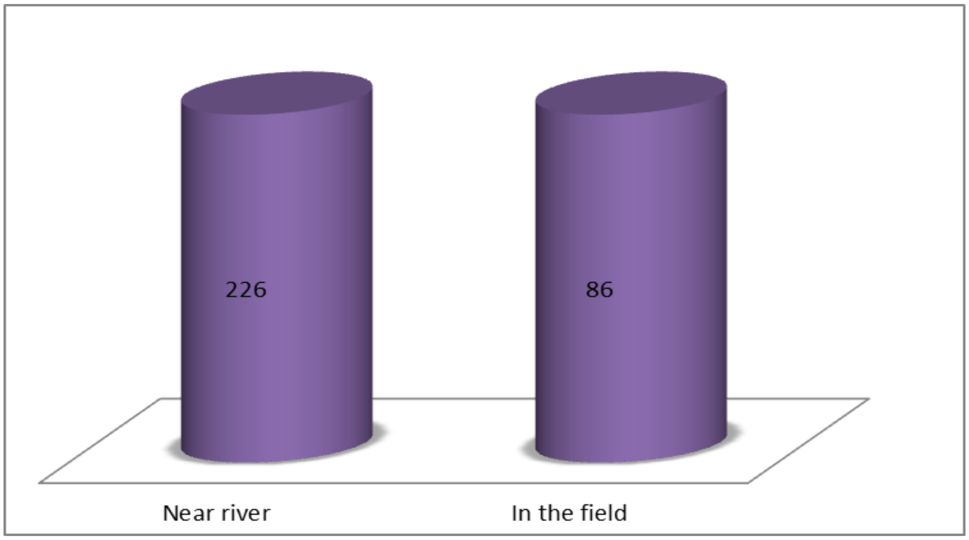


Figure 9: Pesticide mixing practice

Results from table 4 showed that the most frequently used pesticide(insecticides) were malathion 60%EC,dimethoate 40%EC,Lambda cyhalotrin 5%,Fibronil 50SC,diazinon60%EC, Chlorpyrifos 40%EC,profenfos and primiphos methyl were frequently used in the study area and we conclude that farmers in the study area were using knapsack to apply pesticides. In table 3 there were many malpractices concerning pesticide use in the study area and these practices will lead to decrease in colonies of honey bees. Both neonicotinoids and fipronil also generate honey bee immune suppression (Di Prisco et al., 2013) and thus predispose bees to Nosema infections (Pettis et al., 2012) and outbreaks of viral diseases typically spread by Varroa mites (Doublet et al., 2014). As a result, the combined effects of chemicals and diseases may succumb to colonies feeding on honey and pollen contaminated with these neurotoxic insecticides.

Table 4: Pesticides frequently used in the study area

Trade Name of pesticides	Chemical name	Target pest and host they registered for	Spay equipment
Ethiolathion 50%EC	Malathion 60%EC	For the control of sweet potato butterfly	Knapsack
Dimethoate 40EC	Dimethoate 40%EC	Diptera,Lepidoptera on cereals	Knapsack
Karate	Lambda cyhalotrin	To control cotton pests	Knapsack
Lipron 50 SC	Fipronil	To control termite in rice	Knapsack
Ethiozinon 60% EC	Diazinon	For the control of maize stalk borer	Knapsack
Ethiopyrifos 48% EC	Chloropyrifos	For the control of maize stalk borer	Knapsack
Profit 72% EC	Profenofos	For the control of pea aphids (Acyrtosiphon pisum) on field pea.	Knapsack
Carbimog 85 WP	Carbaryl	For the control of stem borer on maize	Knapsack
Actellic 50% EC	primiphos methyl 50%	For the control of mosquitoes	Knapsack
Mahaveer	Fipronil 5% SC	For the control of cabbage Aphid on Cabbage	Knapsack

