Assessment of the Pesticide Use, Practice and Hazards on Cotton Growing Farmers in the Awash Valley Ethiopia

Sileshi G., Zemedkun A., and Nurhussien S.
Ethiopia Institute of Agricultural Research, Werer Agricultural Research Center, Ethiopia
P.O. Box 2003, Addis Abeba, Ethiopia. Corresponding author: e-mail nurhusseinsy@yahoo.com

ABSTRACT

Pesticides are commonly used in the prevention or control of pests such as insect pests, mites, disease, and weeds in crops to increase production and productivity. The aim of the current study was designed to assess the pesticide utilization, practice, pesticide-related knowledge, and perception of farmers and to evaluate the protective measure taken by the farmers. For this purpose, field surveys were carried in Amibara, Gewane, Assayita, and Fentale districts during the 2019 main crop cropping season. A total of 128 small-scale holder farmers, 25 large-scale holder farmers, 30 sprayers, and 12 extensions were interviewed closed and opened questioners. The results revealed that the majority of farmers (44.5%) between the age of 41 and 50 years old, while only fourteen those (9.4%) were more than 51 years old. Regarding the educational level of smallholder farmers, 49.2% were illiterates, 27.9% elementary school, 17.0% secondary school and 5.8% had completed high school. The majority of sprayers (66.7%) were elementary school level. The unsafe and indiscriminate use of pesticides in agriculture represents a major hazard to the environment and human health. All farmers (100%) acknowledged that pesticides were harmful to their health and the environment. Over 63.2% of the farmers did not read or follow pesticide label instructions, and 78.5% did not use any personal protective equipment during spray operation and formulation pesticides. When disposing of pesticide empty containers, respondents adopted unsafe practices such as through near irrigated canal, burning, dumping in the field, domestic use, and burying. Less than 50% of smallholder farmers obtained training on pesticide use 14.8%, application method 16.6%, disposal of empty container 13.3%, and storage and safety 10.2%. Results also demonstrated that all farmers showed poor practices regarding the disposal of empty pesticide containers. The present study revealed that the utilization and practices of pesticides in irrigated cotton-producing areas in the Awash Valley of Ethiopia. It also demonstrated the role of retailers, importers, and state extension workers in providing information and advice to the farmers. Future researches should focus on the merit and demerit of mixing two or more pesticides to control insect pests and on the evaluation of different pesticide resistance development against a variety of insect pests in cotton-growing areas.

Keywords: smallholder farmers, large holder farmers, sprayers, extension workers

1. INTRODUCTION

Cotton is an annual cultivated fiver crop that is produced commercially in over 80 countries in the world located in the tropics and temperate climate zones (Lundbaek, 2002). Cotton is one of the most important internationally traded agricultural commodities in terms of volume and value traded (Serunjogi *et al*., 2001). Cotton is the main commercial uses are in the manufacturing of textile and garment, edible oil, soap, and livestock feeds. In Ethiopia, the total agro-ecologically potential areas for cotton production is estimated to be 2, 575, 810 hectares, and actual production was estimated at 477, 000 hectares in 2006 (Hiwot, 2007).

Chemical pesticides are commonly used in the management of pests, insects pest, mites, diseases, and weeds in cotton production in Ethiopia is increasing due to the expansion of cotton production and food crop which resulted in higher consumption of chemical pesticides. Pest control is one of the most significant items in the total production cost of cotton if appropriate pest control measures are not taken by spraying chemical pesticides to minimize the damage caused by insect pests. Recently, Ethiopia has been considered as having the largest accumulations of obsolete pesticides in the whole of Africa. It was estimated that there were 402 stores at 250 sites containing 1, 500 tons of obsolete pesticides (Tilahun, and Hussen, 2014). This estimate does not include the massive but unquantifiable amounts of pesticides soaked in soils.

In worldwide, the manufacturing and consumption of pesticides have been increasing rapidly year after year, Since the 1940s, pesticides have been used intensively in agriculture across the globe to control a variety of pests and diseases affecting crops (WHO, 2009). Different types of pesticides were imported by both private and public companies for agricultural uses (Tizazu, 2016). The main source of pesticides in Ethiopia is an importation from international manufacturing companies; such as, Bayer, Syngenta, BASF, and Monsanto which are represented by local agents, active in Ethiopia. The agents act as importers/ distributors or suppliers of pesticides to retailers and users. All over the countries in the world over and under-dose use or misuse of pesticides in agriculture cause environmental and human health effects including in Ethiopia (Brodesser *et al*. 2006; Farah, 1993; Tizazu, 2016).

Ministry of Agriculture (MoA) and its counterparts in the agricultural bureau of regional states are the major government agencies responsible for regulating, implementing, and monitoring pesticide policies: pesticide registration, importation, distribution, and use. State environmental and social institutions and private actors could play important roles in pesticide governance to overcome failures of the state in pesticide policies (Hoi *et al* 2009; Tizazu, 2016). The government of Ethiopia has formulated pesticide legislation (Pesticide Registration and Control Proclamation No. 674/2010) to govern pesticide use by farmers (Tizazu, 2016). This is taken into account by considering the whole pesticide life cycle, including registration and procurement, importation manufacturing of pesticides, distribution, utilization, monitoring, quality control, waste management, and improving the environment, the health of growers, and the surrounding community (Tizazu, 2016). Environmental pollution with pesticides is one of the most serious problems that facing the world due to their potential toxicity, high persistence, and slow degradation (Ghorab *et al*., 2016).

Environmental hazards associated with Pesticide poisoning, the Population groups at risk are pesticide workers mixing or applying pesticides and children and others ingesting pesticides accidentally. Pesticide residue in the soil may concentrate in the bodies of arthropods and other soil invertebrates. From there, they may be transported into the bodies of higher organisms through the food chain. Chronic (long-term) poisoning leads to severe health problems, such as cancer, damage to the reproductive system, the liver, the brain, and other parts of the body (WHO, 2009). The WHO (2009) classifies pesticides in five groups based on their hazard level, ranging from extremely hazardous (class Ia), highly hazardous (class Ib), moderately hazardous (class II), slightly hazardous (class III) to unlikely to present acute hazards (class U).

The present study aimed to assess the pesticide use, practice, and hazards by cotton-producing communities in the Awash Valley Ethiopia focusing on Lower, Middle, and Upper Awash. The findings of the study are expected to provide some insights on the trend of pesticide use, source of pesticide, obsolete pesticides in the areas, key cotton pest species, background information of farmers, extension workers, and sprayers, and impacts of pesticide on human health and the environment pollution.

The objectives of the study were to assess the pesticide-related knowledge and perception; pesticide utilization and practices of the farmers and to evaluate the personal protective measures taken by farmers to reduce pesticide exposure.

