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Farmers' Knowledge, Practices, and Safety Measures in Pesticide Use in Western Shoa, Ethiopia: Implications for Human and Environmental Health

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ABSTRACT

Objective: The present study aimed to assess farmers' knowledge, perception, and practices regarding pesticide use, handling, and disposal in two major agricultural districts of Western Shoa, Ethiopia

Results: The results showed some farmers in the Gindeberet region can read (46.66%) and cannot read (53.33%), while some farmers in Abuna Gindeberet can read 30% and cannot read 70%. Farmers in Abuna Gindeberet used pesticides to treat animals (2.33%), protect crops (95.21%), treat seed used (0.45%), treat skin diseases (0.87%), and spray pests in the home (1.14%). Nonetheless, crops are protected by 94.16% of Gindeberet's insecticides. To keep pests out of the house, the farmer used insecticides (2.12%). Herbicides were the most commonly reported agricultural practices in both areas, followed by insecticides and fungicides for common crops. Most farmers leave empty containers in the field for free access, such as hanging on home roofs, using them for other purposes, throwing them in the lake, or storing them inside. Farmers lack understanding about pesticide handling, safety measurement, storage, empty pesticide container disposal, and associated public health, according to survey results. This study came to the conclusion that in order to encourage proper knowledge, abilities, and practices about the safe use of pesticides and the importance of safety precautions, both official and informal training programs are required.

Keywords: Assessment; Farmers Knowledge; Perception; Pesticides; Disposal; Toxicity

Introduction

Human health issues such as carcinogenicity, endocrine disruption, aberrant reproduction, and genetic alteration can result from such exposures [1-6]. Approximately one million people are impacted by pesticide poisoning [7], and hundreds of thousands of people globally pass away from it every year [8]. The health of people, animals, and other beneficial species may suffer as a result of increased exposure brought on by pesticide overuse and unsafe handling techniques [9-12]. Contaminated food, soil, water, and air can all include pesticide residues [13-15]. Ingestion, inhalation, and skin contact are some of the ways that pesticide applicators may come into contact with those chemicals [9,6,17,18]. Pesticide misuse and unsafe handling techniques may result in increased exposure, causing harm to the health of humans, animals, and other beneficial creatures [9-12]. Pesticide residues may remain in contaminated food, soil, water, and air [13-15]. Pesticide applicators can be exposed to pesticides through a variety of ways, including ingestion, inhalation, and skin contact [9,16-18]. Such exposures can lead to carcinogenicity, endocrine disruption, aberrant reproduction, and genetic changes [1-6]. The health risk of pesticide residue is significantly higher in developing countries and small-scale farmers than in large-scale farmers in developed countries, despite the fact that pesticide consumption is lower in developing countries than in developed ones [4]. This is caused by farmers' poor understanding of pesticide behavior, their failure to wear Personal Protective Equipment (PPE), improper handling and storage, and the application of pesticides at higher-than-label rates in developing nations [7,8,10].

Aside from rare reports in Ethiopia's central regions, there is no documented evidence on farmers' level of knowledge and behavior about pesticide use. Previous studies have not adequately addressed pesticide usage, spraying methods, crop types, pre harvest re-entry intervals, and storage and disposal mechanisms. Moreover, it is unclear if farmers in Ethiopia, particularly in the West Shoa of Oromia, follow the required pesticide application and handling protocols. The current study aimed to investigate farmers' knowledge and practices regarding agricultural pesticides. The findings can serve as a baseline for future interventions in pesticide handling and management. In Ethiopia, despite warnings about the possibility of more miserable deaths, there is no appropriate recording and documentation of miserable deaths for community health resolutions in concerned administrative bodies [19]. Pesticide use has a negative impact on agricultural land, wildlife, vegetation, and overall agricultural and environmental sustainability [20]. Chemical pesticide consumption in Ethiopia has increased thrice, from 1,440 tons in 2001 to 4,586 tons in 2013 as modern agricultural farms have expanded [21]. During this time, an average of 251 kg of pesticides per hectare were applied annually [22]. According to Negatu, et al. [21], farm laborers in Ethiopia have limited awareness of pesticide application, including inadequate use of personal protective equipment, incompatible pesticide mixing, crop overspray, and disposal in surrounding fields. Studies conducted near Lake Tana [23] and Lake Ziway [14] revealed that 80.16% and 95% of farmers, respectively, used poor pesticide management techniques. Despite this evidence, Ethiopia lacks a strict system for managing the importation of hazardous chemicals; there are no established organizations to educate farmers about pesticide application and local protection issues; and the growth of unlicensed retailers highlights the need for effective regulations to lessen the negative effects of pesticides on agriculturalists' health and environmental sustainability [24]. Therefore, the purpose of the study was to examine farmers' perceptions and knowledge regarding the handling of pesticides and their practices. To reduce illness and death from pesticide exposure, it is essential to have a reasonable understanding of the health risks associated with pesticides, a positive attitude toward their usage, and the proper handling, storage, and use of personal protective equipment.