4.3. Implications of Pesticide use on Beekeeping

About 31.7% of respondents said they have seen bee death during or after application of pesticides, and bees show different behavior. For example the survey respondents indicated that the bees show aggressiveness symptoms and anomalous behavior beside the observed deaths after and/or during the chemicals spray on crops as reported by 52.9% and 15.4% respondents respectively. Therefore, the survey result shows that beekeepers and farmers think that bee colonies were declining overtime due to exposure of bees after or during pesticides application, which was evidenced by of there were observed deaths, aggressiveness, and anomalous behavior of worker bees as rolling. This study align with study which says the bee population is reducing all around world since 2006 and average death rate of honey bee colonies are half-hour in USA and a few beekeeper claimed even greater injuries (Lee et al., 2015). About 25- half-hour honey bee population decline in European countries and Canada is thanks to extreme use of upper concentration of pesticides (Van Engelsdorp and Meixner, 2010). Honey bees and beekeepers are littered with the excessive usage of pesticides each year in agriculture sector because of beginning of agriculture modernization (Maini et al., 2010). Honey bee life depends upon flowering plants. Honey bees foragers collect nectar from nectariferous plants, collect pollen only from polliferous plant and a few bee foragers collect nectar and pollen on the identical plant (Pătruică, 2006).This result supports the thought of study conducted by ((Kerealem et al.,2009) which stated as, In Ethiopia, the poisoning of honeybees by application of pesticides has increased from time to time, and a few beekeepers were also lost all their colonies thanks to agrochemical application.

In relation to the effect of agro-chemicals on bees, Craig et al., (1998), underlined that droplets and dust from the applications will fall directly on the bees traveling through or around the treated fields and wind will bring the small droplets and soil particles several meters away from the flower, which cause effect on bees. Similarly Marinelli et al, (2004) research verified that one insecticide droplet of agro-chemicals like pesticide could destroy a bee since the spray solutions contain concentrated doses of pollutant compounds, which could be the most common cause behind the bee outbreaks.

The current study showed that 31.7% of respondents replied they observed deaths of honey bees during or after pesticide application. As revealed from current research almost all farmers (97.4%) didn’t move their hives to safe place during pesticide application. This finding supports the idea forwarded in the review on pesticide use practice and its effects on honey bee in Ethiopia by Fikadu, (2020) which indicates that majority of beekeepers do not use any control measures for chemical poisoning to honey bees. Likewise Sanchez-Bayo, (2014) indicated that most of the time, bees are exposed to pollutants by the ingestion of pollen and nectar residues from infected seeds, whether from crops or from weeds across the fields. It is important to note that bees eat chemicals wherever they go and search for the most fitting flowers that provide ample pollen and nectar. Such crops are also more attractive than others; for example, canola (rape seed oil) yellow flowers, sunflowers, and many of the weeds that grow in and around the crops are more attractive to bees than potato plant flowers, in converse farmers apply chemicals to these crops to control pest, insect, disease and weed. The forager bees take pesticide residues in pollen and nectar to their colonies and live inside the beebread and honey for quite some time (Orantes-Bermejo et al., 2010). These residues are then fed to the larvae and the queen as well, who are influenced by the forager bees in comparable ways. Bees also consume water in addition to sugar, to keep their temperature under control (Schmaranzer, 2000). Pesticide compounds in the soil gradually get into the water and emerge in and above the lakes, creeks and rivers in rural areas, polluted with a combination of agrochemicals (Beldel et al.,2007). Additionally, some water pollution is due to drift from spray applications, particularly from insecticides (Woods et al. 2003). Honey bees, bumblebees and wild bees prefer to drink from puddles, drainage ditches, rivers and lakes, and they are often eaten by forager bees if these waters are polluted with pesticide residues. Thus these exposures of honey bees to pesticides cause the collapse of bee colonies.

