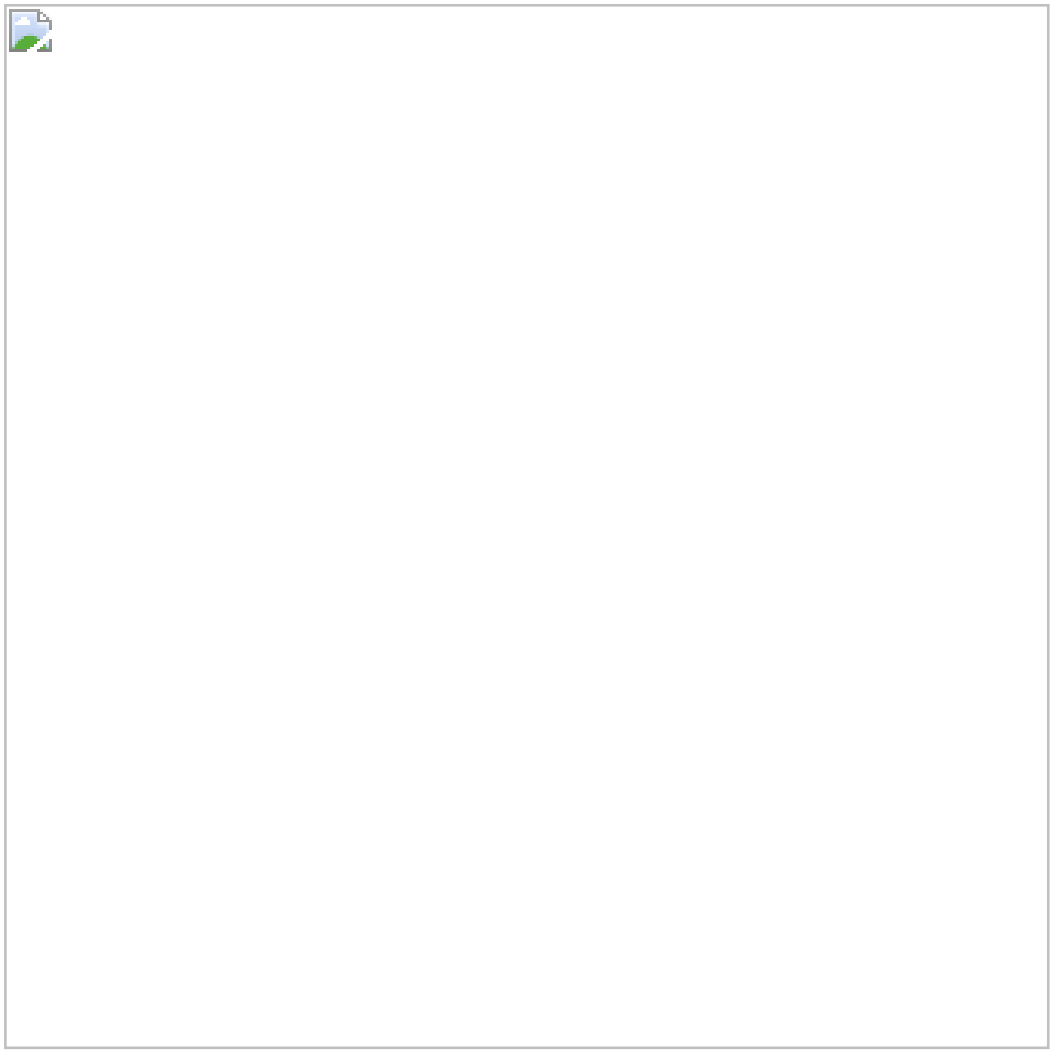

Pesticide Use Practice and Associated Factors Among Rural Community of Malga District, Sidama Regional State, South Ethiopia