Materials and Methods

Description of the Study Areas

The study locations were two districts in the Western Shoa region of Ethiopia (Abuna Gindeberet and Gindeberet), which are significant crop-growing areas. Farmers were selected based on their prospective area, and each district comprised three kebeles. The potential area of the crops in each kebele was taken into consideration when selecting the places. Abuna Gindeberet district is located at about 170 km from the West of Addis Ababa and 128 km from the zonal town (Ambo). It was characterized as lowland (68%) and midland (32%) which was about 28 low land and 13 midland kebeles. The altitude of the district varies between 1,000 and 2604 m.a.s.l. receives an annual rainfall of 800-1400mm, and has an annual temperature range of 10-300c. The district has a total of 44 kebeles of which 41 are rural administrative kebeles and 3 are city administration. The district was characterized by a subsistence mixed farming system in which the production of both crops and livestock was a common economic activity. The total land of the district was estimated to be 138,484 ha, out of which 53,751 ha was cultivated land, 13,927.4 was grazing land, 25,907 was forest and shrubs and 44,894 ha was covered within others. The district is known for its high production potential of crops and livestock. Gindeberet district is Far away from Addis Ababa 193 kilo meters. It is located latitude between 90 N and longitude of 370 E, Altitude1000-2500 above sea level an average annual Rainfall, 845mm, Average temperatures 10.30c -210c, Agro-ecologies highland (40%) and lowland (60%), Population 133,428 (M= 67,307 and F=66,121).The Selected Kebele from Gindeberet District

1. Goro menerga
2. Damota and
3. Kiltu senbeta from each kebele were selected thirty farmers in total ninety farmers were selected.

Methods for Sampling

The data came from farmers who had been engaged in agricultural production for at least two years. A single random selection method was used to pick exactly 180 farmers from two districts of farmers involved in agricultural production activities in the research locations. The goal was to achieve a 50% population percentage and a 5% margin of error [25]. Accordingly, 90 farmers from the districts of Abuna Gindeberet and Gindeberet were included in the study. The primary actors on the farms were the chiefs of the households. The majority of the responders were small-scale farmers.

Data Gathering Techniques

Data was gathered using a home survey method to evaluate farmers' security measures and awareness of pesticide use. To collect data from farmers in the study areas, a semi-structured questionnaire was created. 18 local farmers, 10 leaders of farmers' groups, and two crop protection specialists participated in a pretested interview after the questionnaire was first altered from earlier research done in Ethiopia [22,26]. The five sub-sections of the questionnaire were prepared in English and translated into Afan Oromo. After that, the chosen sample respondents were interviewed in person. The demographic details of the respondents, including age, sex, marital status, and educational attainment, were the main focus of the first section of the questionnaire. The questionnaire's second section asked about the size of the farmer's family, the amount of land they owned, and the number of years they had been involved in agriculture. The final segment con-

centrated on farmers' experiences using pesticides, including how to cure skin infections, treat seed dressing, to prevent livestock pests, and apply pesticide spray in the field and in the house. The fourth portion focused on the types and sources of pesticides that farmers use on their fields. For example, the question was open-ended and asked respondents to name the most essential pesticides, such as insecticides, herbicides, or fungicides, if any, and what kinds of pesticides (fungicides, insecticides, or herbicides) they frequently use to control common pests. The fifth segment was created to evaluate farmers' understanding and practices regarding the use of pesticides, the handling of empty containers, and the timing of application in relation to meteorological conditions.

Analysis of Data

The gathered information was imported into SPSS version 21.0 (IBM, Armonk, New York) after being entered into Microsoft Office Excel 2016 (Microsoft Corporation, Redmond, WA, USA). After that, descriptive statistics were used to examine the data. For categorical data, descriptive statistics like frequencies and percentages were calculated.

Results

Demographic and Socio-Economic Characteristics of Respondents

A total of 180 farmers participated in the survey, with 90 respondents from each district (Abuna Gindeberet and Gindeberet). The majority of respondents in both districts were male, representing 95.55% in Abuna Gindeberet and 97.77% in Gindeberet, indicating that pesticide application and most farm management activities are largely performed by men. The age distribution showed that the largest proportion of farmers fell within the 41–50 year age group, accounting for 41.11% in Abuna Gindeberet and 33.33% in Gindeberet. This suggests that pesticide application is mainly carried out by farmers within the economically active age category (Table 1). Educational levels among farmers were generally low. In Abuna Gindeberet district, 67.77% of respondents had no formal education, while only 11.11% had completed secondary education. Similarly, in Gindeberet district, 61.11% of farmers had no formal education, and only 1.11% had attended college. Illiteracy levels were also considerable, with 70% of farmers in Abuna Gindeberet and 53.33% in Gindeberet unable to read, which may affect their ability to interpret pesticide labels and safety instructions (Table 1).

Table 1: Socio-economic characteristics of farmers in Abuna Gindeberet and Gendeberet districts, Oromia, Ethiopia (2022).

Variable	Category	Abuna Gindeberet (n=90)	Gendeberet (n=90)	F-value	SD
Age (years)	18–30	12 (13.33%)	10 (11.11%)	0.12	0.03
	31–40	19 (21.11%)	20 (22.22%)	0.15	0.04
	41–50	37 (41.11%)	30 (33.33%)	1.02	0.05
	51–60	22 (24.44%)	30 (33.33%)	0.87	0.06
	>61	10 (11.11%)	10 (11.11%)	0	0
Sex	Male	86 (95.55%)	88 (97.77%)	0.28	0.02
	Female	4 (4.44%)	2 (2.22%)	0.28	0.02
Can read	Yes	27 (30%)	42 (46.66%)	5.12	0.08
	No	63 (70%)	48 (53.33%)	5.12	0.08
Can write	Yes	28 (31.11%)	35 (38.88%)	1.43	0.06
	No	62 (68.88%)	55 (61.11%)	1.43	0.06
Education status	No education	61 (67.77%)	55 (61.11%)	1.03	0.05
	Elementary	19 (21.11%)	26 (28.88%)	1.38	0.07
	High school	10 (11.11%)	13 (8.90%)	0.36	0.03
	College	0	1 (1.11%)	0.99	0.01

