

Full Length Research Paper

Knowledge and attitude of *Khat* growing farmers on the safe use and handling of pesticides in Haromaya Wereda, Oromia Regional State, Eastern Ethiopia

Girma Regassa^{1*} and Challa Regassa²

¹Department of Chemistry, Madda Walabu University, P. O. Box 247, Bale Robe, Ethiopia.

²Department of Chemistry, Addis Ababa University, P. O. Box 1176, Addis Ababa, Ethiopia.

Received 6 September, 2020; Accepted 27 November, 2020

The awareness level of the farmers growing *Khat* regarding the safe use of pesticide was investigated in this study at Haromaya Wereda, Eastern Ethiopia. In order to achieve the proposed objectives, structured questionnaires, oral discussions, and field observations were organized with the farmers growing *Khat* on the safe use of pesticide. After the study sites were selected purposively, systematic random sampling of the target population was applied. The study result revealed that the farmers lack training on pesticide practices, and most of them use their own experience and consult their neighbours. The findings of the study further indicated that majority of the farmers do not believe that pesticides can be detected in the soil, fruit and leaves of tree, air, ground water and food. Nearly half of the farmers were aware of the harmful effects of using pesticide on insects and birds. The farmers have poor understanding of the effect of long term exposure to pesticides compared to short term exposure. The farmers' understanding of exposure to pesticides through respiratory system and mouth is relatively satisfactory compared to the dermal exposure. Over one third of the farmers had no knowledge of how to store pesticides in the right conditions. However, greater percentage strongly believes that pesticides should be kept out of the reach of children. Even though, majority of the respondents indicated that DDT was used on *Khat*, only few of them have knowledge of its illegal importation. The outcomes of the study confirmed the need of training on the safe use of pesticides to raise the awareness of the farmers and safeguard the health of the farmers and the environment.

Key words: Knowledge, attitude, pesticide, environmental, health, *Khat* growing farmers, Haromaya, Ethiopia.

INTRODUCTION

Pesticides are widely used chemical compounds in agriculture to destroy insects, pests and weeds. In modern era, they form an indispensable part of agricultural and health practices (Esteban et al., 2020).

Pesticides have helped to duplicate food production during the last century, and the current need to increase food production to feed the rapid growing human population mounts pressure on the intensive use of

*Corresponding author. E-mail: Girma2015gudi@gmail.com.

pesticides and fertilizers (Fernando, 2017). Exposure to chemical pesticides is one of the most significant occupational risks among farmers in the developing countries as they can easily get in contact with pesticides, for example, when mixing the chemicals or when applying them to crops and when pesticide residues are applied in houses (Chitwan et al., 2017). Besides their agricultural uses, pesticides are also becoming essential in household pest control. The continuous application of insecticides has caused some insects to develop resistance. Besides, the continuous use of synthetic insecticides causes ecological disturbance by acting on non-targeted insects (Azeem et al., 2019).

Ethiopia is a developing country and majority of its population, estimated to be 80%, solely depend on agriculture. Reports of United Nations, Department of Economic and Social Affairs (2017) indicated that, the population of Ethiopia was 18,128,000 in 1950 and has grown to 104,957,000 in 2017, and is expected to escalate to 139,620,000 and 190,870,000 in 2030 and 2050, respectively. Feeding large population size will be one of the great challenges to human kind, and may be one of the most intimidating encounters facing the world during the remaining years of this 21st century (Fróna et al., 2019); thus to feed this rapidly growing population of the country, agricultural yields need to be increased. In addition to this the introduction of high production of fruits, vegetables, horticulture farms, and cash crops is highly pronounced in modern agricultural practice. Due to the frequently changing weather conditions, agricultural practices are facing unpredictable challenges resulting in food shortage and food self-sufficiency. Thus, various strategies are designed towards combating the problems of food security, and increasing food production that can meet the demands of the growing population. Agrochemicals have enabled more food production during the last century, and there is a current need to increase food production to feed the rapid growing human population (Carvalho, 2017).

One of the cash crops, produced in largest quantity in Ethiopia is *Khat*. It is an evergreen perennial shrub plant that belongs to the Celastraceae family. *Khat*, a small flowering bush native to the Horn of Africa, is an illegal drug in most countries in Europe, Asia, and North America. It is cultivated in most regional states of the country, though the extent may vary. The potential areas where *Khat* is grown are found in the eastern highlands of Ethiopia. There is a production and prevalence of *Khat* chewing variation among regions in Ethiopia (Awell et al., 2016). The highest *Khat* chewing prevalence is found in Harari (53.2%). Similarly, extensive *Khat* production is the major agricultural practice in all the districts of East Hararge Administrative Zone of the Oromia Regional State, Ethiopia. The region alone constitutes 53.4% of the total production area of *Khat* production in Ethiopia (Hurni et al., 2016).

According to Mekuria (2018), *Khat* is the third largest export commodity after coffee and oil seeds. *Khat* can generate considerable amount of revenue at individual, household and national level. Some farmers prefer *Khat* to other crops for several reasons. *Khat* is a cash crop, which can bring substantial returns. The plant is less vulnerable to drought with less cost for labor demand throughout its production. *Khat* has both positive and negative economic advantages. On the positive part, it serves as employment opportunity and source of income in the cultivation and marketing processes. The source of cash income (up to 76.8% in Harar) and drought resistance behavior of the plant are among the main economic advantages of *Khat* growing.

