Original Research Article||

Pesticide use practice and implications on farmer's health: the case of Shebedino district, Sidama Region, Ethiopia

Hirut Tsegaye Feleke[1*]

[1]*School of Plant and Horticultural Sciences, College of Agriculture, Hawassa University, P. O. Box 5, Hawassa, Ethiopia*

Abstract

The current need to produce marketable vegetables entails increasing pressure to use agricultural pesticides. Shebedino district of Sidama region is known for its agricultural crop production and farmers use agrochemicals, mainly for the control of pests. However, information on pesticide usage practice and human health problems associated with inappropriate applications of pesticides were lacking. The present study, was therefore, aimed to assess the major types of pesticides used in the study area, examine farmer's attitudes about pesticides, and evaluate the health problems associated with pesticide use in Shebedino district of Sidama region, Ethiopia. A community-based cross-sectional survey was conducted to assess farmers' pesticide handling practice and associated risks in the study area. Farmers who use pesticides were purposively selected for the interview. The result showed that the extent of pesticide utilization in the study area has been increasing, but farmers' knowledge on pesticide handling and the risk awareness were very low. The results revealed that none of the interviewed farmers in the district received training on the proper use and storage of pesticides. A total of seventeen different pesticide were used by the farmers, of which mancozeb was the dominant fungicide used by all farmers. Nearly all the farmers apply pesticides through spraying, however, except some head covering and handkerchiefs, farmers/ applicators never use pesticides protective equipment while spraying. Headache (87.65%), skin rash (49.38%) dizziness (48.15%) and blurred vision (43.21%) were among the health problems reported by pesticide users. The finding showed that there is high risk of farmer's pesticide exposure in the study area, the pesticide residues may accumulate in the food products (vegetables) and cause a wider public health risks. Intervention through awareness creation and training on appropriate pesticide handling measures are required to reduce the potential health and environmental hazards in the district.

Key words: Health problems, Knowledge, Pesticide handling, Toxicity symptoms, Unsafe practices

Original submission: February 16, 2025; **Revised submission**: March 17, 2025; **Published online**: March 25, 2025
***Corresponding author's address:** Hirut Tsegaye Feleke, Email: *hirut@hu.edu.et*

INTRODUCTION

Pesticides are considered as a vital component of modern farming, playing a major role in maintaining high agricultural productivity (Srivastav, 2020). If applied carefully, pesticides can contribute to increased agricultural productivity. Without pesticide application, the crop yield will be reduced significantly due to insect damage, weed infestations and plant diseases (Jansen and Dubois, 2014). The report by Tudi et al. (2021) showed that pesticide utilization allows farmers to avoid 78, 54 and 32% fruits, vegetables and cereal yield losses, respectively. Pesticides are easy to apply, reduce the cost of production and are sometimes the only option for pest management (Chala, 2022). However, extensive applications of pesticide like in the sub-Sahara African region, including Ethiopia, may lead to a serious environmental degradation and various health problems (Loha et al., 2018).

Agricultural pesticides are introduced to Ethiopia in the 1960's when various types of agrochemicals were imported by private and public companies and since then, their use has been increasing rapidly (MOA, 2013). Currently, the need to feed the growing population of the country and the growing interest to produce exportable volumes of agricultural product to access the global market entail an increasing pressure to intensify agriculture and use chemical pesticides. For instance, during the 2020/21 cropping season, about 6.85 million smallholders applied pesticides on an estimated crop area of 4,456,912 ha (MOA, 2021). The report showed only the treated area, but not the frequency of pesticide application which would be high, especially in vegetable growing areas. The growth of the agricultural sector in Ethiopia, partly associated with intensive application of pesticides. In our country, there is increasing trends in the use of pesticides; however, there is lack of regulatory mechanisms that reduce the side effects on human health and the environment (FDRE, 2018). Selection of the appropriate pesticide type and amount, mixing and application time are vital to enhance the efficiency and effectives of the pesticide used, and minimize environmental risks (Van et al., 2020). However, several reports showed the misuse of pesticides, and inappropriate storage and disposal of empty pesticide containers in Ethiopia (Mengistie et al., 2017; Mergia et al., 2021). Insufficient knowledge regarding safe and proper pesticide handling by farmers in Ethiopia has led to a serious health and environmental problems (Mergia et al., 2021). Indiscriminate and inappropriate use of pesticides results in illness and poisoning of individuals, as well as contamination of the environment (Mengistie et al., 2017). About 17 different pesticide residues including six banned ones were reported from the study area (Feleke and Belete, 2025). The report showed the potential risks of river and underground water contaminations by the pesticide residues. Recent studies on pesticide residues in Ethiopia also revealed the existence of different health and environmental problems associated with mismanagement of pesticides (Abaineh et al., 2024; Loha et al., 2024).