Ethical Statements

This study were proposed with the intention to evaluate or assess the physical practice and perception of cotton producers in Ethiopia during 2015 by Nurhussein Seid and due to shortage of financial support from the government it was postponed to the next research year. The work passes through three stages of peer evaluation processes like process, center and national level reviews. During 2016 the activity was restructured to mini-project under pesticide research project in the in Ethiopian Agricultural Research Institute and to be conducted in three centers with their respected crop commodity for Kulumssa (Wheat), Melkassa (Onion) and for Werer (Cotton) in the annual review it gets ethical approval of the study were granted in national level. This work is the cotton commodity wing of the three commodities. These studies were conducted with the ethical frame work to see the status of the farmers. The participants were well informed about the aim of the study, agreed to give firsthand information and their culture in cotton protection. We interviewed the producers with the questioners and recorded their status about the issues. The study was focused on the working age and class community in cotton production so no need to ask the guardians consents.The case study we brought here to talk about is that among the exposed workers in errors during pesticide application work. The one person doesn't have the know-how to ask the right to be insured for medical treatments for the poison when exposed in his work place. Even though the industrious man was intoxicated and paralyzed during the endeavor to help his family and the company. He lost attention from everyone even from us before we create even the go fund to cover his medical cost 60,000 ET Birr (nearly 2050USD) he passed away. The patient was gone to his lord with shortage of medical fee cover up; with the pain he was through and his family was gearing the load.

2. Materials and Methods

2.1. Survey Areas description

The survey was carried out in irrigated cotton-growing areas of Lower (Assayita), Middle (Amibara and Gewane), and Upper Awash (Fentale) districts of Ethiopia. The study was carried out in 2019 between June to December to assess the pesticide use, practice, and handling to the small-scale and large-scale holder farmers in Awash Valley Ethiopia. Survey areas lied in arid and semi-arid climates with high temperatures and low rainfall. The cotton production in Afar is larger in area coverage and amount of production than Oromia regional state.

2.2. Study Population and Sample Size

The source of the population included those cotton-producing farmers in Awash Valley. A total of four district representative farmers were included in the study. The numbers of participants were one hundred twenty-eight small scale and twenty-five large scale holder farmers, twelve extension experts, and thirty sprayers were asked the questionnaires for data collection. Before the sampling process, personnel and extension workers in agricultural offices were interviewed and cotton-produced farmers randomly were selected based on information received from extension workers.

2.3. Data Collection

Data collection was carried out from June 2019 to September 2019. A structural questionnaire was used as a data collection tool. The survey was conducted to gather all the available and relevant information for a detailed study. Random systemic sampling technique farmers and land locations were used to take a representative sample. A total of 153 representative small and large scale holder semi-pastoral farmers were selected. The structured open and close-ended questionnaire in four languages (English, Afar, Amharic, and Afan Oromo) with similar contents were prepared and given to respondents according to their language of preference in their residence but different questions were prepared for small scale and large scale farmers, sprayers and extension expert.

Background information of farmers, pesticide sprayer, and extension workers such as their sex, age, and educational level was included. Besides data on names of pesticide used, level of pesticide used, knowledge on the pesticide used, time of pesticide application, frequency of pesticide application interval, name of key pest species, the practices of farmers using personal protective equipment during pesticide application, and smoking, drinking, eating of chat and food during pesticides application were gathered.

2.4. Data Analysis

Both qualitative and quantitative data were gathered through observation, questionnaires, and interviews. All questionnaires and answers have been checked and revised by the researcher and then the data have been entered and analyzed by using SPSS software version 20. Finely appropriate statistical methods such as frequency, average, and percentage were used to describe the profile of the respondents in terms of socio-demographic, education, and pesticide variables. Results were presented using tables and bar graphs.

3. Results and Discussion

3.1. Socio-Demographic Characteristics

The majority of farmers interviewed in studied localities were males (Table 1). The number of smallholder farmers 121(95.0%) was males and 7(5.0%) females, all pesticide sprayers 30 (100%) were male, the female were not contributed to pesticides formulation and application. The majority of extension workers interviewed 11 (95.2%) males and only one worker (4.8%) was female. The age with a minimum of 20 years and maximum of 60 years old farmers were working in cotton production, 20-30 age (13.3%), 31-40 (32.8%), 41-50 (44.5%) and twelve participants were more than 51 age (9.4%). The result similar to the report in Sudan majority of the farmers between the age of 25 and 45 years old, while only one farmer was aging more than 45 years old (Awad *et al*., 2018). Also the sprayers 20-30 age 12 (30.6%), 31-40 age 15(60.6%), and 41-45 age 3(8.6%).

In smallholder farmers (49.2%) were illiterate, (27.9%) elementary school level, (17.0%) secondary level and (5.9%) were completed high school level. For sprayer (5%) were illiterate, (66.7) elementary school level, and (28.3%) secondary level. The majority of sprayer education levels found in primary school (1 to 6 grades) and no one was completed post-secondary school (Fig. 1). This study revealed extension workers were Diploma (56.3%) and bachelor degree (43.7%) (Table 1). The majority of DAs in Awash Valley are diploma holders with very limited technical skills, it is expected that their involvement in the service training program will benefit them a lot in advancing their skills and build confidence in what they are doing. In Sudan reported that 20% of workers were illiterates or had never attended school, 40% completed their secondary high (Awad *et al*., 2018) while in the United States 55.8% of pesticide applicators had at least 12 years of schooling (Karunamoorthi *et al.*, 2012).

Table 1. Socio-demographic characteristics of farmers, sprayers, and extension in Awash Valley

Variables	**Frequency**	**Percent**	**Variables**	**Frequency**	**Percent**
Sex:			Widowed	3	8.9
Male Farmers	121	95.0	Divorced	2	3.3
Female farmers	7	5.0	**Age of respondent**		
Age of respondent			20-30 years	12	30.6
20-30 years	17	13.3	31-40 years	15	60.6
31-40 years	42	32.8	More than 41 years	3	8.9
41-50 years	57	44.5	**Extension Worker**		
More than 51 years	14	9.4	Sex:		
Pesticides sprayers			Male	11	95.2
Sex:			Female	1	4.8
Male	30.0	100.0	Education level:		
Female	-	-	Diploma	8	56.3
Marital status			BSc	4	43.7
Single	18	61.7	MSC	-	-
Married	7	26.1			

This study revealed that the majority of pesticide sprayers marital status were unmarried/single (61.7%) followed by the married (26.1%) sprayers, the windowed (8.9%) and the divorced (3.3%) pesticide sprayers were the least contributed one in pesticide spray operation and formulation (Table. 1). The majority of smallholder farmers growing cotton in Lower, Middle, and Upper Awash are pastoral, they did not have experience in pesticide spray operation and formulation, the most of the workforce involved in spray operation were hired laborers, (96.1%), the family laborers (3.9%) were the less workforce in the operation (Table 4).