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ABSTRACT: In Ethiopia, like that of the other developing countries, pesticides are widely used for a variety of purposes, but their unsafe use causes a major environmental and health hazard. The aim of this study was to assess pesticide use practice and its associated factors among the rural community of Malga district, Sidama region, southern Ethiopia. A community based cross-sectional study was conducted from February to March 2021 at Malga District. Data were collected from 549 farmers by a structured and pretested interviewer-administered questionnaire. Binary and multivariable logistic regression was used for the data analysis. Adjusted odds ratios and their 95% confidence intervals (CIs) were calculated to determine the association between safe practices of pesticide use and several related factors. Safe practice of pesticide use was observed in 193 (35.2%). The participants who had primary education [AOR = 5.605, 95% CI: 3.309, 9.495], secondary education and above [AOR = 9.847, 95% CI: 5.007, 19.368], used pesticide for 10 years and above [AOR = 6.790, 95% CI: 3.589, 12.843], used pesticide between 6 and 10 years [AOR = 1.913, 95% CI: 1.166, 3.141] pesticide bought from any shop [AOR = 2.320, 95% CI: 1.364, 3.947], agricultural office [AOR = 7.187, 95% CI: 3.654, 14.137] were associated with safe use of pesticides. The safe practice of pesticide use was low in the study area. Continuous training programs should be implemented on the safe practice of pesticide use to the local farmers.

KEYWORDS: Pesticide, use practice, Malga district, South Ethiopia

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Introduction

Pesticides are chemical compounds that are used to kill pests, including insects, rodents, fungi, and unwanted plants (weeds).[1] Pesticides are used in public health to kill vectors of disease and agriculture, to kill pests that damage crops.[2,3] Globally, approximately 2 million tons of pesticide utilized, out of which 47.5% are herbicides, 29.5% are insecticides, 17.5% are fungicides, and 5.5% are other pesticides.[4]

The negative consequences of pesticide use, results in environmental degradation, particularly water pollution, and compromise human health, ranging from nerve damage to cancers.[5] All pesticides have the potential to harm human, animals, or other living organisms and the environment if used and disposed improperly.[6] Worldwide a significant number of people die annually from the consequences of pesticide exposure.[7] Short-term complications such as acute pesticide poisoning have been reported as a major consequence in the farming community.[8]

According to the World Health Organization, 20% of pesticide use in the world is focused in developing countries, and this use is increasing.[9] African pesticide use may still be small only 2% of the total amount used globally, but the ways in which they are used are causing serious environmental and health problems. Safety equipment is rarely used, storage methods are unsafe, and the instructions for use are not always understood.[10] The problem is also persistent in other developing countries for example common working practices of high exposure risk were shown in Pakistan, the confrontation of pesticide spills in the stage of spray solution preparation (76.4%), the use of low-technology and faulty sprayers (67.9%), and spraying under inappropriate weather (46.5%) were pointed out.[11]

The pesticides are prepared in different formulations, and are usually applied as an aerosol produced from knapsacks and simple hand sprayers. The health hazards associated with pesticide handling are little understood by the sprayers. The communities living around the farm fields may also be unaware of the health hazard. However, it is known that extensive use of pesticides has adverse effects on human health.[12]

Chronic health effects may occur years after even minimal exposure to pesticides or which we ingest through our food and water. Some pesticides have been restricted or banned because they pose risks of cancer, birth defects, or neurological damage, little attention has so far been given to what may be their greatest risk: impairment of human and animal immune systems. Suppress immune responses to bacteria, viruses, parasites, and tumors, making people significantly more vulnerable to disease.[13]

In rural areas of developing countries, 3 million farmers suffer annually from serious pesticide poisoning and 25 million farmers suffer from mild poisoning, resulting in approximately 180 000 fatalities among agricultural workers annually.[14] Each year, about 3000 000 cases of pesticide poisoning and 220 000 deaths are reported in developing countries. Besides, some people are more susceptible to the toxic effects of pesticide than others, (infants, young children, agricultural farm workers, and pesticide applicators).[15]

Exposure to pesticides is one of the most important occupational risks among farmers in developing countries. Exposure to pesticides occurs primarily through dietary residues, outdoor pesticide exposures, indoor pesticide exposures, occupational exposures, and through unsafe use of pesticides on domestic animals.[16] About 4% to 7% of agricultural workers suffer ill-health from pesticides each year in Sri Lanka, Costa Rica, and Nicaragua.[17,18]