Vegetable production in Ethiopia, including in Sidama region, is highly dependent on the application of pesticides, and the presence of pesticide residues in fruits, vegetables, and groundwater has been reported in these areas (Mutengwe et al., 2016; Loha et al., 2020). Recent study around Hawassa city, Sidama region, indicates that farmers lack knowledge about proper application and storage of pesticides (Alshalati, 2021). Only few researches on the subject have been reported from the region so far (Gesesew et al., 2016 and Alshalati, 2021). Further studies on the extent of pesticide use, protective methods and pesticide use associated health problems are needed to design more effective methods that reduce the exposure to pesticide, and enhance farmers to adopt sustainable agricultural practices. The present study was therefore, conducted to assess the major types of pesticides used, farmers' attitude and awareness about pesticide management, identify and evaluate the farmers' health problems related to pesticide use in Shebedino district of Sidama region, Ethiopia.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Shebedino, one of vegetable producing districts of Sidama region, Ethiopia. Shebedino is found at 6^0 46′ to 7^0 45′ N and 39^0 34′ to 39^0 53′ E, 30 km from Hawassa city, capital of the region. Land features of the district include plains and plateaus with varying hills and altitudes. The area has annual temperature, elevation and rainfall ranging from 16 to 25 ° C, 1500 to 3000 m and 800 to 1600 mm, respectively (BoFED, 2015). Farmers in the district produce different types of vegetables such as tomato, cabbage, potato, and pepper, to supply to many market centers in the region. Site map of the study area is shown in Figure 1.

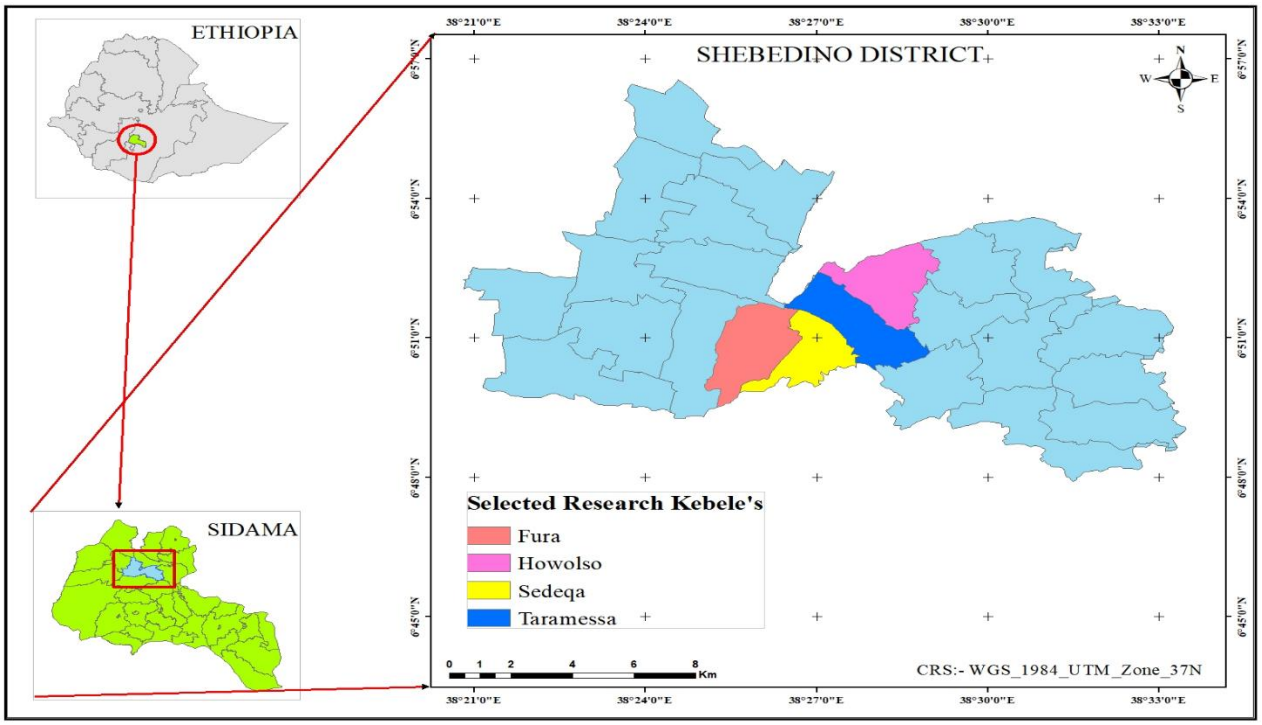

Figure 1. Location map of the study area

Study Methodology

Purposive sampling technique was employed to identify sample households for the present study. Four intensive vegetable producing kebeles (Fura, Howolso, Sedeqa and Taramessa) and 30 households from each kebele, a total of 120 sample households were selected intentionally. Farmland size, type of crop produce and management practices was the major selection criteria. The selected households were those having more than at least 0.5 ha of farmland, cultivated the farm for more than two years and produce mainly vegetables with the use of chemical pesticides. It was assumed that an increase in the frequency of cultivation increased the frequency of pesticide use per unit area per year (Maurya et al., 2019). The study was conducted from March to June, 2023.

The required information was collected using semi structured and pretested questionnaire through face-to-face interviews using the Kobo Toolbox application. Prior to data collection, information about the aim of the study and the confidentiality of the data gathered were communicated to the respondents and their agreement was confirmed. All vegetable producing farmers included in the study were those who have irrigation facilities and had more than two years of experience in pesticide utilization. The data collected includes farm size, income, land tenure situation, type of vegetable they produce and extent of pesticides application, vegetable production experience, etc. Basic information on frequently used pesticides and their source, methods of pesticide application and follow up of instructions, pesticide storage and empty container disposal mechanism, safety measures, perception on pesticide use, awareness of farmers on the effect of improper pesticide application and associated risks were collected. Furthermore, focus group discussions were conducted with development agents and key informants such as district agriculture bureau officers, pesticide retailers and environmental health officers. Interviews were also conducted with randomly selected pesticide applicators who have been hired by farmers at the time of pesticide application.