Frequent use of pesticides is becoming a common practice by the plant cultivars in order to control the pests, insects and diseases that are significantly affecting the yield. Results of interviews and questionnaires showed that majority of farmers in Chiro Woreda use DDT and other unknown pesticides to grow their *Khat* and majority of them mix DDT and other pesticides, especially malathion (Derso and Dagnaw, 2019). Another study also confirmed that some selected pesticides such as aldrin, dieldrin, BHC, diazinon, DDT, 4,4-DDE and heptachlor were investigated in water and *Khat* samples that were collected from five different sites Haromaya Wereda. Diazinon and DDT levels in *Khat* sample one (0.0323 mg/L), *Khat* sample two (0.0293 mg/L) and *Khat* sample one (0.0134 mg/L), *Khat* sample two (0.0173 mg/L), respectively are above the maximum residue level (Adamu et al., 2019). Pilot study participants (retailers and consumers) confirmed that pesticide chemicals are sprayed on *Khat* bushes and trees, and *Khat* farmers disclosed the use of Dichlorodiphenyltrichloroethane (DDT) and Malathion on their farm (Beyene et al., 2020). Another survey study in Haromaya Wereda also identified that the farmers were using pesticides including DDT for growing *Khat* (Regassa and Regassa, 2018).

If improperly used, pesticides can lead to secondary pest outbreaks, destruction of non-target species, soil, water, and air contamination, and residues in primary and derived agricultural products that endanger both the environment and human health (Azeem et al., 2019). Farm workers' exposure to pesticides has been associated with adverse health effects like cancer and birth defects resulting in hundreds of fatalities, the majority of which occur in developing countries (Damalas and Koutroubas, 2016). Farmers and especially those directly involved in the handling of pesticides, are at a high risk of exposure to pesticides through contact with pesticide residues on treated crops, unsafe handling, storage and disposal practices, poor maintenance of spraying equipment, and the lack of protective equipment or failure to use it properly (Kosamu et al., 2020). Pesticide handlers are regularly involved with various activities like mixing, loading or application of pesticides.

Consequently, high care has to be taken during

preparation, transportation, storage and handling of pesticides (Ndayambaje et al., 2019). People who work with these chemicals need to receive proper training on the safe use and personal protective equipment to minimize exposure and reduce health risks.

Farmers' knowledge of pesticides and their safe use are critical for implementing effective pest management program. These risks may be exacerbated by lack of information on pesticide hazards, the perception and attitude of farmers regarding risk from pesticide exposure, lack of education and poor knowledge and understanding of safe practices in pesticide use, including storage, handling and disposal (Mustapha et al., 2017). Higher levels of education give pesticide users better access to information and more knowledge of the risks associated with pesticides, and how to avoid exposure. Less educated farmers may be hampered in their ability to understand the hazard warnings on pesticide labels, how to avoid exposure, and how to follow recommended safety and application guidelines. For example, illiteracy and lack of knowledge on the extent to which pesticides represent a hazard have been considered the most important barriers to the adoption of self-protective behaviors by farmers. A higher proportion of pesticide poisonings and deaths occur in developing countries where there are inadequate occupational safety standards, lack of use of personal protective equipment (PPE), inadequate hygienic facilities, illiteracy, and insufficient knowledge of pesticide hazards (FAO and WHO, 2020; OECD/FAO, 2016).

The use of pesticides, for obviously beneficial reasons in *Khat* production, may lead to undesirable effects on the environment and health. Several previous researches identified that farmers in developing countries are exposed to toxic chemicals due to lack of technical knowledge on toxicity levels of pesticides and safety measures to protect themselves from the exposure (Beyene et al., 2020). To make a balance between the beneficial and adverse effects of pesticide use for *Khat* production, investigation of the awareness, knowledge and perception of the farmers on the health and environmental effects of pesticide uses and handling is needed; the aspect that has never been considered in the eastern part of Ethiopia (major *Khat* producing area). Therefore, the objective of this research work is to investigate the knowledge and perception of *Khat* cultivating farmers regarding the safe use of pesticides, proper handling and pesticide storage, and the impacts of pesticides use on human health and the environment.

MATERIALS AND METHODS

The study areas

The survey study was conducted at Haromaya Wereda, East Hararghe Zone, Oromia Regional State of Ethiopia (Figure 1). The district is known for its extensive cultivation of varieties of *Khat* plants and there is a great dependence of the people on *Khat* crop.

The *Khat* products are highly demanded both in national and international markets, particularly the one with the local brand name "Awaday". It was also observed that losses due to pests, diseases and weeds are the major factors affecting their yields, directly or indirectly. Realizing all these and other related problems, the district was selected as a research site and thus considerable attention was paid to the extent to which the villagers of the study areas understand the risks caused by traditional way of pesticide use and handling.

Data collection

In consulting and discussing with the district agricultural staff, the villages under study were clustered into five mutually exclusive geographical zones to make the data collection systematic and easy to handle within a reasonable period of time. Depending on the size of the clusters, seven villages were sampled from a total of 33 in *Awaday* district (Figure 1). Multistage sampling method was used to prepare an exhaustive list and sampling frame of all members of the *Khat* growing farmers with the help of the agricultural development office. After determination of the sample size, the number of *Khat* producing households, sites and elevation factors (quotient between the size of the population and the size of the sample), the first unit was selected randomly. Then, systematic sampling was applied to draw samples at regular interval from the list. Accordingly, a total of 245 farmers were selected randomly from these villages. Representative number of agricultural workers and health professionals were also made to participate in the interview to evaluate the training status of the farmers on the safe use, handling and alternative use of pesticides.