African farmers are possibly the least equipped among the developing world to protect themselves and their community against the hazards of pesticide use, in terms of literacy, education, access to information and poverty.[19] In addition exposed to toxic pesticides by eating while spraying, entering into freshly sprayed fields, inhalation, and direct contact of the skin with any form (liquid, powder, or aerosol) of pesticides.[20] On the other hand, regarding the burden of pesticides in the environment, a pesticide soil standard regulation study in China showed that, indirect pathways contributed more than the direct pathway to the overall exposure to soil pesticides.[21]

Pesticide use in farming activities requires knowledge and safe practice in order to prevent the health impacts of pesticides. Implementing safe use of pesticides can help to reduce these harmful effects, and increasing farmers' awareness of pesticides use may increase the adoption of safe use of pesticides among farmers in the study area. It has been found that farmers in North Carolina were more likely to use personal protective device when they understand about the pesticides they are using, which demonstrates that knowledge significantly influences the behavior.[32] The positive perception toward handing pesticide by-products and proper disposal of pesticides is more prevalent among aware farmers.[33]

A study done in China explained the knowledge of the farmers and their behavior in terms of safe pesticide use and revealed that the existing awareness level of farmers significantly affected their adoption of safe behaviors like wearing personal protective devices and storing pesticides carefully. This finding implies that lack of knowledge lead to unsafe utilization of pesticides.[34] Likewise, farmers in Nepal have been found to handle pesticides more safely when they understand the color-coding that represents the relative dangers presented by different pesticides.[15] Another study revealed that, perception of pesticide danger and experience of pesticides' adverse effects on public health have both been shown to be driving factors to wear personal protective device among farmers in Northern Greece.[36] Based on the research findings explained in the paragraphs above, the present study hypothesized that there is no difference between the mean of pesticide use practice and the routine safe pesticide use practice.

Pesticides of various kinds have been widely used on farms in Ethiopia. These pesticides are usually organophosphates, carbamates, organochlorides and the like. Nevertheless, no study explored the pesticide use practice and associated human and environmental consequences specifically in the study area and the country at large. Therefore, this study investigated the pesticide use practice of the farmers and its associated factors. The findings can be crucial for responsible bodies like agriculture and health sectors in the study area to plan interventional activities like community health education about the safe use of pesticides and alternative pest control options.

Method and Materials

Study area description: This study was conducted from February to march 2021 at Malga District, Sidama Zone, and Southern Ethiopia. This study area was selected from the region since the district is a cash crop area due to a coffee plantation and used pesticide intensively by the farmers. There are 26 kebeles, of 23 rural and 3 urban. Currently, 4 public health centers, 1 primary hospital and 26 health posts are available.

Study design: A community based cross-sectional study was conducted to assess pesticide use and associated factors among the rural community of Malga District, Sidama Zone, South Ethiopia.

Sample Size Determination and Sampling Techniques

The sample size was computed using single population proportion formula

$$n = \frac{\left(Z\frac{\alpha}{2}\right)2.P(1-P)}{D2}$$

n = Sample size

$Z\frac{\alpha}{2} = Z$ value corresponding to a 95% level of confidence = 1.96

D = margin of error (5%),

and considering the following assumption: 95% level of confidence, margin of error (5%), prevalence of safe utilization of pesticide 63.2%,[23] design effect of 1.5 and non-response rate of 10%. The final sample size was 572. Using a simple random sampling technique 5 kebeles were selected from 23 rural kebeles of the district and the calculated sample size was proportionally allocated to the selected kebeles. Finally the study households were selected using the systematic sampling technique with K-intervals (Figure 1).

Data collection: The data was collected by interview using structured questionnaires developed by referring different studies carried out in Chitwan, Nepal, and Ethiopia[15,23,24]