Data Analysis

The collected data were cleared and entered in the MS-Excel spreadsheet and analyzed using version 29 of SPSS (2022). The results were presented in descriptive statistics such as frequencies, and percentages for specific variables, and as means for continuous variables.

RESULTS AND DISCUSSION

Characteristics of the Farmer Households

The basic socio-demographic information of selected households was presented under table 1. Most of the farmers (96.67%) involved in the present study were males (Table 1). The dominance of males over females might be associated with the culture and nature of work as men are usually involved in pesticide handling than women (Mrema et al., 2017). The gender ratio presented in this study was in agreement with the previous report by Zyoud et al. (2010). It was revealed that most of the respondents, (86.67%) were in the age between 24–64 years. The decrease in the number of farmers with younger and older age might be due to lack of interest and labor demanding nature of agricultural practices. The tendency to migrate in to the nearby cities for better job and payment might be the other reasons for limited participation of youth in vegetable production practices (May et al., 2018).

Table 1. Socio-demographic characteristics of the sample farmers in the study area

Socioeconomic indicators	Categories	Frequency	Percentage (%)
Sex	Male	116	96.67
	Female	4	3.33
Marital status	Married	111	92.50
	Single	9	7.50
	widowed	-	-
	Divorced		
Educational status	Illiterate	6	5.00
	Formal education	79	65.83
	Primary	28	23.33
	Secondary	7	5.83
	Certificate	-	-
	Diploma/Degree	-	-
Age	≤15		
	15-24	12	10.00
	24-64	104	86.67
	≥64	4	3.33
Farm Size	<1 ha	110	91.67
	>1ha	10	8.33
Pesticide use (last 5 years)	Increasing	120	100
	constant		
Farming Experience	2-4	24	20.00
	5-10	89	74.17
	>10	7	5.83
Professional training	Yes	-	
	No	120	100
Source of income	Agriculture	113	94.17
	Other	7	5.83

Regarding the education of the farmers, 65.83% of them had basic education out of which 23.33% primary and 5.83% secondary education. Majority (74.17%) of the farmers who participated in the assessment had 5-10 years of vegetable production experience and agriculture was the only means of income for 94.17% of the farmers (Table 1). Vegetables were the most commonly grown agricultural products in the study area. Among them, tomatoes and cabbage were the most

common ones followed by potatoes. Most of the farmers produce both tomatoes and cabbage for consumption as well as for local markets.

The present study showed that the extent of chemical pesticide utilization in the district has been increasing for the last five years, but none of the farmers received training on the use and safe handling of pesticides during the same period. This might be due to unavailability of a relatively vigilant institution like the Ethiopian Horticultural Producer and Exporters Association (EHPEA) and others that provide training to farmers and agriculture extension workers. Previous studies on pesticide utilization in Ethiopia showed that more than 80% of individuals who spray pesticides had not received any training on pesticide utilization and management practice (Negatu et al., 2016; Agmas and Adugna, 2020). The present finding showed an increase in pesticide use, as compared to previous estimates in the various farming systems in Ethiopia. It appeared to be 13-fold higher than in case for small scale individual farmers in Ethiopia (Pretty and Pervez, 2015). The increased use of pesticides in combination with the generally poor pesticide handling and management practices in this study could potentially lead to serious human and environmental risks.

Knowledge, Attitudes and Understanding towards Pesticide among Farmers

The farmers' level of knowledge on pesticide, routes of exposure, impact on the environment, health effects of pesticide and awareness of pesticide policy and code of practice are summarized in table 2. Regarding protective equipment while they were spraying pesticides, 40 (33.33%) used normal clothes, 46 (38.33%) used cotton overalls. Only a small proportion of the surveyed farmers, farm workers and pesticide applicators utilized pesticide protective Equipment (PPE). Except for the use of some sort of head covering and handkerchiefs, there was no complete PPE used by any of applicators in the study area, mostly exposing their face, hands, palms and their fingers (Table 2).

Previous surveys in Ethiopia indicated that personal protection was not always provided and not always commonly used during application of pesticides (Mergia et al, 2021). Alshalati (2021) reported that, in Sidama region Tulla kebele, almost all the study participants (93.15%) did not use any means of pesticide protective equipment while mixing and applying pesticides and 6.85% of the respondents reported the use of gloves only. Even if 49 (40.83%) of the respondents indicated that they could read and understand labels on pesticide containers, only 21(17.50%) could understand and follow instructions. Some of them also revealed that they usually buy pesticides which have no labels on the containers. Reading the label and using scaled equipment are important as to adhere to the recommended amount of pesticides, which can result in very high exposures if used over the recommended amount or might result in pesticide resistance if used at rates below the recommended utilization. Other studies showed similar figures with only 27 and 31% of respondents in the central eastern and Zeway part of Ethiopia respectively read pesticide labels (Negatu et al., 2016; Mergia et al., 2021). It has been observed that a lever-operated knapsack sprayer was the only type of sprayer used by small-holder farmers in the district. The present finding showed that 67.50% of vegetable farmers in the area mix the different pesticides while 32.50% of them never use mixed pesticides (Table 2).