Farm Size, Family Size, and Agricultural Engagement

Table 2 displays land size, family size, and agricultural engagement. Nearly 41.11% of farmers in Abuna Gendeberet had more than 21 years of farming experience, followed by 25.55% with 16–20 years and 22.22% with 11–15 years and more, respectively. Less than eleven years of farming experience was possessed by the remaining farmers. The farmers owned an average of 2.5 hectares of land in Table 2. Thirty-four percent of farmers owned land (2.1-3 ha), thirty-two percent of framers owned land (0.1-2 ha), sixteen percent of framers had land (3.1-4 ha), and eleven percent of framers owned land (4.1-6 ha). Family size According to Table 2, 21.11% of farmers had family members aged 1-2, 40% had family members aged 3-4, 27.77% had family members aged 5-6, and 11% had family members aged >6. The majority of respondents in Gendeberet (45.55%) had been farming

and used pesticides for more than 20 years, followed by those with 16–20 years (32.22%) and 11–15 years (15.55%) of farming experience. Less than eleven years of farming experience was possessed by the remaining farmers. Typically, the respondents were farmers with an average farm size of 2.5 hectares, with farm sizes ranging from less than one hectare to more than six hectares. Of the framers, some farmers (36.66%) owned land (2.1-3), 23.33% owned land (0.1-2 ha), 17.77% owned land (3.1-4 ha), and 11.11 percent owned land (4.1-6 ha). The percentage of farmers who had family members was as follows: 16.66% had family members (1-2), 36.66% had family members (3-4), 26.66% had family members (5-6), and 20% had family members (>6) (Table 2).

Table 2: Land size, family size, and agricultural engagement of respondents.

Variable	Category	Abuna Gindeberet (n=90)	Gendeberet (n=90)	F-value	SD
Years in agriculture	1–5	4 (4.44%)	3 (3.33%)	0.11	0.02
	6–10	6 (6.66%)	3 (3.33%)	0.43	0.03
	11–15	20 (22.22%)	14 (15.55%)	0.87	0.04
	16–20	23 (25.55%)	29 (32.22%)	1.02	0.05
	21+	37 (41.11%)	41 (45.55%)	1.12	0.05
Family size	1–2	19 (21.11%)	15 (16.66%)	0.52	0.03
	3–4	36 (40%)	33 (36.66%)	0.34	0.02
	5–6	25 (27.77%)	24 (26.66%)	0.11	0.01
	>6	10 (11.11%)	18 (20%)	2.11	0.05
Land size (ha)	0.1–2	29 (32.22%)	21 (23.33%)	0.91	0.04
	2.1–3	31 (34.44%)	33 (36.66%)	0.12	0.03
	3.1–4	15 (16.66%)	16 (17.77%)	0.05	0.01
	4.1–6	10 (11.11%)	10 (11.11%)	0	0
	6.1–8	5 (5.55%)	10 (11.11%)	1.23	0.05

Farm Size, Family Size, and Agricultural Engagement

Farmers in both districts had substantial agricultural experience. In Abuna Gindeberet district, 41.11% of respondents had more than 21 years of farming experience, followed by 25.55% with 16–20 years of experience. Similarly, in Gindeberet district, 45.55% of respondents reported more than 20 years of farming experience, indicating that most farmers have long-term exposure to pesticide use. Farm sizes were generally small to medium. The average farm size was approximately 2.5 ha, with most farmers owning between 2.1 and 3 ha of land. In Abuna Gindeberet district, 34.44% of respondents owned between 2.1 and 3 ha, while 32.22% owned less than 2 ha. A similar pattern was observed in Gindeberet district, where 36.66% of farmers owned 2.1–3 ha. Household sizes were relatively large in both districts. In Abuna Gindeberet, 40% of households consisted of 3–4 family members, while 27.77% had 5–6 members. In Gindeberet district, 36.66% of households had 3–4 members, while 26.66% had 5–6 members (Table 2). ANOVA results indicated no significant difference in land size or family size between districts ($F < 1.5$, $P > 0.05$), but a moderate difference in years of farming experience ($F = 2.78$, $SD = 0.05$).

Farmers Knowledge and Practical Use of Pesticides

The findings show that the majority of respondents in every region are aware of the significance and adverse consequences of pesticides, as well as their practical application. Regarding awareness of the negative effects of pesticides on the environment and human health, the majority of respondents are aware of the risks associated with pesticides, but a very small percentage are not. Farmers in the Abuna Gendeberet district were aware of the need for pesticides. Pesticides were employed by the farmer to protect their crops (95.21%), treat skin illnesses (0.87%), treat seed used (0.45%), spray pests in the residence (1.14%), and treat livestock (2.33%) (Figure 1). Concerning the experience of applying pesticides, the following years are included: 1–5 years (5.55%), 6–10 years (10%), 11–15 years (31.11%), 16–20 years (16.66%), 21–25 years (20%), 26–30 years (13.33%), and >30 years (3.33%), 94.16% of pesticides in the Gendeberet district are used to protect crops.

