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Research Article

Keywords: Pesticide, Farmers, Environment Health Risk

Posted Date: October 8th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10843691/v1

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Additional Declarations: No competing interests reported.

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Abstract

The impact of pesticide on small scale farmers is a considerable public concern. The study, evaluated the awareness level, use practice and health problem of pesticide among 102 farmers in Surulere L.G. Area Nigeria using the multistage sampling and questionnaire from June - October 2023 and data was analyzed using descriptive statistic and Pearson Correlation.

The result indicated majority of the respondent (85%) are male, age 49yr ± SD, experience >24yr, choice priority for pesticides DD Force, Atrazine, Paraforce were price not safety and, practice of pesticide: storage at home or farmland, 52% ;Reuse of old pesticide 58%, washing contaminated clothes by the stream: 83%, wearing of glove 9%; sandles87% and, other wore slipper only; whereas, all 100% reported health effect (chest pain 72%; Severe headache35%; Excess Sweat 36%)), Spill during pesticides 67%.

The result of correlation showed socio-economic variable (age, educational level, household size and years' experience) had the same effect with knowledge on practice of pesticide by farmer. This suggest lack of awareness is strongly correlated with poor practice. Conclusion There is wide gaps between knowledge and practice of pesticides due to prioritization of low cost over safe products which increase health risks for farmers and the environment, lack of proper training, strong correlation of some socio-economic characteristic with farmer's practices for better improvement, the study recommends the implementation of safety certification scheme and more awareness campaigns against careless pesticide application in farming practice, with the collaboration of the pesticides dealer's agents/wholesalers, so farmers choose cheap and less harmful pesticides products.

Key Words: Pesticide, Farmers, Environment Health Risk

1. Introduction

Excessive and uncontrolled use of pesticides is a serious threat to the health of almost two and a half billion people worldwide, of whom a third are exposed to ten times more than the permissible concentration [1]. Farmers are at the highest risk since they handle the toxins directly, which significantly damages their skin and lungs causing both mild conditions, such as headaches, and severe pulmonary edema [2, 3].

Primarily, agricultural workers living in developing countries bear the highest burden, despite only comprising a quarter of the world's population. Being exposed to almost 99% of poisoning incidents, the residents of these countries report to hospitals about 25 million mild and 3 million severe poisoning cases a year [4,5]. For example, there were 24 pesticide-related deaths in Maharashtra (India) only in one district within 2017 due to the prevalent utilization of potent insecticides and improper application [6, 7].

The global agricultural production has a dual problem of feeding the growing world population while reducing the negative impact of pesticides on humans. To address the first problem, numerous studies have shown the critical importance of chemical agents for modern agriculture [8]. However, despite the increasing use of these poisonous substances, the overuse leads to significant health and environmental consequences, particularly in rural areas where agricultural workers are often exposed to pesticides without the proper equipment [9, 10].

Pesticides affect a wide range of species, including insects, by targeting the central nervous system, meaning that they are hazardous to humans as well. The most common insecticides comprise organophosphates (OPs), carbamates, pyrethroids, and neonicotinoids [11]. Highly hazardous pesticides (HHPs) such as WHO Ia and Ib OPs are no longer used in developed countries but are still present in low and middle-income countries due to their low cost and efficiency [12, 13]. Meanwhile, newer variations of Pesticide offer various advantages but are suspected to cause endocrine disruptions and long-term neurological effects [2].

Knapsack spraying is the most prevalent method of pesticide application, particularly among small-scale farms. Moreover, it involves close contact with the toxin, which makes the workers' skin, lungs, and accidental oral ingestion the most affected areas [14]. At the same time, the size of exposure is primarily dictated by the spraying practices, including the frequency, dosage, and weather conditions, such as heat [15].

The international guidelines recommend that pesticide applicators use protective clothing, including masks, coveralls, gloves, and eye protection. Nevertheless, the studies report a large "knowledge-practice gap," meaning that while most workers understand the potential damage, they do not use the available equipment [16]. There are several reasons for this gap, including the complexity and costly nature of the recommended gear, insufficient training, and the lack of availability of proper clothing in the target regions [17, 16]. As a result, agricultural workers continue to suffer from exposure to chemical agents, with millions of cases of pesticide poisoning occurring every year worldwide.