Table 2. Farmers' Knowledge, Attitude, and Understanding of Pesticides Use (n = 120)

Variable	Frequency	Percentage (%)
Do you wear protective clothing when applying pesticides?		
Yes	46	38.33
No	40	33.33
Yes Sometimes	34	28.33
At what time during the day you apply the pesticides?		
Morning	37	30.83
Middle day	25	20.83
Afternoon	56	46.67
Evening	2	1.67
Do you read and understand pesticides label		
Yes sometimes	49	40.83
Yes always	43	35.83
No	28	23.33
Which basic information do you check during pesticide purchase?		
Name of pesticide	27	22.50
Expiry date	24	20.00
Price	21	17.50
Type pest control/kill	21	17.50
Rate of application	21	17.50
Did you follow the instruction that you read on the pesticide container in application?		
Yes always	21	17.50
Yes some time follow	34	28.33
No	65	54.17
Do you mix pesticides?		
Yes	81	67.50
No	39	32.50
Do you rotate pesticides?		
Yes	102	85.00
No	18	15.00

As explained by the farmers during the group discussion, those farmers who mix the different pesticides spray their farms during the production time less frequently as compared to those who never mix the pesticides. This might be due to the different mode of action and target pests of the pesticides that enable the farmers for a better control of the pests. In agreement with the present study, Van et al. (2020) explained that selecting appropriate sprayer and application time of pesticide plays a key role for effective control of the pests; minimize the adverse effects on crops, the environment and human health from pesticide residues.

Information for efficient utilization pesticides are important, particularly for small-holder farmers, however, none of pesticide importers employed technical employees at district or farm level for such purposes. As shown in figure 2, farmers in the district get information on use and pesticide storage from development agents, neighbors and retailers who have limited knowledge on agro-chemical utilization. Previous report revealed the existence of big difference between experts and beginners in the way they perceive, remember and express their observations through the language they use (Kim et al., 2011). This finding was in agreement with the finding of

Brhane et al. (2017) who reported that 57.2% of the farmers seek information from woreda agricultural extension officers.

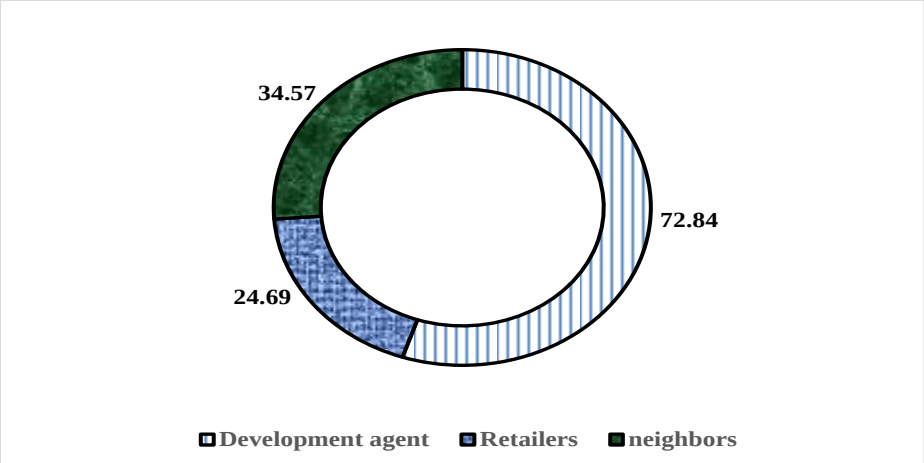

Figure 2. Source of information about use and storage of pesticide

Hazardous Impacts of Pesticides on Human Health

The present study regarding health problems after pesticide application showed that the majority of the pesticide applicators feel discomfort after spraying the pesticide. The feeling of headache (87.50%), skin rashes (49.17%), dizziness (48.33%), blurred vision (43.33%) and difficulty in breathing (30.00%) were also reported as major health problem symptoms by the applicators in the district (Figure 3). Similar studies on pesticide associated health problems revealed that 68% pesticide user farmers in Ethiopia reported some sort of unidentified illness, the rest felt head ache (37%), skin irritation (28%) vomiting (8%) and other symptoms after applying pesticides (Mojo and Zemedu, 2022). A study conducted elsewhere in Ethiopia also showed an increased risk of respiratory system diseases related to young workers with increased exposure to pesticides (Negatu et al., 2016). Moreover, regular deaths of farmers and blurred vision because of unintentional exposure or misuse of pesticides were also reported in Ethiopia and Ghana (Loha et al., 2018). The study of Abaineh et al. (2024) confirmed that pesticides are among the top ten human health problems in the northern part of, Ethiopia, and pesticide-related cases are reported to the Zonal and the Regional Health offices monthly.