Questionnaires were developed in English language and then translated to Oromo language (the local language) so that it was easy to communicate with the respondents during data collection. Illiterate respondents (unable to write or read) were assisted by the researcher in reading questions, and writing their ideas. Prior to the data collection, the questionnaires were pre-tested on limited respondents, 20 farmers, and four experts from the health sector and agricultural staff who were living and working in the study areas. In addition to the structured questionnaires, the data collection was also supported by semi-structured interviews and observations in order to validate results of the study.

Statistical data analysis

All the data collected were coded, entered and then analyzed using the Statistical Package for Social Sciences (SPSS) computer software version 20 windows. Descriptive results were expressed as frequencies and percentages for the categorical variables.

RESULTS

Socio-demographic characteristics of the participants

Table 1 reveals that the ages of the respondents who participated in the structured interview ranged from 21 to 61. However, 66.93% of the farmers were in the age range of 30 to 40, which indicated that majority of them are productive. Analysis of the educational level also revealed that 33.1% of the respondents were at no schooling level, illiterate. However, nearly half of the respondents (48.97%) attained basic education (reading

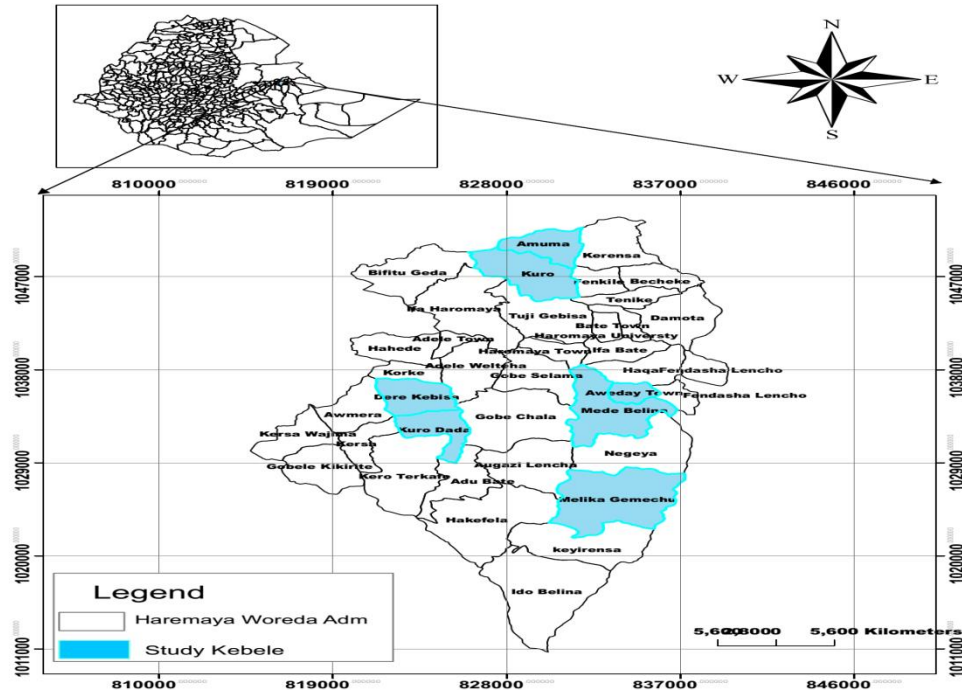


Figure 1. Study sites around the *Haremaya*. The seven study sites were selected including the Amuma, Kuro Finkile, Dere Kebiso, Kurp Dada, Mede Gemechu, Melka Belina and Awaday villages, based on the quantities of *Khat* production.

and/or writing using either the local or national languages). Furthermore, respondents with primary, secondary and diploma levels accounted for about 10.3, 6.2 and 2%, respectively. The research results further indicated that there was no participant with Bachelor degree and above. Almost all (96.7%) of the participants were married and are thus heads of their families. About half (53.1%) of the respondents had household family member that ranges from 6 to 10; and nearly half of the family members were in the age range of 6 to 10. On the other hand, majority of the respondents (95.3%) lived in the study area for more than six years and about 93.2% worked on *Khat* crop for more than six years and thus had rich experiences on *Khat* farming. Demographic characteristics of the *Khat* growing farmers who provided their responses for the study questionnaire or took part in the interview are shown in Table 1.

Pesticide knowledge and perceptions

All the results presented here and the relevant discussions provided subsequently are based on the numerical information compiled in Table 2.

The respondent farmers were asked whether they know or not the name of pesticides they are using on the *Khat* plant. Based on their responses, 63.7% knew the name of pesticides they were using. They were also asked whether or not they knew well about the safe use

of pesticides they were using. Accordingly, 42% of the farmers responded that they have knowledge of the safe use of pesticides they use on their farms. Similarly, significant number of the respondents (40.2%) said that they have awareness on the proper storage of the pesticides.

A large proportion (80.0%) of the farmers also responded that they consult their neighbours. However, it was only 16.7% farmers who said that they consulted agricultural experts on the use of pesticides and the corresponding safety considerations. It was also learned that 78% of the farmers used their own experiences when dealing with pesticides for various purposes and handling of pesticides compounds generally. Most of the respondents also said they do not get information from sellers. Only 7.3% of the respondent farmers agreed that they received information, such as brochures, when they were purchasing the pesticides. It was also learned that 95.5% of the sampled farmers used pesticides with instructions in a language they do not understand and only 4.5% understand the instructions for pesticides use. Only few farmers, 12.6%, replied that they read the instructions on the labels of the pesticide containers. On the other hand, majority of the respondents expressed that the information available on the containers were not important.