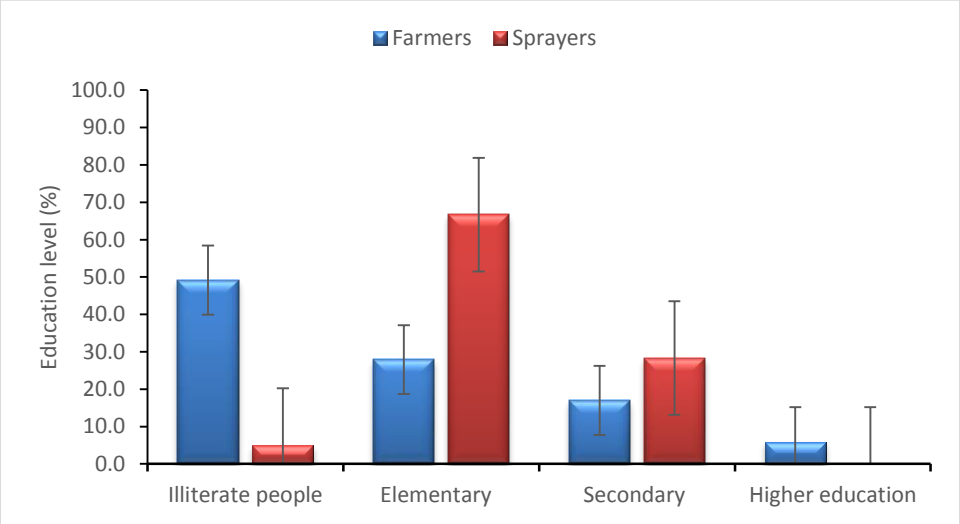

Figure 1. Education levels of smallholder farmers and sprayers in Awash valley

3.2. Toxicity Symptoms Related to Pesticides

The farmers reported at least one toxicity symptom of acute pesticide poisoning in the spraying and formulation operation of pesticides in Awash Valley (Fig. 2). The majority of pesticide sprayers most frequently reported symptoms were skin irritation (29.5%) followed by eye irritation (19.6%), sometimes they feel vomiting (4.4%) and shortness of breathing (3.9%) during and after pesticide application respectively. In study areas nausea feel (17.5%) and headache (23.0%). In cotton production designing the best pesticide management practices could help to reduce potential hazards of pesticide poisoning of sprayers. As discussed above, poor management practices resulted from poisoning and the death of sprayers. All sprayers working in cotton production were reported at least one of many symptoms of acute pesticide poisoning.

The majority of the farmers not wearing personal protective equipment, due to lack of availability and affordability in surveyed areas, and also none of the pesticides companies are involved to provide personal protective equipment at a cheaper price to enable farmers to buy them. When the accidents happened to farmers, they mostly took an action by bathing their body and sometimes medical care.

In Amibara district two sprayers were serious poisoning with pesticides, both of them took medical treatment, the one who got early treatment was partially healthy, the other man was

worked as a pesticides sprayer for 12 years, we interviewed him in May 2019 and he told us a medical test indicated that a large amount of chemical was cumulated in his body, one of the hospitals in Addis Abeba was asked him 60000 ETB for medical treatment but he was poor unable to pay it, due to this reason he died without medical treatment in the 2020 year. The majority of sprayers in Awash valley are not trained well in a safe method of spray and formulation of pesticide, due to this reason, they are easily exposed to pesticides. When working with pesticides the sprayer should follow pesticide label directions and use personal protective equipment.

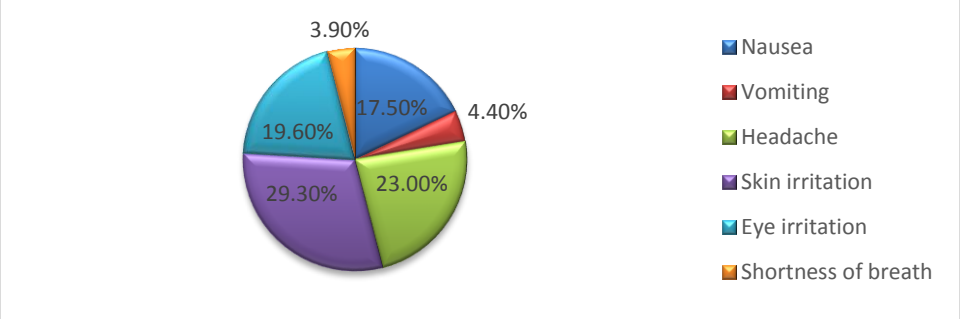

Figure 2. Pesticides illness symptom to chemical sprayer

3.3. Empty chemical container

This study revealed unsafe practices of disposing of empty pesticide containers; the majority of farmers in Awash Valley were found disposing of empty pesticide containers by dumb in the field (55%). These findings disagreed with the study in Sudan (Awad *et al.*, 2018) when disposing of empty pesticide containers, the majority of farmers adopted unsafe disposal methods such as discarding by burning containers on-farm. The manual again warned against the burning of pesticide containers because they can give off poisonous gases. Farmers in studied areas were disposed of empty containers through into irrigated canal after pesticide application in studied areas and also few of them the domestic use (1.7%) (Fig. 3). These unsafe methods of disposal and practices may lead to environmental contamination and a risk to human health and have been reported by Environmental Health Manual 2010; Tizazu, 2016 and Awad *et al.* 2018. In the study area, different pesticide containers were deposited before removed in-store or out of the store (Fig 4).

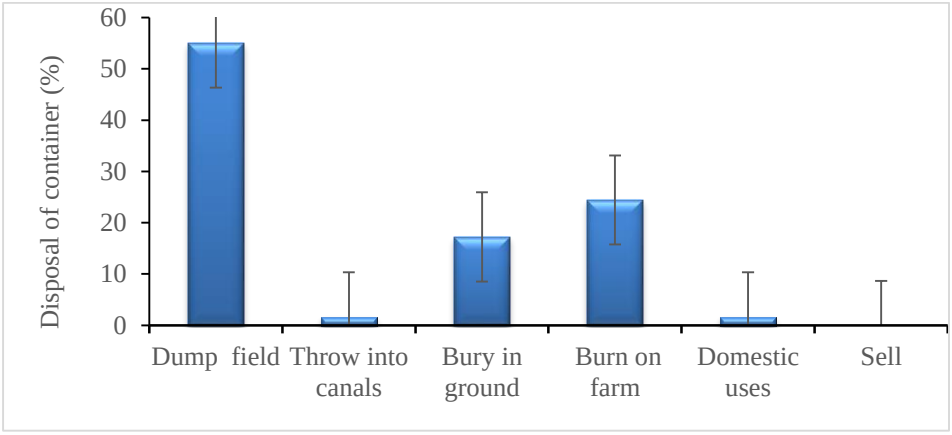

Figure 3. Disposal methods of pesticides containers after pesticide application

Figure 4. Empty pesticide containers disposal

3.4. Obsolete pesticides management

This study revealed that poor obsolete pesticide managements, 14.0% of large-scale farmers, and one Agricultural research center were reported the deposited obsolete pesticides (Tale 4). Obsolete pesticide stocks accumulated in the study area storages were deteriorated and exposed to humans' health and environmental pollution. The stores were wrongly built, some of them had not ventilation with high suffocation, and others had the whole wall and roof leaking obsolete pesticides stocks to near labor residence. The climate condition of the area is warm temperature and it needs ventilated types of chemical storage. The Forman and sprayer were badly affected with suffocation or contaminated air when they draw materials and equipment from the store. Obsolete pesticides stored in unsafe and uncontrolled stores leak off into ground and surface water and disperse into the air exposing entire populations to unavoidable health risks. The

research office and other stores are also exposed to obsolete pesticide pollution hazards and contamination. In middle Awash a large amount of disposal of obsolete pesticides and banned pesticides were available. The bad odor, illness, groundwater contamination, and microorganism degradation related to obsolete pesticides is a serious problem in Awash valley. In this study areas, people contaminated not only those people working with pesticides but also people living around cotton farm areas, the contaminated air spread to longer distance.