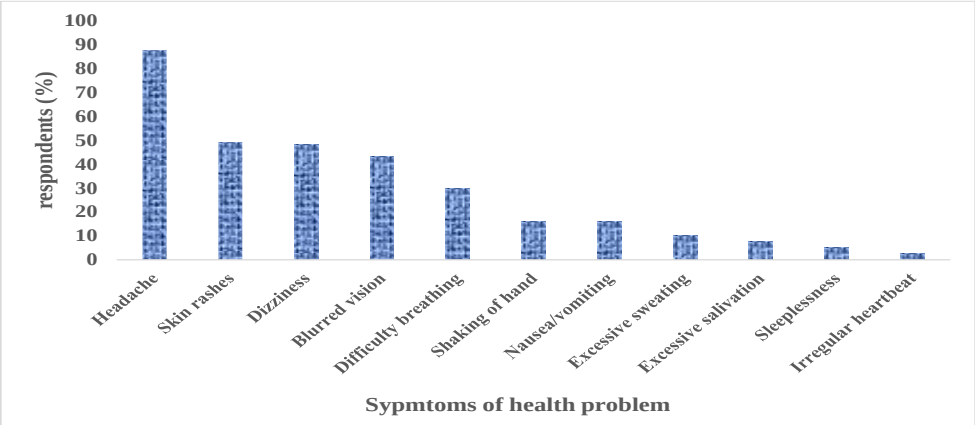

Figure 3. Symptoms of pesticide exposure reported by farmers in the district (multiple answers were possible)

Pesticides Used by Small-holding Vegetable Producers

The present investigation showed that different pesticides are used by vegetable producers in the district. A total of 17 pesticides were found to be used in the district. The pesticides are presented in table 3 based on the world health organization (WHO), acute toxicity hazard class (WHO, 2010). Most of the pesticides used in the study area were belongs to the WHO toxicity Class II (moderately hazardous), followed by Class-U (unlikely to present acute hazards in normal use) and Class III (slightly hazardous). Extremely hazardous (Ia) or highly hazardous (Ib) classified pesticides were not reported by any of the farmers. The primary WHO Class II pesticides reported by small-scale farmers in the study area included metalaxyl, profenofos, dimethoate and Chlorpyrifos. Among Class-U pesticides, mancozeb were the most reported pesticides. The use of herbicides such as propanil and 2, 4-D were also reported by some farmers. Insecticides and fungicides have been used by 95 and 90% of farmers, respectively, in the district. In related to this study, Abaineh et al. (2024), reported that farmers have been using various types of pesticides to control weeds and pests of crops with different spraying frequencies in Ethiopia.

Out of the pesticides applied on vegetable crops of the study area, Metalaxyl and Dimethoate will persist up to 30 days, and Chloropyrifos and Diazinon will remain in the environment for a range of 30–100 days (Rahman et al., 2020). Since the vegetables are consumed by the farmers or presented to the market a few days after spraying, there will be a high chance of the pesticide to be consumed by the consumers. Similar studies in Fogera District, Ethiopia confirmed that all the farmers supplied their cultivated crops from the first day after pesticide spray (Abaineh et al., 2024).

Table 3. Pesticide use in surveyed farms

No	Common name	Chemical class	WHO	Type
1	Metalaxyl	Phenyl amide	II	F
2	Karate	Synthetic pyrethroid	III	I
3	Dimethoate	Organophosphate	II	I
4	Mancozeb	Dithiocarbamate	U	F
5	Copperoxichloride	Inorganic	II	F
6	Ethioprofos	Organophosphate ester	II	I & N
7	Dimethomorph	Morpholine	III	F
8	Profenofos	Organophosphate	II	I
9	Malathion	Organophosphate	III	I
10	Cymoxanil	Cyano acetamide oxime	II	F
11	Chlorpyrifos	Organophosphate	II	I
12	Abamectin	Bio-origin	NL	I
13	Propiconazole	Triazole	II	F
14	Sulfur	Inorganic	III	F
15	Kocide	Oxime + inorganic	II	F
16	Diazinon	Organophosphate	II	I
17	Copper	Inorganic	III	F

NL = not listed; II = moderately hazardous, III = slightly hazardous, U = unlikely to present acute hazard, I=Insecticides, F= Fungicides, N=Nematicides.

Pesticides Use, Storage and Disposal

With regard to pesticide use practices, storage and disposal mechanisms of empty containers; the finding revealed that most farmers in the study area had inappropriate practices. Figure 4 showed that most respondents were not concerned about over-dosing; 41.98% of them applied the leftover

solution to crops repeatedly. Others disposed of the solution in the field and water bodies which could be another source of environmental pollution. Similarly, Agmas and Adugna (2020) reported that, 72% of pesticide users responded that they apply the leftover solution to crops repeatedly. Others (28%) disposed of the solution in the field and in the water body.

Regarding farmers pesticide storage in the district, our investigation revealed that a significant number of respondents (44.4%) kept pesticides in their residential house (Figure 5). None of the respondents reported direct use of pesticides immediately after purchase. Our finding was similar with the report from farmers around Lake Ziway watershed, Ethiopia (Mergia et al., 2021). The majority of vegetable producing farmers (60.9%) in the North-Western part of Ethiopia reported that they stored pesticides in the living houses (Agmas and Adugna, 2020). The finding showed that even children and mothers who have no direct involvement in vegetable production practice may have direct exposure to the pesticides.