Besides, the farmers were all asked whether certain trainings were done on proper handling and application of pesticides on *Khat* or other plants. It was learned that on

Table 1. General information and personal particulars of the respondents.

Variable	Frequency	%
Ranges of age (years)		
18-30	24	10
31-40	164	66.9
41-50	31	12.7
51 and above	26	10.6
Educational level		
No schooling	81	33.1
Read and write (Basic education)	120	49
Primary education	26	10.6
Secondary education	14	6.1
College diploma	5	2
Marital status		
Married	237	96.7
Divorced	7	2.9
Widowed	1	0.4
No of family members		
Less than 2	19	7.8
2-5	59	24.1
6-10	130	53.1
11 and above	37	15.1
Stay period in the study area		
5 and bellow 5 years	9	3.7
6-10 years	72	28.8
Above 10 years	164	65.6
Working duration on Khat Farming (years)		
5 and bellow 5 years	17	6.9
Between 6-10 years	170	69.6
Above 10	58	23.7

average, 95.9% of the respondents said that no scheduled trainings were held or delivered on the practices of pesticide usage. However, the remaining 4.1% responded that they received informal training from pesticide retailers on how to operate the spraying devices. It was also known that the explanations by the retailers were simple orientations, when they visit the retailers' shop to purchase the spraying equipment. The respondents were not sure whether the referred retailers were properly trained or not. The subjects were also asked whether they need additional training or not on the safe use and storage of pesticides. The need for further training was stressed by 63.7% of the respondents on safe use and similarly 41.6% on storage of pesticides.

Agricultural experts and health professionals were also asked for their views on the need of training or a program

to raise awareness among the communities and households on safety issues related to pesticide use on *Khat* plant. Their reactions to the questions are summarized as follows: out of 21 agricultural professionals, 90.5% expressed that there were no training or awareness raising programs that have been organized and delivered; while 9.5% responded that they have never had any information on the issue. In the same manner, 60% or 20 health professionals also responded that no training or awareness raising programs have been carried out with the subjects while about 35% answered that they did not have any information whether any training was given to the farmers during their stay in the villages.

The respondents were further asked to reflect their opinions on the health effects of the chemical pesticides

Table 2. Study results on the knowledge and awareness of farmers on pesticide uses.

Variable	Frequency	%
Farmers that have enough information on right use pesticides	103	42
Farmers that have enough information on right storage of pesticides	99	40.2
<i>On the right use and storage of pesticides (sources of information)</i>		
From retailer	16	6.5
Agricultural worker	41	16.7
Health extension	16	6.5
From my experience	191	78
From neighbors	196	80
Farmers who usually read the labels on pesticide containers	31	12.4
Farmers who could understand the instructions for use	12	4.9
Farmers who used chemicals with instructions in a language they don't understand	235	95.5
<i>Harmfulness of the chemical pesticides to the environment?</i>		
Not harmful	31	12.7
Moderately harmful	16	6.5
Very harmful	5	2
Do not know	192	78.4
Farmers who have awareness on the possibility to protect environment from the harmful effects of pesticides	5	23.8
<i>Harmfulness of the chemical pesticides to human health?</i>		
Not harmful	30	12.2
Moderately harmful	58	23.7
Very harmful	89	36.3
I do not know	68	27.8
Farmers who have awareness on the possibility to protect against the harmful effects of pesticides on health	98	66.7
Farmers who have understanding short-term impact of pesticides on their health	142	58
Farmers who have understanding long-term impact of pesticides on their health	25	10.2
Farmers who responded that they had training about use of pesticides	10	4.1
Farmers who need of any further instruction and/or training on pesticide use	155	63.3
Farmers who need any further instruction and/or training on Safe handling use	102	41.6
<i>Khat growing farmers who have knowledge on:</i>		
Names of pesticides you use	156	63.7
The adverse health effects of pesticides on humans	46	18.8
All pesticides have not the same degree of health impact	46	15.8
Pesticides can enter the body through respiratory system	167	68.2
Pesticides can enter through dermal contact	70	28.6
Pesticides enter through mouth into the body	169	69
Pesticide residues may be detected in the soil	58	23.7
Pesticide residues may be detected in the fruits and levels of sprayed tress	64	26.1
Fate of pesticide residues can be in air	57	23.3
Fate of pesticide residues can be in ground water	13	5.3
Biological and natural pest control methods as alternatives to pesticides use for pest control	28	11.4
Pesticides are harmful to fishes and pollinating insect like bee	97	39.5
Pesticides residues may be detected in the food products like milk, meat & crops	11	4.5
Pesticides cannot be legally used in Ethiopia could be used in their village	27	11
Particular pesticides are legal to use in Ethiopia while buying pesticides	42	17.1

and their environmental impacts. Majority (78.2%) of the farmers responded that they had no information on the effects of the pesticides sprayed on the plants and the physical environment. However, significant number of the farmers (59.9%) responded that they know the effects of pesticides on human health. They were then asked whether they knew how they protect themselves against the harmful effects of the pesticides they use. Out of the respondents that know the effect of pesticides on human health, 66.7% reacted that they protected themselves from the harmful health effect of the pesticides. On the other hand, from 8.53% of those farmers who know the impact of pesticides on the environment, only 23.8% believed that it is possible to protect the environment from harmful effects caused by pesticide use (Table 2).