3.5. Farmers Knowledge and perception on pesticide effect

This study revealed that 75.6% of farmers understood the pesticides in cotton production were very harmful to human and animal health while 20.8% of them said that pesticides are moderately harmful, only one participant (3.5%) said pesticides were slightly harmful (Fig. 5). This result revealed that the majority of cotton-producing farmers in the study areas had some knowledge and awareness of the harmful effects of pesticides concerning the livestock (100%), human health, and environmental health (100%) (Table 5). But they had low efficiency in using personal protective equipment. These findings are in line with the findings in Sudan (Awad *et al.,* 2018), which found that the majority of farmers (85.7%) understood most pesticides are harmful to human and environmental health.

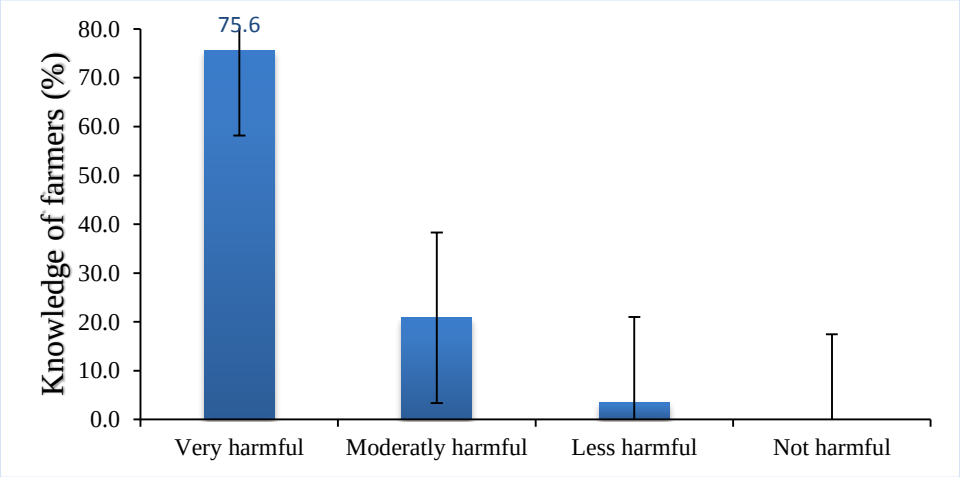

Figure 5. Knowledge of farmers regarding the harmfulness of Pesticides

3.6. Pesticides Formulation and Utilization of Personal Protective Equipment

Farmers in the study areas were mixed pesticides in different places of the cotton farm, most of them mixed nearby irrigation canals (62.8) followed by in the cotton field (35.1%), and only a few farmers were mixed nearby houses (2.1%). This result indicated that the majority of farmers were mixed pesticides nearby irrigation canals to simplify fetching of water far away from cotton fields and some other people mixed pesticides nearby houses due to the cotton farms around their home (Fig. 6). The majority of chemical sprayers (88.3%) were mixing pesticides in the plastic drum using a stick with a bar hand (96.1%) and only 27.3% of them mixed using a glove with a

stick. The sprayers are the victim of chemical hazards, due to they did not use PPEs during pesticide formulation and application. After chemical application, 94.5% of sprayers took shower (Table 2). The majority of sprayers had the experience of not smoking, eating, or drinking while working with pesticides.

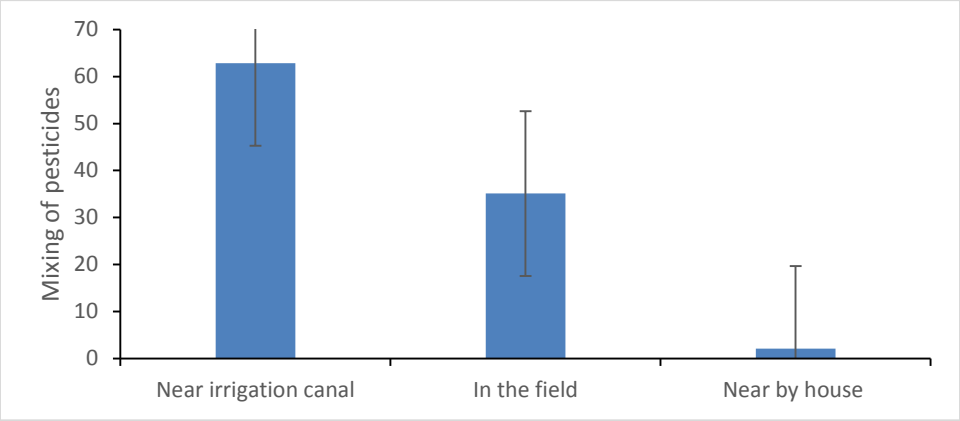

Fig.6. Pesticides formulation trends of farmers in Awash valley

This study revealed that (78.5% and 21.5%) farmers clothed normal cloth with rubber shoes and overall with boot/shoes during spraying and pesticide formulation. The protective devices such as eyeglass and full face mask were absent during spraying and formulation respectively (Table 2). Farmer's protective equipment such as normal cloth, glove, goggle, eyeglass, hat, full face mask, boot, respiratory, and overall were reduced contamination from pesticides (Awad *et al.* 2018). Also, these findings are in agreement with Keifer Matthew (2000) who indicated that the use of appropriate PPE, such as coveralls, and the adoption of other protective measures and good personal hygiene. The majority of chemical sprayers in the Amibara, Gewane, Assayita, and Fentale districts were mixing pesticides in the plastic drum using a stick with a bar hand and some of them mixed using a stick with the glove. Most sprayers are the victim of chemical hazards, due to they did not use the personal protected device properly during pesticide spray operation and formulation. This result agrees with the finding in Sudan, 42% of farmers did not use any personal protected device to protect themselves against pesticide exposure (Awad *et al.*, 2018).

Table 2. Protection measures are taken by farmers and sprayers during pesticides spraying N=158

Variable	Frequency	Percent	Variable	Frequency	Percent
Wearing normal cloth	124	78.5	Full face mask	-	-
Glove	35	22.2	Boot/shoes	63	39.9
Goggle	2	1.3	Respiratory	1	0.6
Eyeglass	1	0.6	Overall	34	21.5
Hat	27	17.1	Spraying with bare feet	36	22.8

3.7. Training provided for farmers

Farmers' capacity building through training before the preparation and spray operation of pesticides is crucial. The present study indicated that some of the participants in cotton production were received training on pesticide use (14.8%), Storage and safety (10.2%), disposal of empty container (13.3%), the application method (16.6%), all farmers understood effect pesticides to health and environment (100%) (Table 3). The smallholder farmers have received training on pesticide use and handling from either the Ethiopia institute of Agricultural research (Werer Agricultural research center) or the Regional Agricultural office. In all surveyed localities, not any farmer bought unregistered pesticides, they bought the registered pesticides with labels from the local market (Table 5). More than 63.2% of the farmers never read pesticide labels, because they were unable to read the label. After all, the labels were written in English, language and some of them are illiterate. The result revealed that only 36.7% read and understood pesticide labels (Table 3).