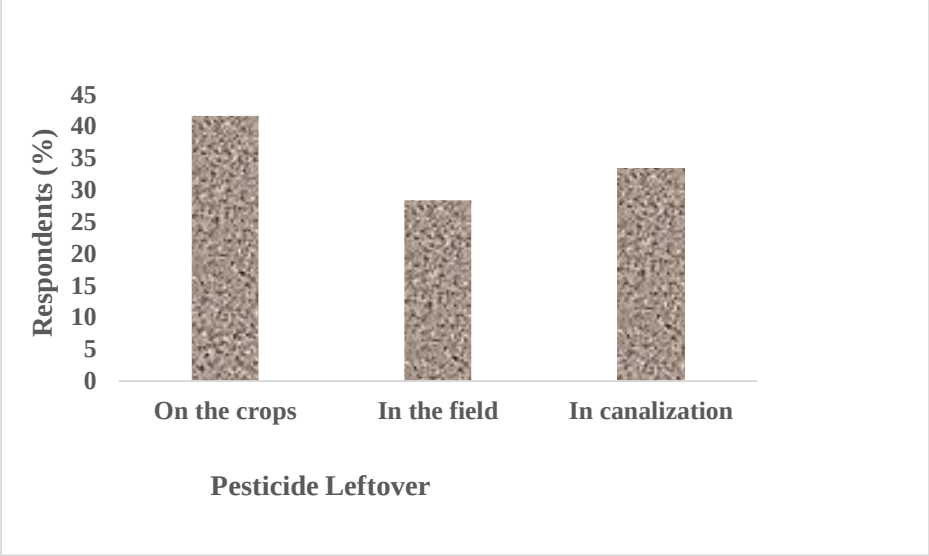

Figure 4. Pesticide leftover disposal practice in the study area

Unsafe pesticide containers disposal was also another pesticide management problem in the district. The finding showed that 42% of the households disposed the containers through burning, while more than 49% of the farmers threw the containers either on the open field or in the garbage. This indicates that, in addition to contaminating the soil and water bodies, the containers have a chance to harm the health of young children and livestock.

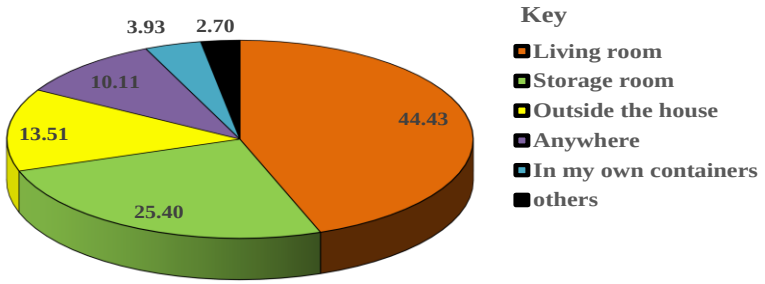

Figure 5. Pesticide Storage Practices

Likewise, Ligani (2016) reported that about 65% of the respondents hang empty pesticide containers near the farm, while Ocho et al. (2016) described that 32% of the households re-use pesticide containers for other purposes. In all cases, the expired pesticides, after spray leftovers and containers have not been properly disposed of and have inevitable environmental pollution, and human and livestock health effects. The disposal of empty pesticide containers on farmland itself and mixing the pesticides in sensitive areas were also observed. Farmer's pesticide use practices in the study area that cause human and environmental risks are presented under table 4. The practice could expose farmers and the ecosystems in general to the hazardous effects of pesticide residues (Negatu et al., 2016; Agmas and Adugna, 2020). A recent report from the study area showed the presence of ten different pesticide residues in soils taken from vegetable growing farm lands, out of which six were banned by different organizations (Feleke and Belete, 2025). However, farmers were found to underestimate the effects of highly toxic pesticides that enter into soil, water bodies during mixing and spraying, and the residues on supplied vegetables, which are the primary risk factors for consumers.

Table 4. Factors that expose environment and humans to effects of pesticide residues

No.	Variables	Frequency	Percentage (%)
1	Entry of pesticide residues into water bodies at time of washing the pesticide spraying equipment near water bodies.	53	44.17
2	Entry of pesticide residues into home at time of washing the pesticide spraying equipment near to home and bath room in the house.	30	25.00
3	Entry of pesticide residues into surrounding farm lands at time of washing the pesticide spraying equipment at yard.	62	51.67
4	Spraying with wind direction	46	38.33
5	Spraying pesticide on harvested vegetables and supplying them to consumer	116	96.67
6	Using hazardous pesticide to control pests	107	89.17
7	Knowledge gaps on side effect of pesticide among frames	104	86.42
8	Used pesticide container throwing in to open field and trash	59	49.17
9	Used pesticide container burning	51	42.50

Mixing Mancozeb with Dimethoate for cabbage and Mancozeb with Karate for tomato were the common practices in the study area (table 5). Farmers mix pesticides to save their time, and believed that mixed pesticides have a higher efficacy in pest's control. However, farmers have no information on the compatibility of differently formulated pesticides such as emulsifiers and wetting agents. Furthermore, farmers reported that they never practice the use of special tools to mix and apply pesticides on their farms. Hand-mixing increases the risk of pesticide exposure through dermal absorption or ingestion as farmers can easily carry traces of pesticides from their hands to their mouth. The present finding was in agreement with the report by Mengistie et al. (2017). A report by Ngowi et al. (2007) showed that interactions between the different pesticides or with water minerals can reduce its efficiency or make it become more toxic. Place of mixing on the other hand seemed to play a role for environmental pollution. Most farmers mix pesticides near water bodies, or in the yard, which can easily contaminate the ecosystem.