Table 5: Symptoms observed to bees during or after pesticide application

		Frequency	Percent
Which of the following will be observed after pesticides application around hives	Aggressiveness	165	52.9
	Deaths	99	31.7
	anomalous behavior of worker bees as rolling	48	15.4
	Total	312	100.0

4.4. Risk Assessment of Most Frequently Used Chemical Pesticides in the Study Area

For the risk assessment an oral LD50 and a contact LD50 are available and taken from Pesticide Properties Data Base (PPBD). The lowest value obtained is chosen. The EU trigger value of 50 is used. This value is based on empirical research. An assessment of observed bee kills/colony effects for various pesticides and different application rates showed that for sprays a factor of the ETR below 50 is always safe (no field incidents at ETR < 50).

4.4.1. Risk Assessment of Carbaryl for Honey Bees

Carbaryl is one of most frequently used insecticide in the study area according to survey data. Mostly carbaryl was used for the treatment of maize stalk borer. Thus the risk assessment of carbaryl on bees was assessed using PRIMET software. The assessment was done using two scenarios; off-crop and in-crop risk assessment. For both scenarios the ETR (exposure toxicity ratio) were calculated. According to risk classification if ETR values become less 50, it is assumed that the chemical is low risk to bees in the selected scenarios. If the ETR values lies between 50 and 400 it is assumed that there will be possible risk and if ETR values are 400 and above it is assumed that the pesticide is highly risky to honey bees.

From table 6 the ETR value of carbaryl for in-crop scenario was observed that it was 9107, this showed that carbaryl is highly risky to honey bees. From assessment of observed bee kills/colony effects for numerous pesticides and different application rates and from two studies with data from the United Kingdom (Mineau et al., 2008) it appeared that there is about 50% probability of bee mortality at a trigger value of 400 for the ETR. The ETR value of the carbaryl sprayed on maize is highly risky to honey bees in the current study.

For off-crop scenario the ETR value was 255 for carbary sprayed on maize. This implies that there is possible risk of carbaryl to honey bees. Pesticide exposure can have a sizable impact on the nutritional composition of royal jelly produced by honey bees and as a result can influence queen development. Oral exposure to pesticides in adult workers has been shown to influence nurse bee glandular physiology (Bohme et al., 2016) and could therefore impact royal jelly production. Current study revealed that farmers never displace honey bee hives and select time to apply pesticides (Table 3), these practices would make honey bees to be exposed to pesticide poisoning. From PRIMET software result the ETR values of carbaryl showed that carbaryl is highly risky to Apis mellifera of honey bees. Therefore from this fact honey bees were facing risky from carbaryl application.

4.4.2. Risk assessment of Chlorpyrifos on honey bees

Chlorpyrifos is one of the most commonly used insecticides and categorized under organophosphate chemical group. This chemical pesticide was used for the similar purpose with carbaryl to treat maize stalk borer. The risk assessment was done in two scenarios; off-crop and in-crop. Concerning in-crop scenario the ETR (Exposure toxicity ratio) was **3254.** This value indicates the pesticide is highly risky to honey bee in in-crop scenario. Regarding off-crop scenario the ETR value is **91.12** and is found in the risk possible classification (Table 8). According to Mineau et al. (2008) from assessment of two studies with data from the United Kingdom it appeared that there is about 50% probability of bee mortality at a trigger value of 400 for the ETR. Therefore, from the current study the ETR value for in-crop scenario showed that Chlorpyrifos is highly risky to honey bees and there were malpractices of farmers concerning pesticide use and application practice like not selecting time of pesticide application, not moving (displacing) hives to safe position and not selecting plant stage while applying chemical pesticides (table 6) that make honey bees to be poisoned with pesticides. Chlorpyrifos is pesticide used foliarly in crop pest controlling and chlorpyrifos has a relatively high toxicity to bees compared to other pesticides (Johnson et al., 2010). Worker honey bees can forage in range up to 12 km around hive and, therefore, are frequently exposed to a dispersal of pesticide residues present in water, nectar and pollen (Mullin et al., 2010). Chlorpyrifos had the lowest LC50 values and was thus considered the more toxic bee species. Overall, organophosphate insecticides have relatively low toxicity through oral exposure because they are rapidly metabolized or otherwise cleared; however, persistent compounds such as chlorpyrifos may remain in the body long enough to cause toxicity when ingested (Sanchez-Bayo and Goka ,2014). Chloropyrifos inhibit the AchE enzyme is irreversible, once it bind to enzyme target site it permanently block enzyme active site and requiring more enzyme to control overstimulation of nerve impulses (Mahnoor and Farkhanda,2021).These effects cause the decline of honey bees colonies.