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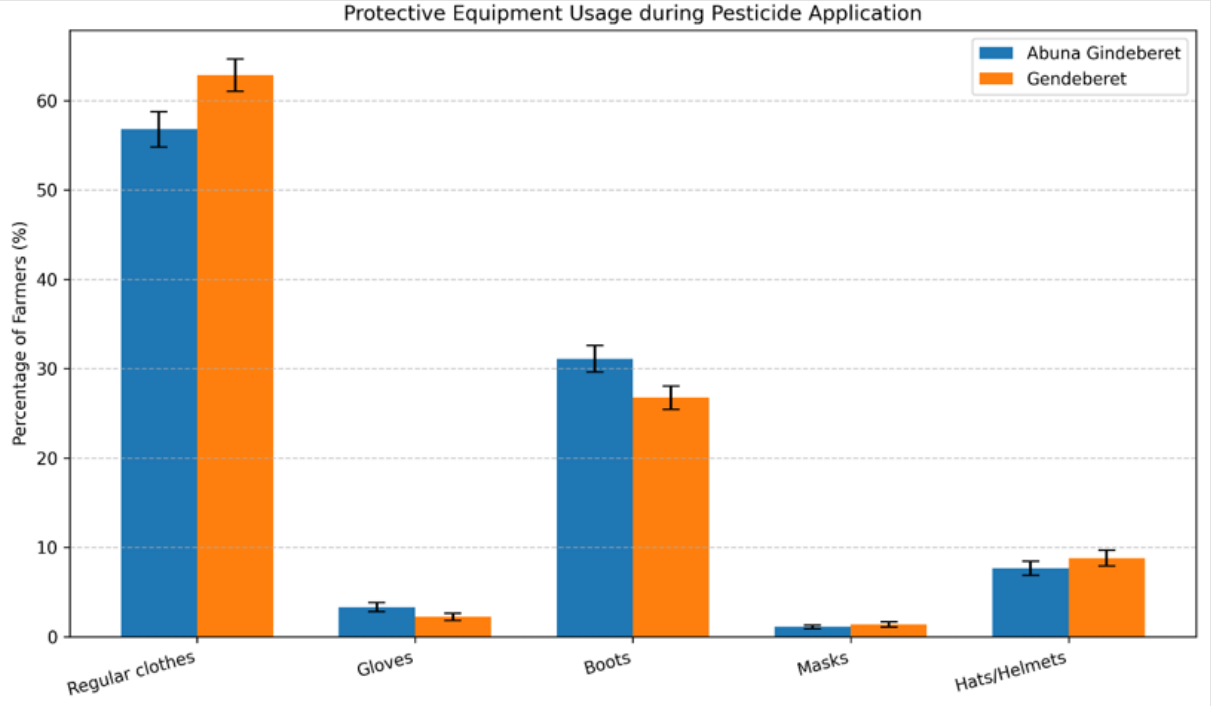

Figure 1: Farmers' pesticide application by purpose in Abuna Gindeberet and Gendeberet districts (SD bars included).

Pesticide Application Practices

The Table 3 presents the purpose of pesticide use among farmers in Abuna Gindeberet and Gindeberet districts and compares the proportions using a chi-square (χ^2) test to determine whether there is a significant difference between the two districts. Crop protection is by far the dominant reason for pesticide use in both districts. In Abuna Gindeberet, 95.2% of respondents reported using pesticides for crop protection, while 94.2% of respondents in Gindeberet reported the same purpose. The chi-square value (χ^2= 0.10) with a p-value of 0.75 indicates that there is no statistically significant difference between the two districts regarding pesticide use for crop protection. A very small proportion of farmers reported using pesticides for livestock purposes, with 2.3% in Abuna Gindeberet and 2.1% in Gindeberet. The statistical test (χ^2= 0.02, p = 0.89) again shows no significant difference between the districts. Similarly, the use of pesticides for domestic purposes was low in both districts. About 1.1% of farmers in Abuna Gindeberet and 2.1% in Gindeberet indicated domestic use. The chi-square test (χ^2= 0.34, p = 0.56) suggests that this difference is not statistically significant Table 3). Regarding skin infection treatment, very few respondents reported such use, with 0.87% in Abuna Gindeberet and 1.3% in Gindeberet. The chi-square value (χ^2= 0.10) and p-value of 0.75 indicate no significant difference between the districts. Finally, seed treatment was the least reported purpose of pesticide use, with 0.45% of farmers in Abuna Gindeberet and 0.28% in Gindeberet reporting this practice. The statistical analysis (χ^2= 0.05, p = 0.82) also shows no significant difference between the two districts. Overall, the results indicate that pesticide use in both districts is overwhelmingly focused on crop protection, while other uses such as livestock treatment, domestic applications, skin infection treatment, and seed treatment are very limited. Moreover, the chi-square test results (P > 0.05 for all categories) demonstrate that there are no statistically significant differences between Abuna Gindeberet and Gindeberet districts in terms of the purposes for which pesticides are used (Table 3). The farmer applied pesticides to the cattle (2.11%), treated skin illnesses (1.33%), prevented seed use (0.28%), and sprayed pests inside the house (2.12%). Pesticide application experience was documented for the following years: 1–5 years (2.22%), 6–10 years (11.11%), 11–15 years (30%), 16–20 years (24.44%), 21–25 years (15.55%), 26–30 years (12.22%), and >30 years (4.44%) (Table 3 & Figure 2).

Table 3: Pesticide Application Practices (Chi-square test for district differences).

Purpose	Abuna Gindeberet (%)	Gindeberet (%)	χ^2	p-value
Crop protection	95.2	94.2	0.1	0.75
Livestock	2.3	2.1	0.02	0.89
Domestic	1.1	2.1	0.34	0.56
Skin infection	0.87	1.3	0.1	0.75
Seed treatment	0.45	0.28	0.05	0.82