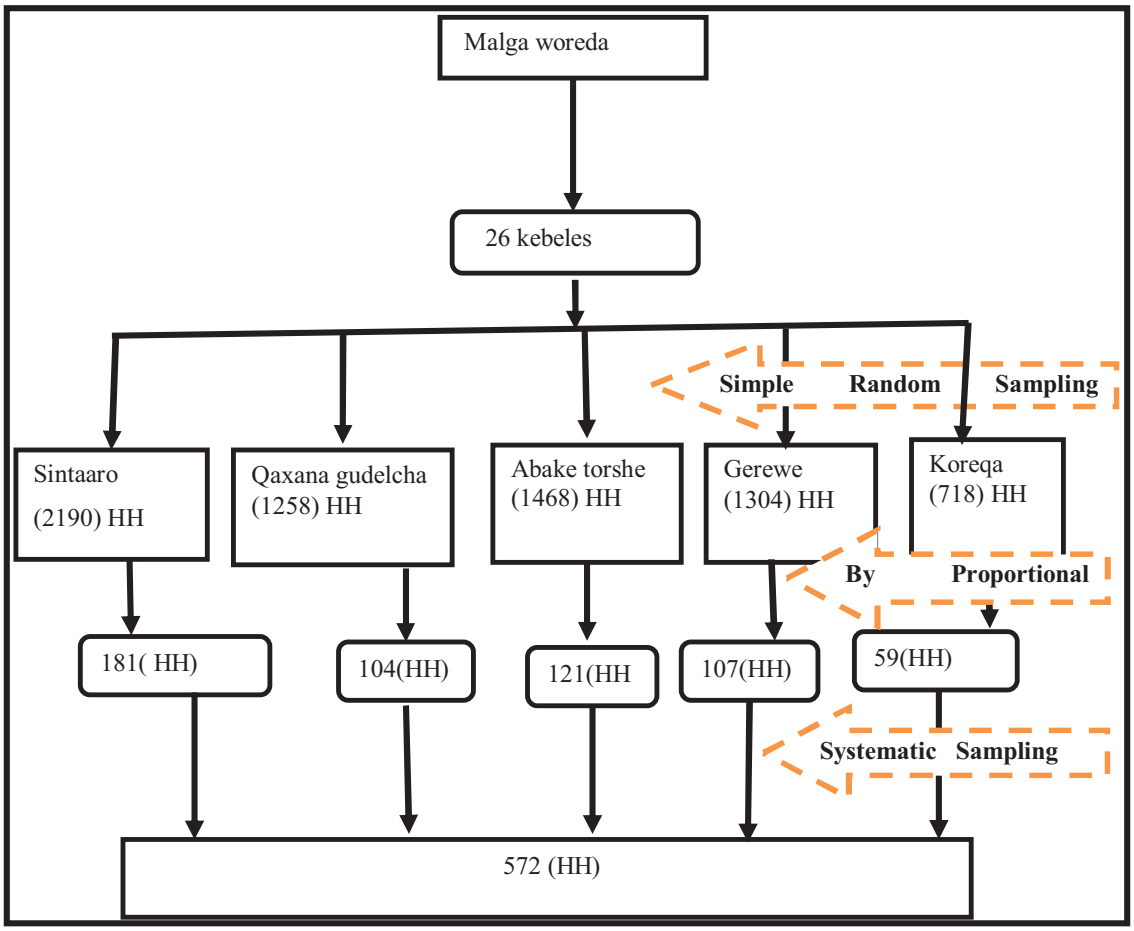

Figure 1. Diagrammatic representation of sampling procedure.

which comprised questions about socio-demographic characteristics, knowledge about pesticide, handling, storage, spray, disposal of residue practice. The quality of data was assured by proper designing of the questionnaire.

Data quality control: Data were collected using pre-tested structured questionnaires by health care providers including health extension workers. The tool was pre-tested before the actual data collection time. We use 5% of the total sample size for the pre-test from another kebeles which were not included in the real study. Then the questionnaire was assessed for its clarity, logical flow, length and completeness and the necessary amendment was made. The supervisor was made close follow up and assistance during the process of data collection. The data was reviewed and checked for completeness and clarity again by investigators and cleaning was done a daily basis and timely feedbacks were given to the data collectors.

Data analysis: Epi-Data Version 4.6 and SPSS Version 25.0 was used for data entry and analysis, respectively. Descriptive and analytical statistics were employed. Descriptive statistics such as frequency and percentages were used. Text, tables, and graphs were used to display the findings. Multicollinearity of the independent variables was checked using variance inflation factor (VIF) which was <1.08. These values indicate no multicollinearity between the independent variables. The model fitness was checked using the Hosmer-Lemeshow test that yield a *P*-value of .906, indicate good fit.