4.4.3. Risk assessment of Diazinon for honey bees

Diazinon is an insecticide registered to treat maize and sorghum stalk borers and armyworm in Ethiopia. In the study area, it was mainly used to treat maize and sorghum stalk borer. The ETR value of diazinon for in-crop scenario was 6667 and this value shows that diazinon is highly risky to honey bees. For off-crop scenario the value of ETR was 186.7 and this value indicated diazinon can be classified in possible risk category (Table 6). As a matter fact, the Diazinon was known to be highly toxic to the terrestrial invertebrates, bees and other beneficial insects following acute contact exposure, where acute LD50 for bees was 0.22 μg/ one bee as per National Pesticide Information Center, (2009). In general, the toxicity of insecticides to honey bees was increased with increases in the exposure time. According to Torchio,(1973) cited in Jason and Robert,(2002). Thus ERT value for diazinon in in-crop scenario in line with study conducted by Jason and Rober,(2002) which stated as Diazinon is well known as a dangerous pesticide for use around bees.

4.4.4. Risk assessment of Fipronil for honey bees

Fipronil is among insecticides used mainly to treat termites in rice and aphids on cabbage. Fipronil ETR (exposure toxicity ratio) is 12*E4 or 120,000 and this value indicates fipronil was highly risky to honey bees for in-crop scenario (Table 7). For off-crop scenario the ETR value of fipronil is 335.5 which categorized under possible risk for honey bee. Fipronil has an antagonistic action on gamma amino butanoic acid (GABA) neurotransmitters and glutamate-activated chloride channels (GluCls) (Narahashi et al. 2010), and this pesticide/insecticide can cause interactive changes in bees that embrace agitation, spasms, tremors, and paralysis (Zaluski et al. 2015). Fipronil is more noxious in sublethal doses, spoiling the motor activity of bees. . Fipronil, the identical to organophosphorus insecticides, causes hyperexcitation of the nerves and muscles of insects. At plenty concentrations, Fipronil causes paralysis and death. Studies on several crops showed Fipronil metabolism in plants to fipronil-amide, fipronil-sulfone, and fipronilsulfide, whilst after foliar application, additional photodegradation to desulfinyl-fipronil occurs (Simon-Delso et al., 2015). With the poor practices of pesticides use and application of study area farmers the fipronil could be one in every of the causes of bee colonies declining within the study area which supports the thought raised study conducted by Simon-Delso et al,2015).

4.4.5. Risk assessment for Malathion to Honey bees

Malathion is one of most frequently used and also formulated locally by Adamitulu Pesticide processing company in addition to the imported ones. According to FGDs and KIIs, Malathion in form of 50%EC was mostly used in the study area to treat maize and sorghum stalk borer. Vis-à-vis in crop scenario the ETR value of malathion was 4688 which is under the category of high risk classification to honey bee (Table 6). Concerning off-crop scenario the ETR (exposure toxicity ratio) of malathion was 131.3 and it is under possible risk classification to honey bee. It is important to note that bees eat wherever they go and search for the most fitting flowers that provide ample pollen and nectar. Such crops are also more attractive to bees than others; for example, canola (rape seed oil) yellow flowers, sunflowers, and many of the weeds that grow in and around the crops are more attractive to bees than potato plant flowers. The forager bees take pesticide residues in pollen and nectar to their colonies and live inside the beebread and honey for quite some time (Orantes-Bermejo.et al, 2010). These residues are then fed to the larvae and the queen as well, who are influenced by the forager bees in comparable ways. Bees also consume water in addition to sugar, to keep their temperature under control (Schmaranzer, 2000).