Table 3. Smallholder farmers Knowledge and Training received on pesticides N=128

Variable	N	%	Variables	N	%
How to use	19	14.8	knowing the names of pesticides	102	79.7
Storage and safety	13	10.2	Pesticides affect human health	128	100
Integrated pest management	11	8.6	pesticides affect livestock	128	100
Disposal of empty pesticides containers	17	13.3	pesticides affect environment	115	89.8
Application methods	20	16.6	Read pesticides labels	47	36.7
Health and environmental effects	15	11.7	Unable read pesticides labels	81	63.2

N= number of the respondent, %= percentage of the respondent,

3.8. Source of pesticides to stallholder farmers

This study revealed that (72%) of local pesticide retailer shops were the most important source of pesticides to cotton-growing smallholder farmers followed by the importer (19%), while the remaining farmers purchased from open market (9%), which involved the least involvement in the source of pesticide to make availability and affordability when needed by farmers. None of the cooperatives or unions used as the source of pesticides for smallholder farmers but it was used as the source of pesticides for large holder farmers in Awash valley for cotton production (Fig 7). These findings are in disagreement with the Brazil Study (Stokes and Stark, 1995) which found most of the farmers purchased the pesticide products at the local cooperative (56.4%). Ethiopian Pesticide Registration and Control Proclamation No. 2010, which aims at ensuring that end-users are provided with complete advice on risk minimization and proper use of pesticides. However, the extension had less contribution in advice and giving guidelines for cotton-producing farmers. The survey showed that the high price of pesticide is the most common constraint (92.3% of the farmers); 60.8% of farmers were encountered pesticides of low

quality (potentially contributing to resistance). Another problem-related pesticide's unavailability when it is needed and lack of safety device in Lower, Middle and Upper Awash (Table 3).

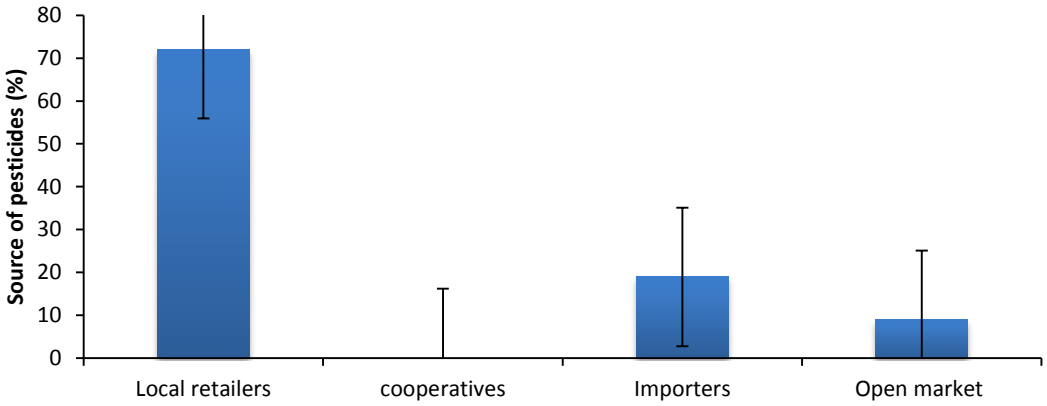

Figure 7. Source of pesticides for stallholder farmers

Table 4. Factors associated with pesticide handling and storage practice among farmers engaged in

Awash valley

Variables	N	%	Variables	N	%
Farm size			-weather on condition	0	0
Farm size ≤5.0	75	58.6	-Knowing the doses of every pesticide	7	5.6
Farm size >5.0	53	41.4	**How farmers mix pesticides**		
Land tenure situation			-With a stick, but bare hands	123	96.1
Landowners	66	51.6	-With bare hands	-	-
Landholders	62	48.4	-With hands and wearing gloves	-	-
Trend pesticide use past 5 years	0		-With a stick and wearing gloves	35	27.3
-Increasing	116	90.6	**Devices used for mixing pesticides**		
-Constant	12	9.4	-Knapsacks	15	11.7
Workforce for chemical application			-Types of mixing containers (drum)	113	88.3
Hired Labor	123	96.1	-Bath after application	121	94.5
Family labor	5	3.9	**Problem related to pesticides**		

-Using pesticides for a cotton farm	128	100	Low quality (ineffective)	73	60.8
Reading the material safety data sheet	79	52.4	Lack of safety device	38	31.1
Pesticides application depending on			High price	112	92.3
-Cotton Plant damage	128	100	Unavailability when it is needed	102	87.5

N= number of the respondent, %= percentage of the respondent,

The majority of cotton-producing farmers in Awash Valley had less than 5 hectares (58.6%) and some of the farmers had more than 5 hectares (41.4%). Among these farmers majority of them, landowners (51.6%) while landholders (48.4%). The farmers (90.6%) manage different pests in cotton fields in the past five years the pesticide consumption was increased rapidly, on the other hand, some farmers said constant pesticides were consumed for cotton pest management in the past five years (Table6). All farmers (100%) were applied pesticides based on insect population and plant damage symptoms, none of them applied based on weather conditions. Dominate workforce in cotton pest management were hired labor (96.1%) on pesticide use and practices while family labor (3.9%) had less contribution on pesticide spray operation and formulation (Table 4).

3.9. Support services available to smallholder farmers

Information is crucial for the safe use, practice, and handling of pesticides to increase cotton production and productivity. Most farmers used their own experience (40.2%) as a source of information followed by retailers (35.9%), farmers in these areas had long experience using their own experience and contact retailer with the phone. Some farmers, neighboring farmers (7.4%), and regional state extension (20.7%) were used as the source of information for safe use and practice on pesticides, there is some contact between the farmers and the state extension at the farm level. This study found no information exchange among the comparative/union and importers, when the smallholder farmers purchasing pesticides, this means the smallholder farmers did not receive important information on safe use, quality of products, handling, storage, method of application, and method of empty container disposal of pesticides (Fig 8)