Bivariate logistic regression was used to determine the association between dependent and independent variable. The variables with *P*-value less than .25 were considered as a candidate for multivariable logistic regression analysis to test the factors associated with safe utilization of pesticide practice. A *P*-value of less than .05 was considered to determine statistical significance.

Results

Socio demographic characteristics

A total of 549 participants (aged 18-78 years, with the mean (±SD) age of 43.8 (±11.53) were interviewed which gives 96.0% response rate. The majority of the participants were 523 (95.3%) male and 519 (94.5%) were married. About 244 (44.4%) had no formal education and only 85 (15.5%) of participants had secondary and above level of education. Regarding the monthly income and land property of the households, 223 (40.6%) earn below 1000 ETB and 249 (45.4%) had below 1.5-hectarefarm land size.

Knowledge about safe pesticide use

This study finding showed that, the majority of study participants 430 (78.3%) had access to information about safe pesticide use among this the main sources of the information were, 243 (44.3%) agricultural worker (developmental agent) and 135 (24.6%) farmer union. The majority 515 (93.8%) knows pesticide affect the health of humans, 393 (71.6%) affect the environment and 376 (68.5%) knows some pesticide are banned or restricted for use. The study participants who knew any (hat, gloves, goggles, boots, and face mask) personal protective equipment (PPE) were 447 (81.4%). While, only 152 (27.7%) had the experience of reading the label on the pesticide container and 114 (20.8%) ever had training on the safe utilization practice of pesticides.

As the figure shows below, the overall level of the knowledge of selected household toward the safe utilization practice of the pesticides was 283 (51.5%), 95% CI (47.4-55.7) had good knowledge (Figure 2).

Safe pesticide use practice

All of the study participants had experience with utilization of the pesticides. Nearly half of them 261 (47.5%) were used PPE

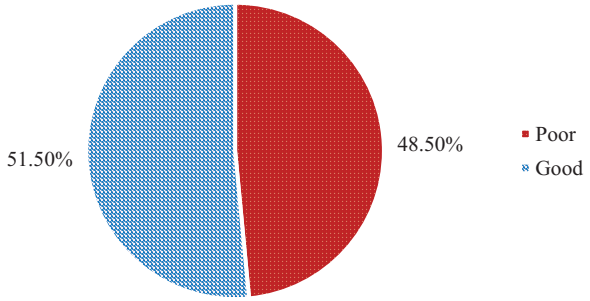

Figure 2. The overall level of the knowledge of selected households toward safe utilization pesticide.

before spraying mainly 86 (33.0%) hats, 68 (26.1%) face masks, and 45 (17.2%) gloves only were used. The majority of the participants 437 (79.6%) keep their work clothes at home and 337 (61.4%) wash them together with other personal clothes. Majority reports that, 436 (79.4%) were took shower after work and 466 (84.9%) wash with soap and water after pesticide application. Regarding the methods of spraying used, majority 508 (92.5%) used Knapsack. Nearly one third 157 (28.6%) of the farmers were involved solely in handling inorganic/chemical (mixing, spraying, and disposal) of pesticides with their bare hands. More than half of the 293 (53.4%) of the farmers were mixed pesticides at home (Figure 3).

Factor associated with safe utilization practice of pesticide

The bivariate logistic regression analysis showed that socio—demographic characteristics like gender, age, education status, household monthly income, years of pesticide use, source of pesticide, and farmland size had *P*-value < .25 and they were candidate for multivariate logistic regression.

After controlling Confounder in the multivariable analysis; education status, years of pesticide use, and source of pesticide, were remained an association with the safe utilization practice of pesticide. This study finding revealed that the study participants who had primary education [AOR = 5.605, 95% CI: 3.309, 9.495] and secondary and above [AOR = 9.847, 95% CI: 5.007, 19.368] were more practiced safe utilization of pesticides as compared with no formal education.

The utilization of pesticide for 10 years and longer [AOR = 6.743, 95% CI: 3.569, 12.738] and used between 6 and 10 years [AOR = 1.913, 95% CI = 1.166, 3.141] had higher odds of safe utilization of pesticides than the study participants with less experience. Furthermore, the source of pesticide bought from agricultural office [AOR = 6.996, 95% CI = 3.585, 13.653] and bought from nearby shop and supermarkets [AOR = 2.312, 95% CI = 1.360, 3.930] had high odds of safe practice of

Figure 3. Pesticide mixing and spraying practice at Malga District Sidama regional state.