Table 5. Pesticide mixtures by small-holder farmers in the study area

No.	Pesticides	Types	Crop
1	Mancozeb + Dimethoate	Fungicides + insecticide	On Cabbage
2	Mancozeb + Abamectin	Fungicides + insecticide	On Tomato
3	Mancozeb + Karate	Fungicides + insecticide	On Cabbage
4	Boss + Abamectin	Insecticide + Insecticide	On Tomato
5	Dimethoate + Helerate	Insecticide + Insecticide	On Cabbage
6	Redomil + Tutan	Fungicide + Insecticide	On Tomato
7	Sulfur + Best	Organic + Insecticide	On Tomato
8	Redomil + Karate	Fungicides + insecticide	On Tomato
9	Boss + Karate	Insecticide + Insecticide	On Tomato
10	Kocide + Dimethoate	Fungicides + insecticide	On Cabbage
11	Mancoze + Copper	Fungicide + Fungicide	On Cabbage
12	Karate + Kocide	Insecticide + Fungicide	On Tomato
13	Coppeerchloroxide + Tutan	Inorganic compound + Insecticide	On Cabbage
14	Mancozeb + Helerate	Fungicide + Insecticide	On Tomato
15	Copper chloroxide + Helerate	Inorganic compound + Insecticide	On Cabbage

CONCLUSIONS

The pesticide use practice and its effect on farmer's health in Shebedino district of Sidama region has been assessed. The result showed that various types of pesticides are used indiscriminately by vegetable produces in the district. More than 17 different pesticides have been used in the study area, among which mancozeb was the predominant one. Improper mixing, storage and disposal mechanism of empty containers were among the major problems that expose farmers for various health hazards. Headache, skin rash, dizziness, and blurred vision were some of the symptoms of health problems associated with pesticide use in study area. Farmer's lack of awareness about proper use of pesticide and inability to read and understand the pesticides labels were observed. Absence of legal control over pesticide and knowledge gap of the farmers were also the other reasons for inappropriate management of pesticides in the study area. Pesticide applications should be restricted to trained personals, and concerned authorities need to intervene to insure proper pesticide management. The present finding is believed to serve as first-hand information for further studies on contamination of vegetables and groundwater by pesticide residues in Sidama region and beyond.

REFERENCES

Abaineh, A., D. Ejigu, M. Atlabachew, E. Dejen, and G. Tilahun. 2024. Pesticides in use, their application and risks on human health and ecosystems: A case of Fogera District, Ethiopia. Sustainable Environment, 10(1): 2298063. [Scholar Google]

Agmas, B., & M. Adugna. 2020. Attitudes and practices of farmers with regard to pesticide use in NorthWest Ethiopia. Cogent Environmental Science, 6(1): 1791462. [Scholar Google]

Alshalati, L. M. J. 2021. Limited knowledge and unsafe practices in usage of pesticides and the associated toxicity symptoms among farmers in Tullo and Finchawa rural kebeles, Hawassa City, Sidama Regional State, Southern Ethiopia. In Emerging contaminants. IntechOpen.

Brhane G, Y. Mammo, and G. Negusse. 2017. Sources of information and information seeking behavior of smallholder farmers of Tanqa Abergelle Wereda, central zone of Tigray, Ethiopia. Journal of Agricultural Extension and Rural Development, 9(4): 47-52. [Scholar Google]

Bureau of Finance and Economic Development (BoFED) of Ethiopia. 2015. Report

Chala, M. 2022. Review of pesticide use in vegetable farms and its consequences in Ethiopia's Central Rift Valley. Agricultural Research Pesticides and Biofertilizers, 3(3): 1–8. [Scholar Google]

FDRE. 2018. Industrial chemical registration and administration proclamation: Proclamation no. 1075/2018. Federal negarit gazeta, Addis Ababa.

Feleke, H. T., and Belete, T. Y. 2025. LC-MS/MS Triple Quadrupole Multiresidue Analysis of Pesticides from Soils of Vegetable Farms: A Report from Ethiopia. Applied and Environmental Soil Science, 2025(1), 4830881.

https://doi.org/10.1155/aess/4830881. [Scholar Google]

Gesesew, H. A., K. Woldemichael, D. Massa, and L. Mwanri. 2016. Farmers' Knowledge, Attitudes, Practices and Health Problems Associated with Pesticide Use in Rural Irrigation Villages, Southwest Ethiopia. PLoS One, 11(9): e0162527. [Scholar Google]

Jansen, K., and M. Dubois. 2014. Global pesticide governance by disclosure: Prior informed consent and the Rotterdam convention. In A. Gupta & M. Mason (Eds.), Transparency in environmental governance: Critical perspectives (pp. 107–131). Cambridge, MA: MIT Press.

Kim, K., J. Bae, M.W. Nho, and C. H. Lee. 2011. How do experts and novices differ? Relation versus attribute and thinking versus feeling in language use. Psychol Aesthetics, Creat. Arts, 5(4): 379-388. [Scholar Google]

Ligani S. 2016. Assessments of Pesticide Use and Practice in Bule Hora Districts of Ethiopia. Haya: The Saudi Journal of Life Sciences Scholars, 1(3): 103–108. [Scholar Google]

Loha, K. M., M. Lamoree, and J.de Boer. 2020. Pesticide residue levels in vegetables and surface waters at the Central Rift Valley (CRV) of Ethiopia. Environmental Monitoring and Assessment, 192: 1-14. [Scholar Google]

Loha, K. M., M. Lamoree, J. M. Weiss, and J. de Boer. 2018. Import, disposal, and health impacts of pesticides in the East Africa Rift zone. Crop protection, 112: 322-331. [Scholar Google]

Loha, K. M., G. Klous, M. Lamoree and J.de Boer. 2024. Pesticide use and practice of local farmers in the Central Rift Valley (CRV) of Ethiopia: implications for the environment and health hazards. International Journal of Pest Management, 70(4): 1399-1412. [Scholar Google]

Maurya, P. K., D. S. Malik, and A. Sharma. 2019. Chapter 9: Impacts of pesticide application on aquatic environments and fish diversity. In Contaminants in agriculture and environment: Health risks and remediation. Haridwar, India: Agro Environ Media | Agriculture and Environmental Science Academy.