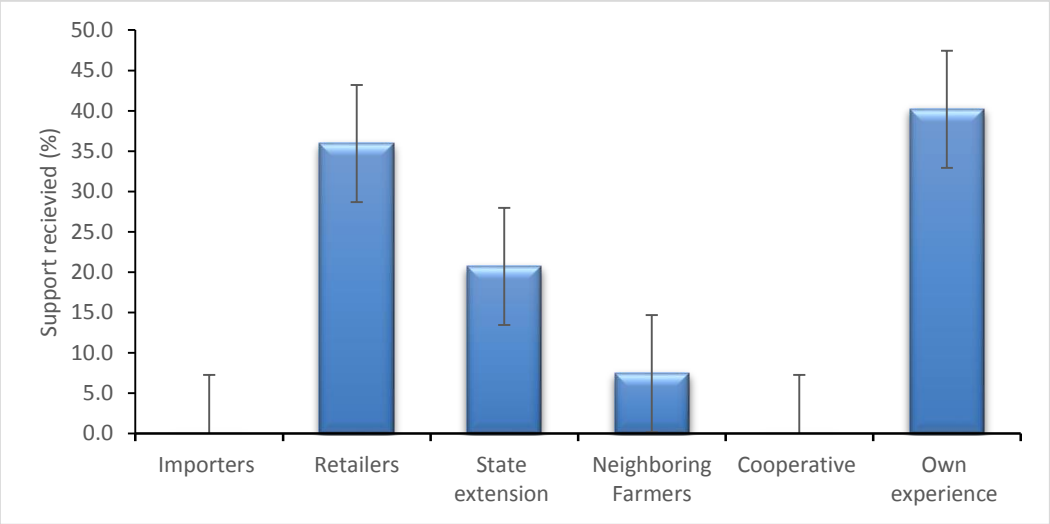

Figure 8. Support services available to smallholder farmers

All large holder cotton growing farmers (100%) are the main users of pesticides in Awash Valley (Table 5). Those interviewed farmers stated that they faced cotton insect pests and weeds during the 2019 production season and they used pesticides to control pests. The majority of farmers spraying pesticides 5-8 times per season and some others were sprayed pesticides 2 to 4 times per season to control insect pests. They also reported the insecticides that they are using low quality and high price, especially that emulsifiable concentration (EC) insecticides required a large number of sprayers than ultra-low volume concentrates (ULV). None of the respondents used chemicals that enhancement the harvest of cotton, due to this they used up to third picking. The source of pesticide for large scale farmers were none governmental organization and commercial importers of registered pesticide, from these commercial importers (98.3%) were the main source of pesticides. The legal status of all currently used pesticides (100%) was registered. Large holder farmers collaborated with research centers (73.1%), trade partners (46.2%) cotton grower neighbor farmers (32.8%), and state actors (36.8%).

Large holder farmers working environment of cotton field safe for workers health, however, all of them reported environmental officers in the farm, health and safety officers in the farm. The most cotton farm inspection was carried out from the Ethiopian Textile Development Institute (58.5%), followed by (40%) (Table 5).

Table 5. Factors associated with pesticide handling and storage practice among large scale farmers engaged in irrigation, Awash valley

Variable	N	%	Variable	N	%
Do you use pesticides in cotton production?	25	100	Ethiopian Cotton Producer Association	5	8.8
Frequent pesticides application			Environmental Protection Authority	1	1.8
2 to 4 days	4	31.3	The internal or external auditor	3	35.1
5 to 8days	21	68.7	-Support or services received from state or non-state actors	20	80

Do you use chemicals harvest enhancement of cotton	0	0	-A member of the Ethiopian cotton producer association (ECPA)	9	25.4
Source of pesticide used			-Organization had certification	12	45.6
Ministry of Agriculture	0	0	-Potential for the quality levels to be used in marketing cotton	5	33.0
None governmental organization	1	1.7	-Potential for the quality levels to be used in governing	17	54.1
From commercial importers of registered pesticides'	24	98.3	-Supply/provide certified cotton	13	17.5
The legal status of currently used pesticides			**How is your supply channel of cotton?**		
Registered	25	100	-Direct sales channel	17	68
Unregistered	0	0	-Through the auctions	5	8.3
-Farmers training on manage pesticides	19	81.9	-Both	3	5.0
Do you have Pesticide data that deal with health and environmental issues?	0	0	**Faced experience of rejection or dumping caused at auction**		
-Getting relevant material safety data sheet	20	93.0	Lack of certification/ cotton label	18	48.9
-Obsolete pesticides in cotton farm	7	14.0	Due to pesticide residue	0	0
-Environmental officers on the farm	0	0	Due to distorted cotton quality	7	51.1
Health and safety officers in the farm	0	0	**Working with other relevant authorities**		
-Working environment of cotton farm safe for workers health	22	76.1	Collaboration with trade partners	4	46.2
-Inspection from government regulatory body	11	28.6	Collaboration with cotton growers	8	32.8
Ethiopian Textile Development Institute	11	58.5	Collaboration with research centers	14	73.1
Ministry of labor and social affairs	5	38.6	Collaboration with state actors	4	36.8
-Ministry of Agriculture	6	40.4	Collaboration with other relevant actors	1	1.8

*N= number of the respondent, %= percentage of the respondent,

3.10. Method of Cotton pest Management

This study revealed that pesticides played a great role in the pest management of cotton production in the Awash valley (Figure 9). In the study areas (88.3%) of farmers only used pesticides while (1.7%) integrated pest management and (10.0%) of them used any best pest management options (such as tillage, removing alternative host and using different pesticides) but no one was used biological pest management (Fig 9). The most commonly used pesticides were Ethiosulfan, Lamda cylothrin, Dimetheote, and others in table 9. Some farmers used molasses traps with pesticides to control pink bollworm and Africa bollworm. Most of the pesticides used a high level of toxicity (WHO class II) like organophosphates and pyrethroid. The pesticides were purchased from pesticide local retailers, local markets, and importers. These findings are inconsistent with the Sudan Study (Awad *et al.*, 2018) which found most of the farmers purchased the pesticide products at the local market.

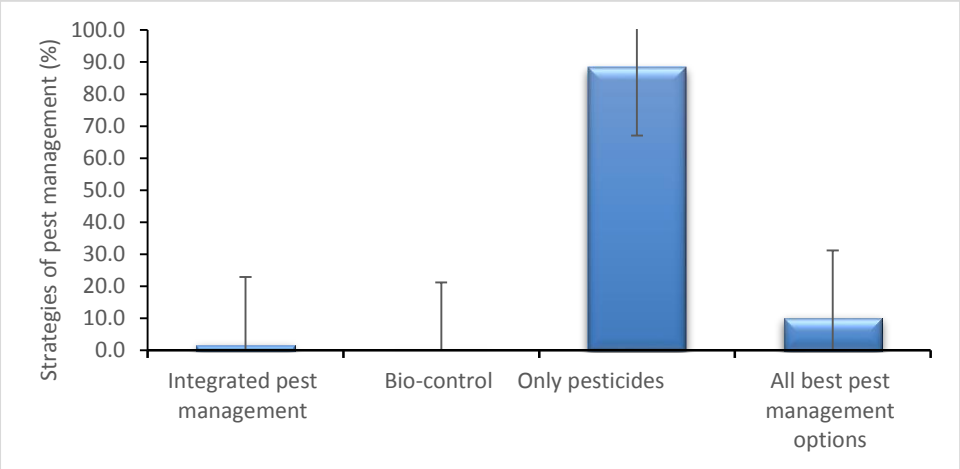

Figure 9. Strategies of pest management in cotton production

The majority of pesticide applicators involved in Lower, Middle, and Upper Awash were unemployed of temporary workers (73.9%), only some of them were permanent workers (26.1%) under this occupation (Table 6). This result revealed that pesticide sprayers need regular training on safe use, handling of pesticides, and also regularly informed about the risks and safety measures related to the pesticides since they did not have enough knowledge on pesticides use and practice, half of the respondents read and understand the label of pesticide. Only two respondents were received proper training concerning health and safety procedures (6.7). All sprayers reported they did not have any workers' association in the organization (0%). The majority of sprayers (93.3%) were followed sometimes about safety interactions regarding pesticide application, only a few of them (6.7%) followed interaction at all-time of application. In all study areas, the appropriate time of pesticide spray was early in the morning and late in the afternoon (Table 6).