Table 1. Bivariable and multivariable logistic regression analysis for safe utilization practice of pesticide among farmers at Malga district.

	SAFE UTILIZATION OF PESTICIDE		COR 95% CL	AOR 95% CL	*P*-VALUE
	YES	NO			
	NO. (%)	NO.(%)			
Gender					
Female	6 (23.1)	20 (76.9)	1	1	
Male	187 (35.8)	336 (64.2)	1.855 (0.732, 4.700)	1.724 (0.526, 5.648)	.369
Age					
⩽35	67 (48.9)	70 (51.1)	3.282 (2.067, 5.209)	1.030 (0.573, 1.852)	.920
36-45	77 (39.5)	118 (60.5)	2.237 (1.457, 3.435)	1.245 (0.722, 2.148)	.430
>45	49 (22.6)	168 (77.4)	1	1	
Education status					
No formal education	31 (12.7)	213 (87.3)	1	1	
Primary (1-8)	106 (48.2)	114 (51.8)	6.389 (4.032, 10.124)	5.605 (3.309, 9.495)	<.001
Secondary & above	56 (65.9)	29 (34.1)	13.268 (7.387, 23.832)	9.847 (5.007, 19.368)	<.001
Household monthly income					
⩽1000 ETB	88 (39.5)	135 (60.5)	1.575 (0.982, 2.526)	1.623 (0.886, 2.970)	.117
1001-2575 ETB	69 (34.0)	134 (66.0)	1.244 (0.766, 2.021)	1.416 (0.759, 2.642)	.274
>2575 ETB	36 (29.3)	87 (70.7)	1	1	
Years of pesticide use					
⩽5 y	43 (21.0)	162 (79.0)	1	1	
6-10 y	83 (33.2)	167 (66.8)	1.872 (1.222, 2.870)	1.913 (1.166, 3.141)	.010
>10 y	67 (71.3)	27 (28.7)	9.349 (5.345, 16.353)	6.743 (3.569, 12.738)	<.001
Source of pesticide					
Local market	34 (20.7)	130 (79.3)	1	1	
Nearby any shop	93 (31.8)	199 (68.2)	1.787 (1.139, 2.804)	2.312 (1.360, 3.930)	.002
Agricultural office	66 (71.0)	27 (29.0)	9.346 (5.203, 16.788)	6.996 (3.585, 13.653)	<.001

pesticide utilization as compared who had pesticides from local market (Table 1).

Discussion

This community based cross-sectional study revealed that the prevalence safe utilization practice of pesticides was 193 (35.2%), 95% CI (31.2-39.2). Only 47.5% were used any PPE before spraying pesticides. This finding may be due to the level of educational background of the farmers and the poor awareness creation in the locality. The finding is in-line with the study conducted in Pakistan, which revealed that more than half of the cotton workers surveyed did not use any protective measure during cotton picking, while only 22.3% used a muffler/scarf/cloth for covering their face and 10.8% used gloves.[35]

Regarding the pesticide preparation, 53.4% of the farmers were mixed pesticides at home. One third 28.6% of the farmers were involved solely in handling inorganic/chemical (mixing, spraying, and disposal) of pesticides with their bare hands. This finding indicates that one-third of the study population was not aware of the pesticide hazards. In this regard, a study conducted in Iran showed a similar result that, education level, reading pesticide labels, and literate members of the household showed positive association with knowledge, attitudes, and perceptions of pesticide use[37] and a different study in the same country showed that, most farmers used trousers and

blouse and to a lesser extent mask, gloves, and hat when handling pesticides.[38]

This result was consistent with the report from the study done showed 69.2% of their farms, 26.9% in their homes, and 26.9% in their store house in Cameroon,[27] 32% practice of pesticide use on agricultural farms of Ethiopia.[26] This study result was lower as compared with the previous study reports, 63% of professionals traced the problem to the unsafe use of pesticides in Haromaya Woreda, Eastern Ethiopia[25] and 50.4% in the West Bank, Palestine.[23] Another study evidenced that over half of the farmers (55.4%) perceived low importance of personal protection in pesticide spraying but the perceived importance of personal protection increased in young farmers, with high education level, perception of risk, knowledge of pesticide toxicity and perceived usefulness of PPE.[39]