4.4.6. Risk assessment for profenfos to hone bees

Profenfos is one of pesticide categorized under organophosphate chemical group. As shown in table 12, the ETR value of profenfos for in-crop scenario was 7579 and is high risk to honey bees and for off-crop scenario the ETR value of profenfos was 212.2 and categorized under possible risk classification of risk to honey bees. Pesticide compounds in the soil gradually get into the water and emerge in and above the lakes, creeks and rivers in rural areas, polluted with a combination of agrochemicals (Beldel et al., 2007). Additionally, some water pollution is due to drift from spray applications, particularly from insecticides (Woods et al., 2003). Honey bees, bumblebees and wild bees prefer to drink from puddles, drainage ditches, rivers and lakes, and they are often eaten by forager bees if these waters are polluted with pesticide residues. These facts indicate that when bees exposed to pesticides their colonies are under risk of damage by poisoning by pesticides.

Table 6: Summary of risk assessment to bees in an in crop and off crop situation

Pesticide	Crop	Application rate (kg/ha)	LD50 Oral/contact (µg/bee)	PNEC (g/ha)	PEC in crop	PEC off crop	In crop ETR=PEC/PNEC	off-crop ETR=PEC/PNEC
Carbaryl	Maize	1.275	0.14	0.14	1275	35.7	9107	255
Chlorpyrifos	Maize	0.192	0.059	0.059	192	5.376	3254	91.12
Diazinone	Maize	0.6	0.09	0.09	600	16.8	6667	186.7
Fipronil	Cabbage	0.05	0.00417	0.00417	50	1.4	12000	335.7
malathion	Potato	0.75	0.16	0.16	750	21	4688	131.3
profonefos	Faba bean	0.72	0.095	0.095	720	20.16	7579	212.2

NB: ETR < 50 = low risk, 50<ETR < 400 , medium Risk, ETR >400 = high risk

4.5. Summary of Risk Assessment Result of Selected Pesticides Using PRIMET Software

For the risk assessment an oral LD50 and a contact LD50 are used by choosing the lowest value of the two and defining exceedance factor for the risk classification. From assessment of observed bee kills/colony effects for various pesticides and different application rates and from two studies compared with data from the United Kingdom (Mineau et al., 2008). Therefore, the current analysis revealed 50% probability of bee mortality at a trigger value of 400 for the ETR. This value is taken as the upper limit of the risk classification for the current study. From the above PRIMET (Pesticides Risks in the tropics to Man, Environment and Trade) ETR value showed that all (six) pesticides types namely: Carbaryl, chlorpyrifos, diazinon, malathion, fipronil and profonefos are highly risky to honey bees in in-crop scenario and in possible risk range in off-crop scenario. These finding is in line with other researches as discussed under.

Experimental exposure to dietary fipronil caused dose-dependent reductions in the longevity (days of exposure survived) of adult honey bees and fipronil can be lethal to honey bees in dietary exposures to the trace residues that typify those in nectar and pollen from treated crops (Philippa, 2018). Including fipronil all insecticides assessed as indicator by PRIMET software were risky to honey bee, therefore it needs protection measures must be taken to keep honey bees from pesticides poisoning during or after application. It is important to note that bees eat wherever they go and search for the most fitting flowers that provide ample pollen and nectar. Such crops are also more attractive than others; for example, canola (rape seed oil) yellow flowers, sunflowers, and many of the weeds that grow in and around the crops are more attractive to bees than potato plant flowers. The forager bees take pesticide residues in pollen and nectar to their colonies and live inside the beebread and honey for quite some time (Orantes-Bermejo etal.,2010). These residues are then fed to the larvae and the queen as well, who are influenced by the forager bees in comparable ways. Bees also consume water in addition to sugar, to keep their temperature under control (Schmaranzer, 2000). Pesticide compounds in the soil gradually get into the water and emerge in and above the lakes, creeks and rivers in rural areas, polluted with a combination of agrochemicals (Beldel et al, 2007).