A limited number of sprayers were taken for a medical check-up (cloistral tests) and monitor workers' health and safety (24.4%). Less than half the sprayers (40%) had an opportunity to discuss their problems with the management when problems arise and were coached by their supervisor when spraying operation and pesticide formulation. All sprayers (100%) interviewed have experiences with the side effect of pesticides for eating and drinking during spraying time.

Table 6. Factors associated with sprayer engaged in pesticides application in Awash valley

Variable	N	%	Variable	N	%
Sprayers employed as:			Never practiced	0	0
-Temporary worker	28	93.3	-Regularly informed about the risks and safety measures related to the pesticides	7	23.3
-Permanent worker	2	6.7	-Medical check-up (cloistral test) and monitor workers' health and safety	6	20.0
-Do you signed a contract with your employer?	2	6.7	-Received proper training concerning pesticide application	2	6.7

Is the company given you a copy of the signed contract?	1	3.3	-Aware of the code of pesticide practice	7	23.3
-Received training on pesticides use	22	73.3	-Are you coached by your supervisor	12	40.0
-Workers' association in organization	0	0.0	-Other workers enter the farm during the spraying process	22	73.3
-Have you opportunities to discuss your problems with the management when problems arise?	12	40.0	-Time of pesticide application	-	-
-Are the working environments are safe for health?	9	53.3	Morning	30	100
-Received proper training concerning health and safety procedures	2	6.7	Midday	0	0.0
-Taking a shower after spraying	30	100	Late afternoon	30	100
-Follow safety interactions regarding pesticides application			The whole day	-	0.0
All the time	2	6.7	-Experiences for eating and drinking during spraying time	30	100
Sometimes	28	93.3	-Understanding the label of pesticide (language)	15	50.0

*N= number of the respondent, %= percentage of the respondent,

3.11. The motivation of state extension workers

The motivation of state actors is crucial to transfer knowledge to farmers and enhance the implementation of pesticide policy at the cotton farm level. All extension workers interviewed were reported pesticides did not include in agricultural extension services. More than half of the workers (51.6%) were trained on the safe use and practice of pesticides. Most DAs (62.7%) visited the farmers every week and all of them (100%) provided advice for farmers on how to act on the appropriate use of pesticide (Table 7). Most of interviewed DAs are working out of their professional duties like animal science of agronomy; they did not have deep knowledge of plant protection. Most extension workers reported the problem of infrastructural such as roads, transportation accessibility, and low chance of getting academic education to upgrade themselves and low salary for the extension workers. Also, the most important constraints included a shortage of DAs work with a large number of farmers, a lack of extension materials, and limited practical skills of DAs.

Other constraint promotion, reward, and incentive systems that attract and motivate DAs on their professional work. They reported that the lack of a clear career structure that includes incentives, promotion, awards, and other opportunities for extension workers remains a major constraint and causes low motivation of satisfaction. The DAs reported that they have no enough information and technical knowledge on different agricultural pesticides that are available in the market. The survey revealed that all DAs (100%) had the technical knowledge to identify symptoms of pest attacks, as well as knowledge of pesticide application methods. All of them (100%) knew field diagnosis of pests, diseases, and weeds are low, so performing this is likely to go beyond the capability of many field extension agents.

Table 7. Contribution of the extension worker in irrigated cotton production

Variable	N	%	Variable	N	%
-Are pesticides included in agricultural extension services	0	0	-Technical knowledge on-field diagnosis of pest, disease, and weeds	12	100
-Training related to pesticide	7	51.6	**Level of satisfaction with the following items related to motivation**		
-Provided advice for farmers on how to act on the appropriate use of pesticide	12	100	-Frequent organizational restructuring on the current job is satisfactory	9	73
Frequency of extension workers visit with smallholder			-Service training, and skills development on the current job is satisfactory	9	90.5
Every week,	8	62.7	-Career structure for promotion on the current job is satisfactory	11	95.2
Every two weeks,	4	37.3	-Rate of items resources availability	0	0
-Growers have sufficient and appropriate information on how to use pesticide	9	95.2	-Transportation facilities are sufficient to access farmers	8	41.3
-Are you interested in your profession	12	100	-The number of DAs assigned to farmers is proportional	6	59.5
Rate of technical knowledge and information on pesticide policy, pest and pesticide issues,			-Effectively available extension materials to work and communicate with the farmers	4	37.3
Pesticide law (proclamation)	5	54	-Training about the use of pesticides	7	51.7
-Necessary knowledge & skill to identify a symptom of pest attack	12	100	-opportunity to participate in the process of formulating agricultural policy, strategy in the district	5	35.7
Knowing different pesticide application methods	12	100	-Are you aware of the Ethiopian pesticide policy (proclamation)	11	83.3

3.12. Insect pests of cotton and pesticides used in Awash valley

The factors that affect cotton production were lack of improved variety, insect pests, disease, and weeds. More than 68 species of insect and mite pests were identified in Ethiopia (Tsedeke, 1982; Woktole, 1996; Ermias *et al*., 2009). During this study, the most common and important insect pests of cotton were recorded in Fentale, Amibara, Gewane, and Assayita districts (Table 8).

Table 8. Important cotton insect pest in Awash Valley

SN	Common name	Scientific name	SN	Common name	Scientific name
1	Africa bollworm	*Helicoverpa armigera*	11	Semi-looper,	*Cosmophilla flavus*
2	Pink bollworm	*Pectinophora gossypiella*	12	Lacer armyworm,	*Spodoptera exigua*
3	Spiny bollworm	*Earias insulana*	13	cottonseed bug,	*Oxycarenus hyalinipennis*
4	Sudan bollworm	*Diparopsis watersi,*	14	cotton stainer bug	*Dysdercus faciatus*

5	Thrips	*Thrips, tabaci*	15	cotton stainer bug	*Dysdercus faciatus*
6	Cotton Aphid	*Aphid gossypi*	16	Red spider mite	*Tetranychus cinnabarinus*
7	Cotton Jassid	*Empoasca lybica*	17	Camploma bug,	*Camplom nicolacl*
8	whitefly	*Bemisia tabaci*	18	cotton stainer bug,	*Dysdercus faciatus*
9	Mealybug	*Phenacoccus solenopsis*	19	cotton flea beetle,	*Podogarcia puncticollis*
10	Leafworm	*Spodoptera littoralis*	20	Leaf miner,	*Liriomyza Sativae*

Cotton growing farmers were used different types of commercial pesticides with different chemical composition organochlorines, organophosphates, pyrethroids, and carbamates were commonly used by consulting retailers, own experience, neighboring farmers, and extension professionals from the agriculture sector. About 20 pesticide active ingredients were used in the surveyed areas (Table 9). These pesticides belonged to the classification of World Health Organization (2009) toxicity class II pesticides (moderately hazardous), class III pesticides (slightly hazardous), class Ib pesticides (highly hazardous).