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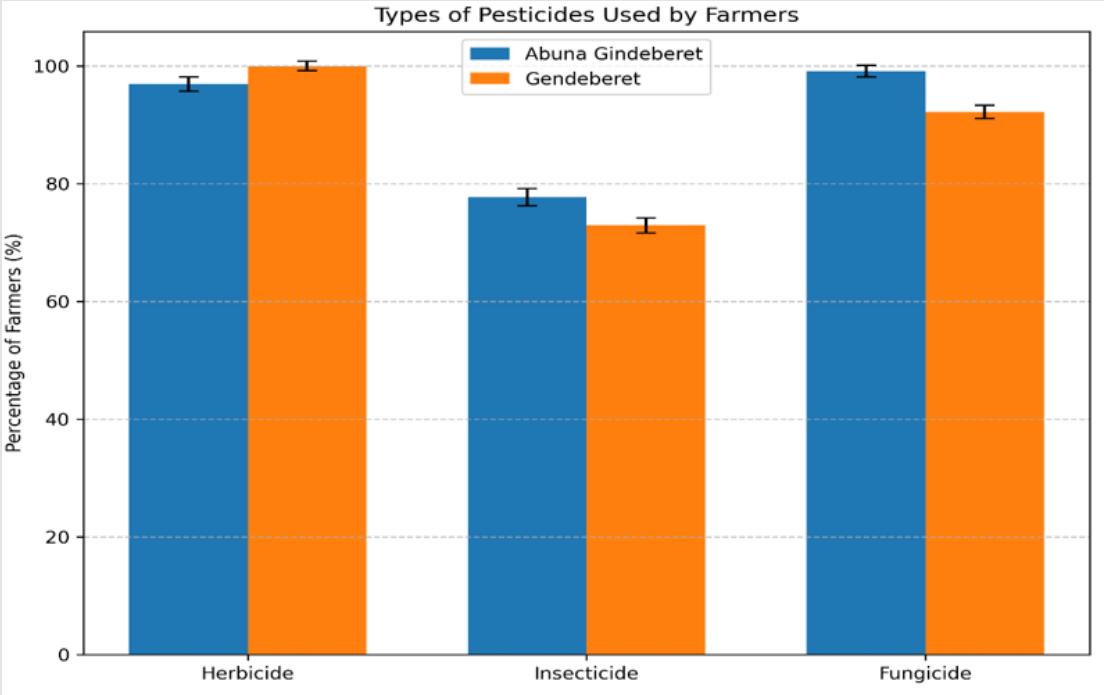

Figure 2: Types of pesticides used by farmers in Abuna Gindeberet and Gendeberet (SD bars).

Common Pesticide Used and Safety Measurement During Pesticide Handling

Herbicides were the most commonly reported pesticides by farmers in the Abuna Gendeberet district. These included Glyphosate 48%SL (26.61%), Palls 45 OD (10.13%), 2.4. D amaine (16.51%), Pick up 50% WDG (20.17%), Crop star 750 WDG (23.45%), and other (3.13%). Malathion 50% E. C. (10.40%), Karate zeo 50% (45.47%), and Diazinon 60% EC (21.8%) were the insecticides used. Fungicides used by farmers included Mancozeb 60MG. TAB (16.91%), Mancozeb 80WP (23.35%), Mancozeb 75% WP (34.42%), Tilt (20.87%), and other (4.45%). Approximately 96.66% of those surveyed said they took measures, while 3.33 percent said they did not. The farmers wore regular clothes (56.79%), gloves (3.33%), boots (31.11%), masks (1.11%), and hats (7.65%) when spraying pesticides (Figure 1). Herbicides were the most commonly reported pesticides by farmers in Gendeberet. They were 2.4.D amaine (17.77%), Palls 45 OD (5.55), Crop Star 750 WDG (25.55%), Pick up 50% WDG (23.33%), and Glyphosate 48%SL (27.67%). In terms of fungicides and insecticides, Karate Zeon 50% (33.16), Diazinon 60% EC (25.27), and malathion (14.44%) were the most often used insecticides in the studied areas. Fungicide was another tool employed by farmers to save their crops. According to Figure 2, farmers most commonly employ Mancozeb 80WP (30%), Mancozeb 60WP (28.88%), Mancozeb 75WP (26.66%), and Tilt 500 E.C (6.66%).

According to the findings in Figure 1, the majority of farmers applied pesticides while wearing regular clothing (62.85%), gloves (2.22%), boots (26.76%), masks (1.37%), and helmets (8.8%). No respondent wore overall clothing. The respondents reported nearly identical results to those of Abuna Gindeberet. The correct use of pesticides by farmers, as well as the storage and disposal of empty pesticide containers, are depicted in Figure 3. The majority of farmers in the Abuna Gendeberet district watch the weather before spraying. The overwhelming majority of farmers (96.66%) said they paid attention to the weather, while only 3.33 percent said they didn't. The weather was taken into consideration by the farmer, who noted wind direction (8.67%), rain (75.71%), and sun exposure (15.52%). Empty pesticide containers are kept in various locations by the farmers. For easy access, they are kept in empty containers, such as hanging on home roofs (30.29%), being used for other purposes (24.44%), being tossed in the lake (13.33%), being left in a field (19.72%), and being kept in homes (12.22%). Farmers in both districts used the empty pesticide containers for drinking water, salt storage, and pepper powder storage, based on actual or tangible observations in many or large households.