Additionally, some water pollution is due to drift from spray applications, particularly from insecticides (Woods et al., 2003). Honey bees, bumblebees and wild bees prefer to drink from puddles, drainage ditches, rivers and lakes, and they are often eaten by forager bees if these waters are polluted with pesticide residues. These facts indicate that when bees exposed to pesticides their colonies are under risk of damage by poisoning by pesticides.

CHAPTER FIVE

5. CONCLUSION RECOMMENDATIONS

5.1. Conclusion

The result shown that most of respondents (66.35%) have traditional hives, who engaged in two forms of traditional beekeeping, i.e., forest beekeeping and beekeeping in the backyard. Forest beekeeping is practiced by hanging traditional beehives on trees, which has been widely practiced in the study area. In current research focuses on pesticide use and application practices that include selection, application practices and management of pesticides. Concerning pesticides use all respondents (100%) indicated that they use chemical pesticides for agricultural purposes. Among all respondents, only 10.6% knew illegal pesticides, while most respondents (89.4%) didn't know illegal pesticides means. Those who reported that they knew the illegal pesticides they have wrong perception on how to identify the illegal pesticides. In pesticide registration and control proclamation number 674/2010 part four (b) a pesticide importer or dealer have to prominently display a legible label in Amharic and in English, which has been approved and cannot easily be detached (Negaret gazeta, 2010). Therefore, this indicates the legally registered pesticide always have labels in both Amharic and English and approved by Ministry of Agriculture (regulatory body means plant health regulatory directorate). From the current finding most farmers did not consider the pesticides they have using are recommended for only target crop and paste they registered for.

The other finding of the study is that awareness problem and illiteracy impacted the proper use of chemicals as most of respondents (74%) don't read the label while purchasing pesticides. All respondents indicated that they purchase pesticides for local dealer, whom they don't know whether they are legal or not. In addition 79.5% respondents reported that they buy pesticides without label, which means without any instruction found on the container of pesticides they buy pesticides. The survey households also indicated wrong way of preparing the chemical before application, i.e., about 72.7% farmers carryout mixing of pesticides near the river which are under use by local residents for drinking and cooking. As revealed from current research most (97.4%) farmers didn't move (displace) their hives to safe place during pesticide application.

Therefore, the above problem related with agro-chemicals uses practices and application considerably affects the environment in general and beekeeping in particular. This finding supports the idea forwarded in the review on pesticide use practice and its effects on honey bee in Ethiopia (Fikadu, 2020) which indicates that majority of beekeepers do not use any control measures for chemical poisoning to honey bees. Most of the time, bees are exposed to pollutants by the ingestion of pollen and nectar residues from infected seeds, whether from crops or from weeds across the fields. From the above PRIMET (Pesticides Risks in the tropics to Man, Environment and Trade) ETR value of the six pesticides under current study consideration namely: Carbaryl, chlorpyrifos, diazinon, malathion, fipronil and profonefos are highly risky to honey bees in in-crop scenario and in possible risk range in off-crop scenario. Therefore, protection measures must be taken to honey bees to protect or reduce their exposure to pesticides.