The discrepancy in safe utilization practice might be due to the difference of the technology they used in the study area, limited use of reliable techniques and difference in socio-economic status variation between the study participants and geographical characteristics of the study area. In addition to this, the different factors might have contributed for this discrepancy, including farmers' low educational level, lack of information and training on pesticide safety, poor spraying technology, and inadequate personal protection during pesticide use.[40] Identifying these relevant factors in this study is very crucial, in addition to the contribution of this work pint out in the introduction part, it is also helpful to the capacity building for actors involved in the chain of pesticide use.

This study finding revealed that the study participants who had primary and above education were more practiced safe utilization of pesticides as compared with no formal education. This result was in line with the report from study finding done on the farmers' low education level associated with the unsafe pesticide use among farmers in the Amazon basin of Ecuador,[30] Central Punjab-Pakistan,[28] and in Midwestern Brazil.[29] In addition a study indicated that education has a significant positive role toward pesticide technology utilization[31] which is similar to these study findings.

The study participants who had 6 and above years' experience of utilization of pesticide had higher odds of safe utilization of pesticides than the study participants with less experience. This result was consistent with the report from the study done in Central Punjab-Pakistan,[28] and practice of pesticide use on agricultural farms of Ethiopia.[26] This may be because the more experienced participants could probably have enough safe preparing, handling, storing and spraying pesticide can affect the health of themselves, the child, the entire family and also the environment.

Furthermore, the source of pesticide bought from agricultural office and bought from the shop and supermarkets had high odds of safe of practice pesticides utilization as compared who had pesticides from local market. This result agrees to report from a study done pesticide retailers in the Wei River catchment, China[29] and in developing countries for local urban.[22] This might be due to the participants who bought from agricultural office and bought from shop and supermarket could get properly stored pesticides, while in the local market, they sold with measuring different thins or measurement and they retail unsafely and they did not orient the risk of the pesticides on the farmers' health. More than that, this indiscriminate distribution of pesticides was seen everywhere in Ethiopia and many other countries due to lack of pesticide regulation.[41]

Strength and Limitations of the Study

The study's strength is the use of primary data from farmers who had routinely utilized pesticides in their day to day life. As a limitation, recall bias and social desirability bias such as participants answer the questions positively based on what they perceived to be expected, could result under estimation of practices of safe pesticide use. Therefore, we the authors urge researchers to conduct comparable research on safe pesticide use among farmers' perceptions in rural and pre-urban and/or urban dweller with different educational background. Moreover, we strongly recommend to study on pesticide regulation in relation to environmental pollution

Conclusion

Based on this study finding, safe practice of pesticide and using PPE before spraying and mix pesticides at home was low. These study findings provide vital information about factors that affect safe use practice of pesticides by the farmers. The farmer's level of education, year of experience of utilization of pesticide and the place of pesticide bought were associated with safe practice of pesticide use significantly. Planning and implementation of a continuous training program of safe practice of pesticide use to the local farmers by the responsible body basically the health and agricultural sectors in the study area are recommended.

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We would like to forward our deepest gratitude to Hawassa University College of Health Sciences and Medicine.

Authors' Contributions

SL: conceptualization, investigation, project administration, methodology, formal analysis, writing original draft. TA: methodology, data clearance, analysis, editing, supervision, and writing. AE: data analysis manuscript preparation. NE: data management edition. BN: data management edition. MBA: methodology, data, analysis, editing, supervision, writing, and manuscript preparation.

Data Availability

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

Ethical Approval

Ethical clearance was obtained from Hawassa University College of Medicine and Health Science Institutional Review Board (IRB). Prior to data collection an official written letter from the Institutional Review Board (IRB) was submitted to Malga District. Individual verbal consent was obtained before administration of questionnaires. The consent forms were translated in the local language (sidaamuafoo) and subjects were informed about the objective of the study, possible risks and benefits of the study and to ensure confidentiality; participant's data were linked to a coded number and verbal consent was made with the right not to participate in the study. Honesty and confidentiality were maintained through. Personal privacy and cultural norms were respected.

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