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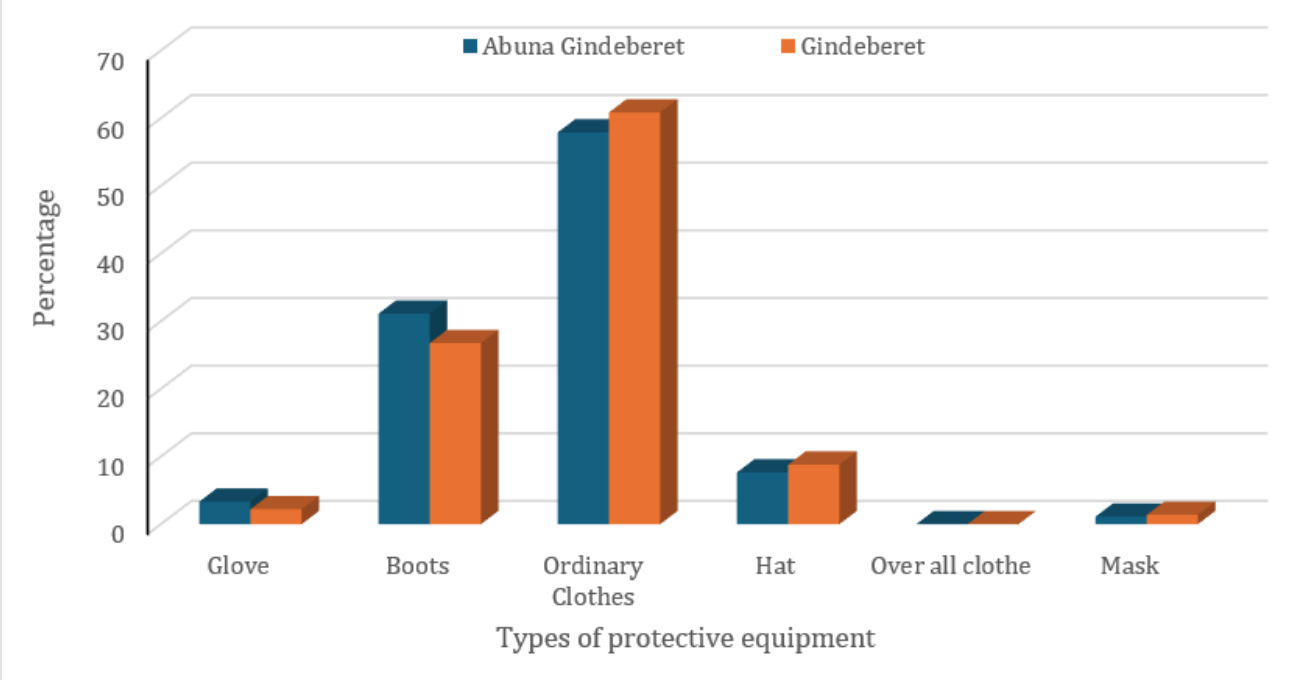

Figure 3: Types of Protective Equipment found in Farmers' hands during pesticide Applications.

The majority of farmers in the Gendeberet district (94.44%) reported observing the weather, while the minority (5.55%) did not, according to the survey, which is shown in Figure 4. According to the respondents, the farmer considers weather conditions, wind direction (7.77%), rain (80.12%), and extreme sun exposure (12.13%) (Figure 2). However, the majority of farmers store empty containers they leave in the field (28.37%), followed by free access areas such as hanging on home roofs (24.33%), being thrown in the lake (15.55%), or being utilized for other reasons (26.66%) (Figure 4). Farmers also reported considering weather conditions during pesticide application. Most respondents indicated that they checked weather conditions before spraying, particularly rainfall and wind direction, to minimize pesticide drift and improve application efficiency (Figures 5 & 6).

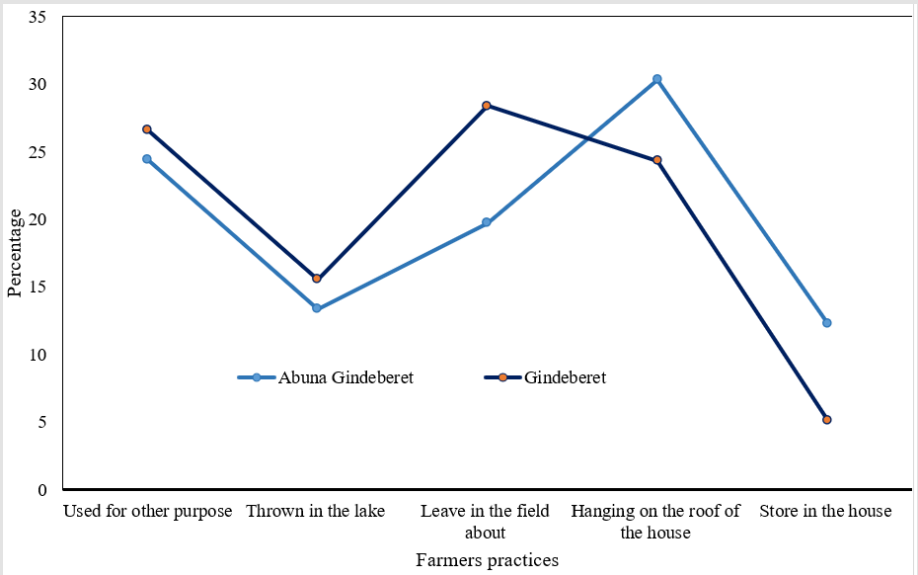

Figure 4: The farmer practices for handling empty containers.