5.2. Recommendation

- The result showed that pesticide use and application practice of farmers were inappropriate and it needs awareness creation for farmers and retailers.
- Remove or cover beehives during application and flowering/ Use only after sunset.
- Making awareness to farmers to notify beekeepers of the neighboring areas before application of the pesticide
- Pesticide registration and control department of Ministry of agriculture should notify and regulate the registrants or agents of pesticides traders to indicate on the labels clearly the toxicity status of pesticides and the labels should have to be translated to local language.
- Institutional setup of pesticide registration and control should have to delegated up to low level or up to woreda to strengthen the control of illegal pesticides
- Most insecticides dangerous to bees/to protect bees and other pollinating insects do not apply to crop plants when in flower or when flowering weeds are present.
- Giving awareness to farmers do not use pesticides especially insecticides where bees are actively for after treatment
- The agricultural extension package should have to include the safe use of pesticides.

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ANNEX I

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ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

Dear valued respondent

First of all let me thank you for sharing your time and information with me. The pesticides use in Ethiopia has been increasing without sufficient knowledge on types of pesticides used and application precautions. Currently, within the Ministry of Agriculture I am pursuing my MSc program at center for environment and sustainable development at Addis Ababa University. My research is entitled **environmental implications of pesticide use and application practices its on beekeeping**. My research encompasses an extensive analysis of the use, applications of pesticide and its implications on beekeeping in Ethiopia, particularly registration, distribution and use, and to review potential impacts of pesticides on beekeeping. In addition to this the study aims to analysis the gaps in pesticides use, applications and the implications of pesticides in beekeeping. You have been requested to participate in this survey. Because I believe that you can give me ideas, information and views on issues related to pesticide use, application practice and beekeeping status of your area. Your kind cooperation in giving me and/or my research assistants an interview is highly appreciated. I want to assure you that the information you give me will be completely confidential and will be used exclusively for our study, and I will not be taking down your name so your answers will be anonymous.

Abaya Alemu

Appendix1: Household questionnaires

Identification

1.1. Question no. ________________ 1.2. Date of interview________________

1.3. Enumerators name __________________________ signature ___________

1.4 Name of Kebele(site): --

1.5. Checked by _________________________________ signature _____________

I. **Household information**

1. Age of respondent_______(Years)

2. Sex of respondent: A) Male B) Female

3. Family size: Female _____ Male ______ Total _________

4. Household type: A) Male headed B) Female headed

5. Marital status of households? A. Married B. Unmarried C. Divorced D. Widowed

E. Other (specify)___________

6. Education level of households? A. Illiterate B. Informal education (read and write) C. Grade 1 to 6 D. Grade 6 – 12 E. Collage and above

II. **Socio-economic**

1. Sources of income for the household head

A. Agriculture (cattle rearing &farming) B. Trading C. Employment (monthly/periodically salaried) D. Casual labor work E. Other (specify) ______________________

2. **Land sizes (ha)**

Types of land	Sizes of land by Ha	Remark
Farm land		
Grazing land		
Non-farm land /woody land		
Home garden		

III. Beekeeping status

1. Do you have Bee hives A. yes B. No
   If yes go to no.2.
2. Fill in the types of beehives you have.

Types of beehives	Numbers	Income obtained annually	Remark
Traditional			
Transitional			
Modern			

III. Pesticides use and application practice

1. Do you use chemical pesticides for your crop/vegetable production? 1. Yes 2. No
2. Which chemicals are you using? (Note: If the respondent does not know the name, or if it is a brand-name product, (you can see the container)
3. Do you know the illegal and legal pesticides? 1. Yes 2.No
4. If you say yes to question no.3, how do you identify?
5. Sources of pesticide 1. Local dealers 2. Government 3. NGO 4. District service cooperatives/unions 5. Open market /informal dealer 6. Other-----------------------
6. Do you usually read the labels on pesticide containers? 1. Yes 2. No
7. Have you ever bought chemical pesticides without a label or without instructions? 1. Yes (if so, please specify from whom/where 2. No
8. When (season/month) and how frequently do you spray pesticides per season?
9. Do you apply pesticides when you suspect the rain will come? 1.Yes 2.No
10. Have you ever used pesticides with instructions in a language you don’t understand? 1. Yes 2. No
11. Do you know the doses of every pesticide you use? 1. Yes 2. No
12. What problems did you encounter in selecting (buying) using pesticide?
13. Could you explain what the pictograms on the pesticide label mean? (answers supported by container/ bottle of a pesticide?
14. Place of pesticide mixing
    A. Near a river canal/community water sources B. In the field (farm area) c. near beehives