Perception of the farmers on short and long term exposures to pesticides was also tested. More than half of the respondents (58%) answered that use of pesticides has short term impact on human health. The remaining 42% respondents expressed that they do not know the implication of short-term effects on health or there is no short term effect due to the use of pesticides on their health. Similarly, it was noted that majority of the participants (89.8%) were noted to have no knowledge regarding the long term impact of pesticides on human health. Only 10.2% of the farmers responded that they know the long term effect of pesticides on human health.

The knowledge level of the participants on the routes of entry of the pesticides into the body was also evaluated. All possible routes of pesticide entry were included as alternatives and then perceptions of the farmers were tested. Accordingly, 68.2% of the farmers responded that pesticides can enter through the respiratory system. Another independent question was also asked to learn whether pesticides enter the body through mouth or not, and 69% of the farmers agreed that mouth is the route of entry while all the remaining farmers responded that they are not aware of the pesticide entry to the body through any one of the system. On the other hand, majority of the farmers (71.4%) denied the entry of the pesticides through the dermal contact.

In order to evaluate the farmers' perception on the fate of pesticide residues in the environments, questionnaires were designed and the farmers were asked to forward their views. It was noted that only 23.7% of the participants agreed that pesticide residues can be detected in the soil while 26.1% answered that pesticides can be detected in the fruits and leaves of the trees. Similarly, fewer proportions of the participants, 23.3%, agreed that pesticide residues can be detected in air. Majority of the participants, 94.7%, however, denied the detection of pesticides in underground water. Furthermore, the farmers' knowledge on the impact of pesticides on bees, useful insects and other living organisms was also assessed. The outcomes indicated that 39.6% of the farmers have some information and thus have awareness on the harmful effects of pesticides

on insects such as bees and other pollinating insects. The remaining significant number, comprising 60.4% of the farmers, responded that they do not have the necessary knowledge about the harmful effects of pesticides on these insects. Besides, smaller percentage of the respondents, 4.5%, agreed that pesticides residues could be detected in food samples such as milk, meat and crops.

Participating farmers were also asked about their past experiences of using any other alternative pest control techniques meant for reducing the quantities of pesticides regularly used. Most of the respondents, 88.6%, replied that they had no past experiences of using alternative methodologies apart from the continuous use of chemical pesticides every year. However, 11.4% of the farmers responded that they sometimes use traditional methods such as smoke, detergent (*omo*) and urine of their cattle. It has also been learned, from the overall responses of the farmers, that the concept and practices of integrated pest management were not known and that the concept was also not clear to them.

In another set of questions, perception of the farmers on legality of the pesticides imported was evaluated. It was noted, from their responses, that they know the pesticides importation legality in different ways. Accordingly, 13.1% of the farmers replied that they are aware of the legality of the pesticides they use while 11% of them believed that illegal pesticides were used in their villages. The latter group was further asked, 'how do they know whether the pesticides used are illegal or not'. Based on their responses, most of them had the perception that pesticides which were provided by the government or unions are considered to be legal, and illegal pesticides could be obtained from illegal markets. The remaining few farmers indicated that agricultural workers are the source of information on the legality of pesticides. However, 39.6% denied the use of illegal pesticides in their villages and 49.4% answered that they do not know whether the pesticides used in their village are illegal or not.

DISCUSSION

Majority of farmers who participated in the data collection were in the age of adult range and had sufficient experiences of *Khat* crop production. The duration of stays of the respondents in the study area is also long enough, and thus the information obtained for the intended study could be reliable. This could be a sufficient condition to conclude that most respondents were permanent residents of the study areas and involved in *Khat* cultivation from their early ages.

Furthermore, as nearly all the study subjects were *Khat* growers, the duration of their stays could linearly be correlated with the number of years they are engaged with *Khat* cultivation. However, the level of education of

most of the respondents is low, either no schooling or at the level of basic education.

Poor pesticide handling, application, and storage can negatively impact the health of humans, animals, and ecosystems. One of the primary concerns of this study was to learn whether the farmers know the types and thus the intended use of pesticides they are using. Even though most of the farmers believed that they know the name of pesticides they use, significant percentage of the farmers responded that they were not sure of the name of pesticides they are using. However, it was generally known, from the farmers' opinions during oral discussions, that most of the respondents do not precisely know the names of the pesticide products mainly because of the variety of reasons including less attention given to the names, lack of information and education, the assumption that all pesticides are the same, some products that are repacked and sold in non-original containers that are not labelled, suspicions of the information obtained from the retailers, which are sometimes misleading, etc. As it has also been stressed by the respondents, they were using the type of container in which it is sold to identify the type of pesticide and by their physical state; liquid or solid. The findings of the current study are similar to the reported results of the field study performed on horticulture production areas of Ethiopia (Mequanint et al., 2019; Mormeta, 2019). In another item of this study, knowledge of the farmers on the safe handling and use of pesticides, their health and environmental impacts were also assessed. The compiled results of the study indicated that significant percentage of the farmers were not confident enough in their knowledge of the health and environmental effects of the pesticides used. Similarly, comparable proportions of the respondent farmers have forwarded their views that they have not had the required knowledge and education to protect their health and the physical environment from the hazardous effects of the pesticides they use. However, awareness of *Khat* growing farmers on the health effects of pesticide use and its protection is relatively higher than their awareness on the environmental impact of pesticides and their protection. The differences in awareness may be due to their low level of education to know the effect of pesticides on the environment and its protection. Evaluation of the research findings indicated that little is known about the mechanism of health protection from pesticide hazard. As has also been learned from most of the farmers, during the oral discussion, to prevent the poisonous effects of the pesticide is not to ingest them.