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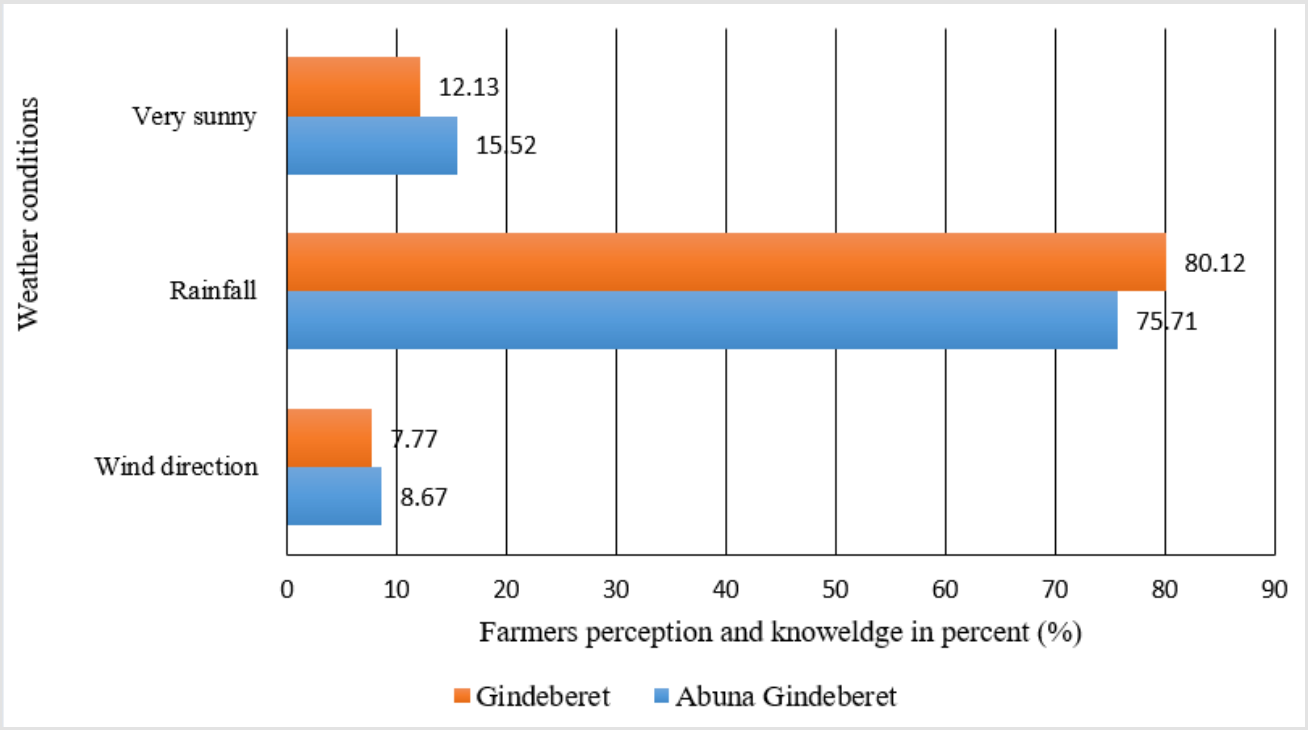

Figure 5: Farmers perception and knowledge during pesticide application regarding Weather Conditions.

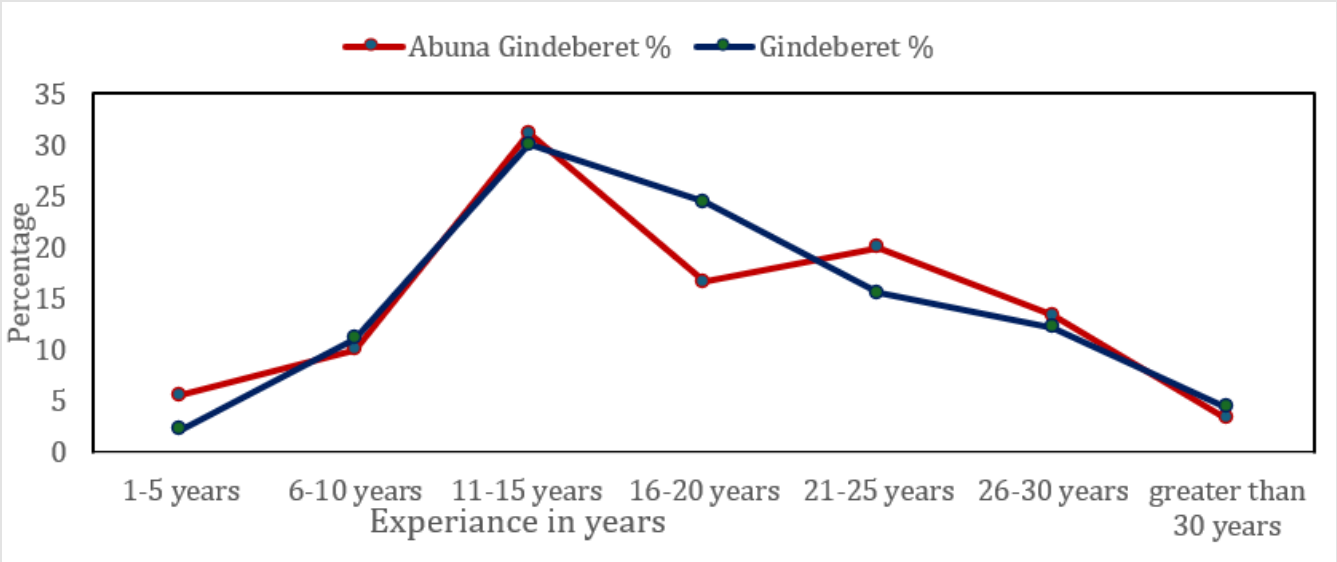

Figure 6: Pesticide application experience in year.