Both acute and prolonged exposure to pesticides pose serious health hazards. The former results in an array of cholinergic receptor effects, causing such side effects as nausea, vertigo, and dyspnea and leading to pulmonary edema in extreme instances [18]. In comparison, chronic exposure to moderate doses can lead to severe neurocognitive effects and is associated with such diseases as Parkinson's [2].

Additionally, research shows that health care professionals are now detecting a wide range of chronic effects resulting from frequent and prolonged exposure to various chemical pesticides [19,8]. For example, the World Health Organization has established a correlation between insecticides and several severe health conditions, including impairments of the developing fetus and the disruption of endocrine functions.

Despite the dangers of exposure to pesticides, there is currently limited information on the association between specific spraying practices and workers' health. Besides, as climate change impacts the world, agricultural producers might begin to use more chemical agents to combat the pests, making it critical to monitor these populations' health [8]. Therefore, this study was conceived to bridge this critical knowledge gap. By conducting a comprehensive survey, this research aims to provide a much more granular understanding of the current landscape of pesticide use, the efficacy of protective measures, and the associated severe health burdens among agricultural workers.

2. Materials and Methods

2. Study Location

The study was carried out in Oko, Kueke, and Poroo Surulere Local Government Area (LGA) communities between June and October, 2023. Surulere Local Government Area was purposively selected due to its agrarian nature. Surulere is a peri-urban local government whose headquarters is located at Iresa Adu. It lies between Longitude 4°20'52.17" E and Latitude 8°04'30.44"N. It borders Oriire Local Government Area to the North, Osun State to the East and South, and Ogo Oluwa, Ogbomoso North, and Ogbomoso South Local Government Areas to the West. Surulere covers an area of 23 km² (by landmass) with a population of 140,339 people in over 300 communities (National Population Census, 2006).