Earlier studies in Pakistan and African countries, including Ethiopia reported that most of the pesticides used by typical farmers are stored inside their house, like kitchen (Mubushar et al., 2019). Similar study conducted in Tanzania, on the other hand, indicated the farmers store pesticides after for next use (Philbert et al., 2019).

On the contrary, findings of the current study reflected that over one third of the respondents described that they

do not know the right storing conditions of pesticides and their containers. The basic and safest storing conditions of pesticides such as storing in dry, cool, locked, well ventilated areas; storing at places far from food items; keeping away from fire and storing in tightly closed original containers were used as the major parameters to evaluate the knowledge levels of the farmers using pesticides. Based on the results, it was noted that knowledge of the sampled farmers on the basic storing conditions is limited, although relatively larger proportions of the study participants, 79.4%, have some awareness on particular aspects of storing pesticides; that is, pesticides should be kept out of the reach of children. Additionally, based on the result of the field observations, it was learned that the housing styles of majority of the farmers are single classrooms that are not partitioned and all the activities related to food preparation including cooking, eating, pesticide storing, etc., are all performed there. It is evident that the pesticides stored indoors could increase the degree of exposure of the family members. In particular, children could easily get hold of the pesticides apart from the improperly sealed containers, potentially leaching their contents into the indoor environments which could contaminate their foods.

Educational level has important roles in increasing farmers' knowledge and perception of pesticide risks. Findings of the research works carried out in different countries also revealed that farmers were not receiving regular agricultural extension services and appropriate information on pesticide risks and safety trainings (Cochrane and O'Regan, 2016). In a similar manner, results of the present study indicated that there was no adequate information or training given to the *Khat* growing farmers on the safe use of pesticides. The primary source of information on the use of pesticides is the farmers' traditional experiences which may not be education based. On the other hand, both the agricultural experts and health professionals confirmed that relevant training on awareness creation was never given to the *Khat* growers. It was further realized that no agricultural extension services were given to these farmers, who are *Khat* growers. Recent study report also indicated that there are no planned assistance and encouragements given to the *Khat* growing farmers. Ethiopian government neither encourages nor takes any action against its cultivation, trade and use (Ndayambaje et al., 2019). It looks like there is no specific government policy that promotes or prohibits the production of *Khat*.

Written information on pesticide packaging is one of the information sources on pesticides safe use. In this regard, few farmers responded that they were provided with the necessary information through different means of information sources including labels of the containers. However, unless purposeful training is organized and farmers are given adequate training, presence of the labels on the containers may not be adequate condition for the farmers to extract the required information from

the labels. Another factor critically affecting the usability of the direction on the products labels could be the difficulty in reading and understanding of the instructions, as the language used on the labels is different from the local/national languages. In a recent study done in South East Ethiopia, majority of the respondents could not read labels on pesticide containers (Gesese et al., 2016). On the other hand, the worst scenario recently reported indicated that some farm workers were found reluctant to read manufacturers' labels even if they are capable of reading them (Jallow et al., 2017).

Pesticide exposure in the field occurs mainly through dermal contact and inhalation. The use of personal protective devices is known to greatly reduce the exposure levels before irreparable disease develops (Surgan et al., 2010). The findings of the presented study also revealed that the farmers' knowledge level on the routes of pesticide exposure, that is, oral, dermal or inhalation is highly diversified. Significant proportions of the involved farmers perceived that pesticide can enter through the mouth and respiratory system. However, most of the farmers do not have the knowledge that pesticides can enter the body systems through dermal contacts. Thus, lack of adequate training and the necessary knowledge on the route of entry of pesticides could be the main cause for the risk of exposure to pesticides. As a consequence, the importance of using protective devices during pesticide handling is not well understood along with the end result for entry of pesticides into the body systems (Okoffo et al., 2016).

In a similar manner, lack of awareness and proper management of pesticides may contaminate the atmosphere, water, soil, agricultural products, and consequently result in direct or indirect pollution of the biological systems, food and food products and human health. In this regard, the outcomes of the current study clearly revealed that, in general, level of the farmers' awareness about the fate of pesticide residues in their environment is low. Moreover, almost all the sampled farmers lacked the knowledge of the presence of pesticide residues, after their application, which could contaminate the food items and other household utensils as well as their possible occurrences in the underground waters. However, it was rather a positive outcome that was noted from the subjects regarding the effect of pesticides and their residues on birds, bees and other pollinating insects.