Discussion

Using relevant knowledge and perceptions of farmers' pesticide handling practices, the study examines pesticides. Both districts' agricultural activities were predominantly carried out by men, and all of the farmers who responded to the interviews were Abuna Gendeberet. The study included almost ninety-five (95%) respondents. Similar research was done by Waichman, et al. [27] and Nguetti, et al. [22], who found that men were responsible for 92% of farming in Togo and 97.4% of farming in Brazil. According to a study by Nguetti, et al. [22], 90% of Kenyan farmers are men. Many farmers in the current study lacked formal education and were illiterate, while many more did not receive training on how to apply pesticides properly. According to the current statistics, 98% of farming activities were carried out by men. In a similar vein, Waichman, et al. [27] and Adjrah, et al. [28] found that men were responsible for 92% of farming in Togo and 97.4% of farming in Brazil. According to a study by Nguetti, et al. [22], men made up 90% of Kenyan farmers. The difficulty of the labor may be the reason for men's arithmetic significance. More than half of the respondents purchased and used pesticides without reading the label, indicating that they were unable to read and identify the expiration date and any toxicity symbols. This outcome is consistent with research by Damalas [29] and Mengistie et al. [24], which found that 73% and 67% of farmers, respectively, never read the container's instructions. Lack of regular training and insufficient understanding of the correct use of pesticides may be the cause of this [10,22,30,31]. Although pesticides are economically significant in reducing output loss from insects, illnesses, weeds, and other pests, improper use of these chemicals can have detrimental effects on the health of people, animals, and the environment [4]. The purpose of this study was to evaluate farmers' attitudes, habits, and knowledge about the usage of pesticides and safety concerns.

In the current investigation, the vast majority of farmers lacked literacy. Experience and educational background might affect pesticide handling safety, including PPE use. According to this study, farmers who had been using pesticides for at least 21 years were ignorant about how to utilize personal protective equipment. Poor PPE use is common among farmers in poorer nations [4], and they are also more vulnerable to pesticide-related risks [22]. The percentage of farmers with an elementary school education ranged from 21-29%, whereas over half of the three districts' respondents said they had no formal education. These studies supported Ecobichon's [32] findings, according to which farmers in developing nations lack literacy and rules are either lax or poorly implemented. Because of this, over half of the illiterate farmers in the area currently struggle to get instruction on how to handle pesticides correctly. As a result, many farmers were unable to read or comprehend pesticide labels that provided information on how to use them safely and appropriately. According to the respondents, the majority of farmers in both districts place greater stress on parents' spraying in their homes. In a similar study, Zadjali, et al. [33] found that men were the most adept at managing pesticides. According to Thapa, et al. [34], men are primarily involved because of the negative consequences of chemicals, and women are less knowledgeable about the manufacturing of pesticides, which must be done carefully. A portion is taken by the farmer. This indicates that the farmer is not taking all the required safety measures, such as cleaning their hands before eating, washing their hands after mixing, or washing their entire body after spraying. The majority of respondents adhered to safety precautions after applying pesticides, however only a small percentage were found to accept appropriate safety precautions, according to similar research published by Aryal, et al. [35].

Another crucial component of ethical pesticide use is the collection of empty pesticide waste. On the other hand, unplanned and uncontrolled pesticide releases into the environment can harm society and contaminate the ecosystem [36]. If empty pesticide containers are not thoroughly cleaned, they may frequently retain an undesired amount of pesticide solution or powder. The ecosystem and the community may suffer as a result of this inappropriate disposal. Farmers used empty pesticide containers for household purposes, such as storing food ingredients and drinking water, according to similar studies by Benjamin, et al. [37] in Rwanda, Nadja, et al. [38] in Tanzania, and Jallow, et al. [10] in Kuwait. According to Mequanint, et al. [39] and Damte [40], our findings indicate that farmers were discarding empty pesticide containers after using them on the farm, but some farmers continue to use the empty containers to store food and other household items. Additionally, a lot of farmers reportedly dump the remaining pesticide solution in the field and return water washed by sprayers to the ground or a river. This could result in the buildup of toxic pesticide residue in soil, water, and agricultural produce, endangering both human and environmental health [5,22].

In the study area, farmers kept empty pesticide containers in various locations within their homes. However, out of both districts, a greater number of empty pesticide containers were kept in homes in Gendeberet district as opposed to Abuna Gendeberet district. These containers were kept in the study area's free-access common area, where they were hung on the walls and sold on the roofs. Similarly, Bass, et al. [41] found that the most prevalent way to store pesticides was in homes rather than in a separate inventory. Additionally, Sharma [4] revealed that dangerous pesticides were being sold alongside food items without the necessary handling skills, demonstrating that there is still a persistent lack of information regarding the safe use of chemical pesticides [42]. Nonetheless, improper management, storage, and usage of these chemicals pose substantial threats to human health, environmental sustainability, and the long-term viability of agricultural systems [43]. Farmers may be at increased risk of exposure if pesticides are stored in household areas where they prepare meals and sleep [44]. Farmers may engage in unsafe practices due to a lack of training and information regarding safe handling and usage of pesticides. According to comparable reports by De Bon, et al. [45] and Mengiste et al. [24], the majority of pesticides used by farmers in the research areas were herbicide, insecticides, followed by fungicides.

Conclusion

Farmers in Abuna Gindeberet and Gendeberet districts demonstrated limited knowledge and unsafe practices in pesticide use. Literacy and formal education were low, PPE use was insufficient, and improper disposal of empty containers was common. These practices pose risks to human health and environmental sustainability. Implementation of training programs, regulatory oversight, and community awareness campaigns is urgently required to improve safe pesticide use in Ethiopia's smallholder farming systems.

Authors Contributions

- **Teferi Bekele:** Drafted the Manuscript, analyzed the data, data curation and revised the original manuscript.
- **Tadele Shiberu:** Designed the experiments, Supervision, Project administration, Methodology, data curation, and edited the manuscript.

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Data Availability

The data sets used and/or analyzed during the current study are available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate

1. Ethics Approval

Not applicable.

2. Consent for Publication

Not applicable.

3. Clinical Trial Number

Not applicable.

4. Human Ethics and Consent to Participate Declarations

Not applicable.

Competing Interests

The authors declare no competing interests

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