Table 9. Types of pesticides used in Awash Valley, Ethiopia, 2019

SN	**Trade name**	**Common name**	**Chemical compounds**	**WHO: hazard class**	**Formulation**
1	Marshal	Carbosulfan	Carbamates	II	25% ULV
2	Deltanet	Metiumarial	Carbamates	II	200 EC
3	Polo	Daipotiuron	thiourea	III	500%SC
4	Ethiozine	Diazinon	Organophosphates	II	60 ES/ULV
5	Decis	Deltamethrin	Pyrethroids	II	0.5EC/ULV
6	Thiodan	Endosulfan	Organophosphates	II	25%ULV
7	Thiodan	Endosulfan	Organophosphates	II	35% EC
8	Proof	Profenofos	Organophosphates	II	72EC
9	Karate	Lambda-cyhalothrin	Pyrethroids	II	0.5%EC
10	Decis	Deltamethrin	Pyrethroids	II	2.5% EC
11	Selecron	Curacuron	Organophosphates	II	72% EC
12	Dursban	Chlorpyriphos	Organophosphates	II	48 % EC
14	Ethiosulfan	Endosulfan	Organophosphates	II	25% ULV
15	Ethiosulfan	Endosulfan	Organophosphates	Ib	5% ULV

19	Fastac	Alpha-cypermethrin	Pyrethroids	III	5 EC/ULV
20	Coragen 200 SC	Chlorantraniliprole	Diamides	III	Tracer 480SC
21	Bestox	Alphacypermethrin	Pyrethroids	II	7.5% ULV

4. CONCLUSIONS AND RECOMMENDATIONS

Pesticides are widely used in agricultural production to control pests, insects, mites, diseases, and weeds in cotton and on other crops. Pesticides have played a great role in improving the quality of cotton production and productivity and ensuring high profits to farmers. A large number of pesticides are used in large-scale farming than small-scale farming, especially in cotton production. This study concluded that there is the highest risk from unsafe use and practice of pesticides to human health and the environment. All sprayers those inappropriate using the pesticides could be felt at least with one symptom. The most important symptoms reported by people working pesticide were nausea, vomiting, eye irritation, skin irritation, headache, and shortness of breathing to pesticide sprayers. Other major problems associated with pesticides are the disposal of obsolete pesticides and empty pesticide containers. Obsolete pesticides in studied areas were stored in unsafe and uncontrolled stores, which leak off into groundwater and disperse into the surrounding environment. According to the assessment carried out in this study, the knowledge and the awareness of smallholder farmers, sprayers, and extension workers were not sufficient. The right application of pesticides can minimize, the environmental and human health impacts being caused by inappropriate utilization of pesticides.

Pesticide sprayers should be had an education and certificate for the proper use and practice of pesticides; to protect themselves, other people, and the environment from chemical hazards. They must be following up on important interactions during pesticide spray operation and pesticide formulation. Stakeholders have to increase farmers' and sprayers' knowledge on the use and practice of pesticides through farm-level training, order to limit the hazards associated with pesticides. All people who working with pesticide warnings to use protective devices before implementing pesticide. All investors needed to provide guarantees for pesticide sprayers when pesticide accidence occurred.

5. REFERENCE

Awad O. Mohamed, Mater, A.A., Hammad, A.M., Ishag, A.E.S., Abdelbagi, A.O., Eldein, A.M., Eltayeb, E.M., Dahab, A.A. and Gader, A.A., 2018. Knowledge, Attitudes and Practices of Pesticide's Sprayers towards Pesticides Use and Handling in Greenhouse Farms, Sudan.

Brodesser, J., Byron, D.H., Cannavan, A., Ferris, I.G., Gross-Helmert, K., Hendrichs, J., Maestroni, B.M., Unsworth, J., Vaagt, G. and Zapata, F., 2006. Pesticides in developing countries and the International Code of Conduct on the Distribution and the Use of Pesticides. Food Environ. Prot. Newsletter, 9, pp.4-7.

Environmental Health Manual (2010). "Disposal of Unused Pesticides and Empty Pesticide Container", Available Online At Http://Www.Health .Gov.Au/Internet /Publications /Publishing.Nsf /Content/ Ohp-Enhealth-Manual-Atsicnt-I-Ch5. Accessed 25 December 2019

Ermias S Geremew T and Zeray M, 2009. Review of Research on Insect Pests of Fiber Crops in Ethiopia. In: Abraham Tadesse (ed) 2009. Increasing Crop Production through Improved Plant Protection- Volume II. Proceeding of the 14th Annual Conference of the Plant Protection Society of Ethiopia (PPSE), 21—22 December 2006. Addis Ababa Ethiopia. PPSE and EIAR, Addis Ababa Ethiopia. Page 93- 116.

Farah, J., 1993. Pesticide policies in developing countries: Do they encourage excessive use?. The World Bank.

Ghorab, M.A., 2016. The Effect of Pesticides Pollution on Our Life and Environment. Environmental Health Criteria, 63, pp.1217-1223.

Hiwot, A.G., 2007. Cotton production and research in Ethiopia. Ethiopian Agricultural Research Institute, Ethiopia.

Hoi, V. P., Mol, A.P., Oosterveer, P. and van den Brink, P.J., 2009. Pesticide distribution and use in vegetable production in the Red River Delta of Vietnam. Renewable agriculture and food systems, 24(3), pp.174-185.

Karunamoorthi K. Mohammed M. and Wassie F. 2012. "Knowledge and Practices of Farmers with Reference to Pesticide Management": Implications on Human Health. Archives of Environmental & Occupational Health. 67, 109-116.

Lundbæk, J., 2002. Privatization of cotton sub-sector in Uganda: Market mechanisms and institutional mechanisms to overcome these. Master's thesis, Royal Veterinary and Agricultural University, Department of Economics and Natural Resources, Frederiksberg, Denmark.

Serunjogi, L.K. Elobu, P., Epieru, G., Okoth, V.A.O, Sekamatte, M.B., Takan, J.P. and Orokot, J.O.E (2001): "Cotton (Gossypium Sp.)" In Agriculture In Uganda Volume II: Crops ed. Mukiibi J.K. Fountain Publishers Ltd./CTA/NARO.

Tilahun, B. and Hussen, A., 2014. Assessment of pesticide use, practice, and risk in gedeo and borena zones; Ethiopia. International Journal of Environment, 3(3), pp.201-209.

Tizazu Mengistie, B., 2016. Environmental governance of pesticides in Ethiopian vegetable and cut flower production (Doctoral dissertation, Wageningen University).

Tsedeke Abate. (1982). Cotton pest problems and their control in Ethiopia. Pp111-127. In Proceeding of the symposium on cotton production under irrigation in Ethiopia. Melka Werer, Ethiopia. October 1982. IAR

Waktole Sori. (1996). Management of cotton insect pests in Ethiopia: a review. Pp 224-252. In Proceedings of Integrating biological control and Host Plant Resistance. CTA/IAR/IIBC, Addis Ababa, Ethiopia.

World Health Organization (WHO), 2009. The Who Recommended Classification of Pesticides by Hazard and Guideline to Classification. WHO: Geneva, Switzerland.

Stokes Lynette, Stark Alice, Marshall Elizabeth, Narang Amarjit. (1995). Neurotoxicity Among Pesticide Applicators Exposed to Organophosphates. Occupational and Environmental Medicine 52, 648-653. Doi: 10.1136/Oem.52.10.648.

Keifer Matthew. (2000). "Effectiveness of Interventions in Reducing Pesticide Overexposure and Poisonings". American Journal of Preventive Medicine 18(4), 80-89. Doi.Org/10.1016/S0749-3797(00)00144-6.