May, D., S. Arancibia, K. Behrendt, and J. Adams. 2019. Preventing young farmers from leaving the farm: Investigating the effectiveness of the young farmer payment using a behavioural approach. Land use policy, 82: 317-327. [Scholar Google]

Mengistie, B. T., A. P. Mol., and P. Oosterveer. 2017. Pesticide use practices among smallholder vegetable farmers in Ethiopian Central Rift Valley. Environment, Development and Sustainability, 19: 301-324. [Scholar Google]

Mergia, M. T., E. D. Weldemariam, O. M. Eklo, and G. T. Yimer. 2021. Small-scale farmer pesticide knowledge and practice and impacts on the environment and human health in Ethiopia. Journal of Health and Pollution, 11(30): 210607. [Scholar Google]

MoA. 2021. List of registered pesticides. Plant Health Regulatory Directorate of Ethiopia. Unpublished official report.

Mojo, D., & L. Zemedu. 2022. Pesticide use practices and effects on crop yield, human health and the environment in selected areas of Ethiopia. Ethiopian Journal of Agricultural Sciences, 32(2): 17-36. [Scholar Google]

Mrema, E. J., A. V. Ngowi, S. S. Kishinhi, and S. H. Mamuya. 2017. Pesticide exposure and health problems among female horticulture workers in Tanzania. Environmental health insights, 11. Doi:10.1177/1178630217715237. [Scholar Google]

Mutengwe, M.T., L. Chidamba, and L. Korsten. 2016. Monitoring pesticide residues in fruits and vegetables at two of the biggest fresh produce markets in Africa. Journal of Food Protection, 79(11): 1938–1945. [Scholar Google]

Negatu, B., H. Kromhout, Y. Mekonnen, and R. Vermeulen. 2016. Use of chemical pesticides in Ethiopia: a cross-sectional comparative study on knowledge, attitude and practice of farmers and farm workers in three farming systems. Annals of Occupational Hygiene, 60(5): 551-566. [Scholar Google]

Ngowi, A. V. F., T. J. Mbise, A. S. Ijani, L. London, and O. C. Ajayi. 2007. Smallholder vegetable farmers in Northern Tanzania: Pesticides use practices, perceptions, cost and health effects. Crop protection, 26(11): 1617-1624. [Scholar Google]

Ocho, F. L., F. M. Abdissa, G. B Yadessa, and A. E. Bekele. 2016. Smallholder farmers' knowledge, perception and practice in pesticide use in South Western Ethiopia. Journal of Agriculture and Environment for International Development (JAEID), 110(2): 307-323. [Scholar Google]

Pretty, J., and B. Z. Pervez. 2015. Integrated pest management for sustainable intensification of agriculture in Asia and Africa. Insects, 6(1): 152-182. [Scholar Google]

Rahman, M. M., M. Awal, and A. M. Misbahuddin. 2020. Pesticide application and contamination of

soil and drinking water. Drinking Water Contaminants in Bangladesh, 1: 90-131. [Scholar Google]

Srivastav, A. L. 2020. Chemical fertilizers and pesticides: role in groundwater contamination. In Agrochemicals detection, treatment and remediation. P.143-159. Butterworth-Heinemann.

Tadesse, F.T., S. Abera, and W.K. Solomon. 2016. Rehydration Capacity and Kinetics of Solar-Dried Carrot (Daucus carota) Slices as Affected by Blanching and Osmotic Pretreatments. Int. J. Food Eng., 12(2): 203–210. [Scholar Google]

Tudi, M., R. H Daniel, L. Wang, J. Lyu, R. Sadler, D. Connell, C. Chu, and D. T. Phung. 2021. Agriculture development, pesticide application and its impact on the environment. International Journal of Environmental Research and Public Health, 18(3): 1112. https://doi.org/10.3390/ijerph18031112. [Scholar Google]

Van, N. S., N. T. Thi, L. P. D. Thi, L. H. Khanh,, and L. K. Hoan. 2020. Effects of pesticides on farmers' health in Tu Ky district, Hai Duong province, Vietnam vu Ngoc Huyena. Sustainable Futures, 2: 100026. [Scholar Google]

World Health Organization (WHO). 2010. Inter-Organization Programme for the Sound Management of Chemicals, & World Health Organization. WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification.

Zyoud, S. H., A. F. Sawalha, W. M. Sweileh, R. Awang, S.I. Al-Khalil, S. W. Al-Jabi. 2010. Knowledge and practices of pesticide use among farm workers in the West Bank, Palestine: Safety implications. Environ Health Prev. Med., 15(4): 252-261. [Scholar Google]