Furthermore, the outcomes of the current study confirmed that majority of the sampled farmers were not aware of the alternative pest management techniques rather than using pesticides. It was however interesting to learn that few of the farmers expressed their traditional experiences of using smoke, detergents and urine of their cattle for controlling pests; though the efficacy and effects on the environment and lives of ecosystems may require further studies. Pesticides banned in the developed world are still entering the developing countries, following

several illegal routes that are not clearly known. Use of DDT, for example, was banned in the developing world, though the use was permitted specifically for controlling mosquitoes in the malaria regions of the developing countries, like Ethiopia. Recent survey conducted in Ethiopia also indicated that DDT is still in use as pesticide by farmers for agricultural purposes (Derso and Dagneu, 2019). The survey further described that DDT is openly displayed in the shops for sale. The farmers' perception of the legality of pesticides used, including DDT, was also evaluated in the study. The responses of the sampled farmers reflected that DDT is in use mainly in agriculture than for the control of mosquitoes. Only limited population of the respondents had the awareness that illegal pesticides are used in Ethiopia or in their villages. The findings of the current study are also in good agreement with the study performed in the Rift Valley region, confirming that most farmers of the study areas did not have the awareness that the pesticides they were using are not legally registered; for example, DDT, are used for the purposes that are strictly prohibited by the international standards (Belay et al., 2017).

Future perspectives

The knowledge gaps identified in this study could be used to design knowledge-based interventions focusing on the *Khat* growing farmers. In this regard, integrated efforts from all concerned that may be aimed at the awareness rising of the farmers on proper pesticide management and related issues should be encouraged. Besides this, further studies should be carried out to assess the usefulness and efficiencies of traditionally used methods by some farmers, for example, the smoke, detergents and urine of the cattle. This would require active involvements of various professionals; including health workers, chemical toxicologists, environmentalists, entomologists, chemical analysts among others. As pesticides are continuously applied to the same farmlands, contamination of the environment with their residues may be highly probable. Furthermore, the current study also identified that persistent organochlorine pesticides, such as DDT, are still in use which are expected to persist in the environment for long time and bio accumulate through the food chain particularly in the fatty tissues. As a result, further studies could also be initiated to investigate the extent of contamination of the soil and water bodies by pesticides in the study areas.

In addition to the occupational exposure to pesticides, further exposures could also occur while spraying and storing mainly through the food eaten and drinking water contaminated with the pesticide residues. Non-occupational exposures originating from the pesticide residues in food, air and drinking water generally involve low doses and are chronic. To safeguard the *Khat* growing farmers as well as the general population, who

consume the plant food and water from pesticide contaminated areas, further investigations of the level of pesticides in the *Khat* plant and food of both animals and plant origins should be carried out. Consequently, developing effective and reliable analytical methodologies are very important to compare the research findings with the international standards.

Conclusion

In this study, the knowledge and perception of the use of pesticides for pest control on *Khat* production was investigated. The field survey study was carried out around the Haromaya Wereda of the Eastern Oromia Regional State of Ethiopia, on pesticide use of the *Khat* growing farmers. The outcomes of the study indicated that almost all the farmers in the study areas are entirely dependent on *Khat* production both for local consumption and as a means of income through export. Furthermore, it was also learned that the economy of the country is also highly supported by the tax from the *Khat* export. On the other hand, the findings revealed that farmers growing *Khat* are using pesticides, including the banned ones such as DDT, as a means of increasing and improving the production yields. However, the knowledge and perception of the concerned farmers towards the health and environmental risks that could result from pesticide use were found to be limited. Outcomes of the study also revealed that no training and awareness creations were made including the safe handling and uses of the pesticides. Based on the responses from the subjects, the possible entry of the pesticide residues to the body systems, through various routes, was not well known. Besides this, most of the respondent farmers do not read and understand the information provided with the labels of the containers, as these are communicated with the language they are not familiar to and most of them are also illiterate. The overall health risks of the pesticide use thus require special attentions of all concerned bodies.

The aspects requiring future involvements in order to minimize risks of pesticides are also identified and suggested. In addition, the necessities for training and awareness raising programs, the need for investigating usefulness and efficacy of the traditional ways of pest controls used by some farmers were emphasized. Similarly, analysis of the extent of accumulation of pesticide residues and understanding of their chemical compositions/contents are suggested as the measures requiring further collaborative efforts in order to come up with reliable solutions to minimize the probable risks to human health and the inhabitants of the ecosystem.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

Madda Walabu University and Addis Ababa University (AAU) are gratefully acknowledged for providing the necessary research facilities. Those who participated during data collection, particularly Haromaya Wereda Agricultural office are kindly acknowledged.