15. Fate of empty pesticide container (multiple answers possible)

A. Dump them by the field (throw away on farm) B. Throw into irrigation canals or rivers B. Collect and bury in ground on farm

16. Do you think that pesticides affect environment (water bodies)? A. yes B. No

17. Have you had training about the use of pesticides? 1. Yes 2.No ; If yes, what type of training or information you receive from state or non-state actors. if yes, from whom?

18. What were you trained on?

A. How to use pesticides B. Integratedpest management(IPM) C. Disposal of empty pesticides containers

D. Application methods E. Others specify----------------------------------

19. Please tell me the pesticides you use, crop, frequency and rate of application

S/No	Pesticide trade name	Common name	Crop	Frequency of application	Dosage/ha	Spraying equipment	**Hive location**		
							Off farm	In farm	Km from the sprayed pilot
1									

IV. **Implications of pesticides to beekeeping**

1. Do you displace your hives when applying pesticides nearby hive? A.Yes B. NO
2. Did you have seen honey bee death or other irregular symptoms after or during pesticide application? A. Yes B. No
3. Do you think honey bee colonies have been declining? 1.Yes 2.No
4. Do you select time to apply pesticides to keep honey bees from pesticides? 1. Yes 2.No
5. Which of the following will be observed after pesticides application around hives?
   A. Aggressiveness B. Deaths C. Anomalous behavior of worker bees as rolling
6. Are pesticide uses included in the agricultural extension service? 1. Yes 2. No If no, why not?
7. Do growers (users) have sufficient and appropriate information on how to use pesticide? 1. Yes 2. No ; If no, why not
8. Do have seen the appearance of excessive numbers of dead honey bees in front of the hives during and after pesticides application? 1. Yes 2. No

Key informant interview

1. What are the main problems you face in conducting appropriate pesticide use among smallholder farmers?
2. Do you think honey bee colonies declining could have caused by unsafe pesticides use? How?
3. How and why farmers use pesticides unsafely?
4. Do you think pesticide use increasing in your area? Why?
5. Do you tell me the pesticide applications techniques, equipment use, dosage, frequency of application and time of application status of your area farmers?
6. Do have observe excessive deaths of honey bees in front of hives after pesticides application?
7. What are the major problems related to the way DAs provide support to farmers regarding proper pesticide use?

Questionnaires for FGD

1. Do you tell us the status of beekeeping status in your area?
2. Explain the use status of pesticides use in your area?Is increasing/decreasing?
3. Do farmers take inconsideration about weather condition during pesticide application?
4. Do farmers know that pesticides can harm honey bees? How they perceive?
5. Do honey bees' colonies declining? Do you think this declining of honey bee related to pesticides misuse?
6. How is pesticides application, status in your area? Do farmers displace their hives away while applying pesticides?
7. Do you observed death, aggressiveness and any related symptoms during or after pesticides application?
8. Do honey production increasing? Why?
9. Why farmers misuse pesticides?

Check list for observation

S/No		Issues concerned	Remark
1	**Pesticide use status of the farmers**	**Selection of pesticides, counterfeit, legal, and which chemical for what crop**	
2	**Application practice status of farmers**	**Apparatus selection time, stage of plant, frequency of application**	
3	**Do hives found in farm pilot**	**To check whether hives are off /in farm during pesticides application**	
4	**Do farmers inform their neighbors while they apply pesticides to take care of of their hives**		
5	Fate of empty pesticide containers ?		
6	Time of spraying (morning, midday, afternoon)?		
7	Pictograms presented to farmers and the level of their understanding?		
8	Availability of spray service providers		