REFERENCES

- Adamu DB, Tesfaye M, Teshome, G, Temesgen A, Tamado T (2019). Determination of Pesticide Residue in Water and *Khat* (*Catha edulis*) Leaves Using GC-ECD. *Chemistry and Materials Research* 11(3):16-21.
- Awell Y, Yerra R, Tadele E, Getu K, Dagim A, Hailekiros G, Tesfamichae G, Yasodha KJ (2016). Socio-Economic and Health Effects of *Khat* Chewing in Mekelle, Tigray Region, Ethiopia. *International Journal of Pharmacy and Pharmaceutical Research* 8(1):11-22.
- Azeem M, Zaman T, Tahir M, Haris A, Iqbal Z, Binyameen M, Nazir A, Shad SA, Majeed S, Mozüraitis R (2019). Chemical composition and repellent activity of native plants essential oils against dengue mosquito, *Aedes aegypti*. *Industrial Crop and Products* 140:1(11609):1-7.
- Belay TM, Arthur PJ, Mol PO (2017). Pesticide use practices among smallholder vegetable farmers in Ethiopian Central Rift Valley. *Environmental Development and Sustainability* 19:301-324.
- Beyene WA, Brimer L, Dalsgaard A, Belachew T (2020). Chemical and microbiological hazards of *Khat* (*Catha edulis*) from field to chewing in Ethiopia. *GSC Biological and Pharmaceutical Sciences* 11(1):24-35.
- Carvalho FP (2017). Pesticides, environment, and food safety, John Wiley & Sons Ltd. and the Association of Applied Biologists.
- Chitwan N, Abhinav V, Deepak G, Sundar T, Badri RP, Erik J (2017). Changes in Perceptions and Practices of Farmers and Pesticide Retailers on Safer Pesticide Use and Alternatives: Impacts of a Community Intervention in Chitwan, Nepal, *Environmental Health Insights* 11: 1-12.
- Cochrane LO, Regan D (2016). Legal harvest and illegal trade: Trends, challenges, and options in *khat* production in Ethiopia. *International Journal of Drug Policy* 30:27-34.
- Damalas CA, Koutroubas SD (2016). Farmers' exposure to pesticides: Toxicity types and ways of prevention. *Toxics* 4:1-10.
- Derso AG, Dagnew GG (2019). Exposure and Health Risk Assessment of Farmers to DDT during *Khat* Production in Chiro Woreda, West Hararghe Zone Ethiopia. *World Journal of Agricultural Research* 7(1):29-35.
- Esteban FD, Aly V, Adolfo M (2020). Natural Organic Compounds for Application in Organic Farming: Review. *Agriculture* 10(41): 1-22.
- FAO and WHO (2020). Guidelines for personal protection when handling and applying pesticide – International Code of Conduct on Pesticide Management. Rome.
- Fernando PC (2017). Pesticides, environment, and food safety, Food and Energy Security published by John Wiley & Sons Ltd. and the Association of Applied Biologists.
- Fróna D, Szenderák J, Harangi-Rákos M (2019). The Challenge of Feeding the World. *Sustainability* 11(5816):1-18.
- Gesesew HA, Woldemichael K, Massa D, Mwanri L (2016). Farmers Knowledge, Attitudes, Practices and Health Problems Associated with Pesticide Use in Rural Irrigation Villages, Southwest Ethiopia. *PLoS ONE* 11(9):e0162527.
- Regassa G, Regassa C (2018). Assessment of pesticides handling practices and health and environmental impacts on *Khat* growing farmers: in Haromaya Woreda, Eastern Ethiopia, *International Journal of Advanced Engineering Research and Science* 5(12):252-263.
- Hurni H, Berhe WA, Chadhokar P, Daniel D, Gete Z, Grunder M, Kassaye G (2016). *Soil and Water Conservation in Ethiopia: Guidelines for Development Agents*. Second revised edition. Bern,

- Switzerland: Centre for Development and Environment (CDE). University of Bern, with Bern Open Publishing (BOP) P 134.
- Jallow M, Awadh DG, Albaho MS, Devi VY, Ahmad N (2017). Monitoring of pesticide residues in commonly used fruits and vegetables in Kuwait. *International Journal of Environmental Research and Public Health* 14(8):833.
- Kosamu I, Kaonga C, Utembe WA (2020). Critical Review of the Status of Pesticide Exposure. *International Journal of Environmental Research and Public Health* 17(6727):1-13.
- Mekuria W (2018). Public discourse on Khat (*Catha edulis*) production in Ethiopia: Review. *Journal of Agricultural Extension and Rural Development* 10(10):192-200.
- Mequanint C, Getachew B, Mindaye Y, Amare D E, Guadu T, and Dagne H (2019). Practice towards pesticide handling, storage and its associated factors among farmers working in irrigations in Gondar town, Ethiopia. *BMC Research Notes* 12(709):1-6.
- Mormeta BN (2019). Assessment of pesticide hazard related knowledge and practices of agricultural extension workers in selected small-scale horticulture production areas in Ethiopia. *Journal of Agriculture and Environment for International Development* 113(1):5-15.
- Mustapha FAJ, Dawood GA, Mohammed SA, Vimala YD, Binson MT (2017). Pesticide Knowledge and Safety Practices among Farm Workers in Kuwait: Results of a Survey *International Journal of Environmental Research and Public Health* 14(340):1-15.
- Mubushar M, Aldosari FO, Baig MB, Alotaib BM, Khan AQ (2019). Assessment of farmers on their knowledge regarding pesticide usage and biosafety. *Saudi Journal of Biological Sciences* 26:1903-1910.
- Ndayambaje B, Amuguni H, Cofin-Schmitt J, Sibbo N, Ntawubiz M, VanWormer E (2019). Pesticide Application Practices and Knowledge among Small-Scale Local Rice Growers and Communities in Rwanda: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health* 16:4770.
- Okoffo ED, Mensah M, Fosu-Mensah BY (2016). Pesticides exposure and the use of personal protective equipment by cocoa farmers in Ghana. *Environmental Systems Research* 5(1):17.
- OECD/FAO (2016). *Agriculture in Sub-Saharan Africa: Prospects and challenges for the next decade*, in *OECD-FAO Agricultural Outlook 2016-2025*, OECD Publishing, Paris.
- Philbert A, Lyantagaye SL, Nkwengulila G (2019). Farmers' pesticide usage practices in the malaria endemic region of North-Western Tanzania: implications to the control of malaria vectors. *BMC Public Health* 19:1456.
- United Nations, Department of Economic and Social Affairs (UN). Population Division (2017). *World Population Prospects: The 2017 Revision, key findings and advance tables working paper No.ESA/P/WP/248*.