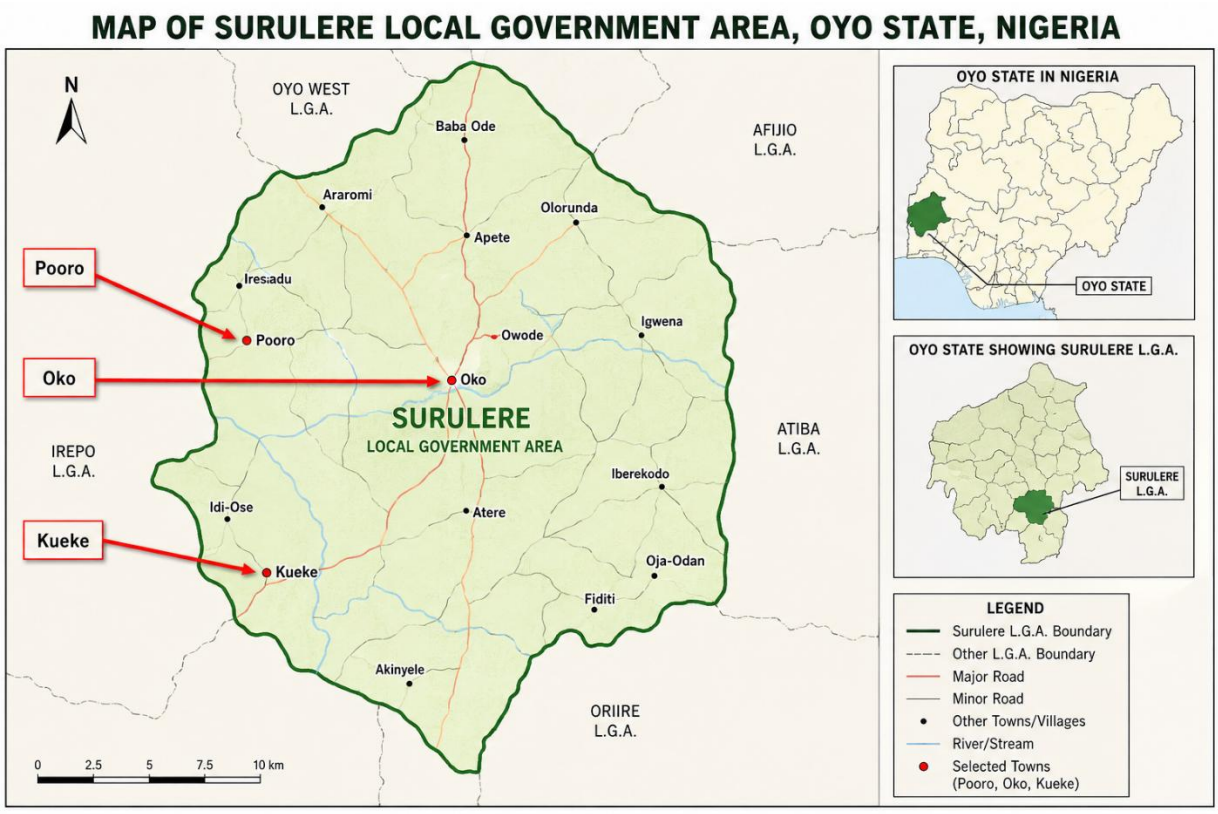


Plate 1: Map of the Study Area.

2.2 Study Design and Study Population

Using a face to face interview, 102 farmers involved in farming activities, purchase, use and storage of pesticides in the two selected LGA, were interviewed using a structured questionnaire. Farmers below the age of 18 years and those with limited years of experience in pesticide handling and application were excluded from the study. The exclusion of these groups was made in order

to comply with the age of consent and also ensure the sampled group had sufficient knowledge and experience of pesticide application.

2.3 Sampling Procedure

The sample size comprised of farmers and people living in the communities. Multistage sampling technique was used for the selection of the respondents. During the first stage, 1% of 300 villages was selected which included Oko, Pooro and Kueke, all along the local government. The second stage involved random selection of 53% of the farmers from the registered list of farmers in the Local Government Area, which amounted to a total of One Hundred and Two (102) farmers, which formed the sample size of the study (Table 1).

Table 1: Selection of the respondents for the study

S/N	Name of Village	No of registered farmers	No of respondents (53%)
1.	Pooro	62	38
2.	Oko	78	42
3.	Kueke	52	22
Total	3 Villages	192	102

Source: OYSADEP

2.4 Data Collection Tools Procedure

Structured, closed ended questionnaire consisting of farmer's socio-demographic data, occupational history, pesticide exposure and knowledge about pesticide safety, crop production profile, types of pesticides used, experience of pesticide application, attitude on pesticide safety, application procedures and use of personal protective equipment (PPE) were used in collecting primary data. Six trained graduate assistants, trained on questionnaire administration and interview techniques, conducted face to face interview of the sampled respondents. The research assistants all had tertiary education and were well conversant with collection of interview data.

2.5 Data Analysis

Data was validated for completeness, encoded and analyzed using the SPSS statistical package, version 22.0. For continuous variables the means standard deviations were calculated and for discrete variables frequencies with percentages were documented. Chi-square test was performed to investigate relationship between respondent's pesticidal handling and application behaviors and sociodemographic, knowledge and attitudinal factors concerning pesticide usage. Logistic

regression analysis was performed to determine the role of education status, smoking habit, exposure to any kind of training and attitude and knowledge toward safe pesticide handling application practices.Statistical significance was defined at $p = 0.05$.

3. Results and Discussion

3.1 Distribution of Respondents by Demographic Characteristics

The results of the statistical analysis which were aimed at determining the demography of the respondents are presented in Table 1 below. It was found that the majority of respondents were middle-aged, male, had received some level of education, were married, and had years of farming experience. In terms of the age distribution, most respondents (38.2%) were aged between 51 and 60, while another 36.4% were aged between 41 and 50, making the average age to be 50. Therefore, it may be concluded that the respondents belonged mostly to the labor force and were capable of engaging in heavy works such as intensive farming.

In terms of gender, it was found that the respondents were predominantly male (85.3%). In relation to the educational level, it was found that most farmers (79.9%) had more than five years of education, with the mean value being 9 years. It may therefore be concluded that most farmers were relatively highly educated. In terms of their marital status, most respondents (83.3%) were married, while 8.8% were single, 4.9% divorced, and 2.9% widowed. It may be suggested that most farmers had family members who could be involved in farming.

According to the results, most farmers (78.4%) had more than five members per household, with the mean value being 9 members. It may therefore be concluded that respondents mostly lived in large families, where family members could be utilized for farm labour. It was also found that most respondents (90.2%) cultivated less than two hectares of land, suggesting that they were mostly small-scale farmers. In terms of the source of land, it was found that farmers mostly (72.5%) acquired their lands through inheritance, while 14.7% had purchased their land, 6.9% received it as a gift, and 5.9% rented their land. According to the results, most farmers (46.1%) had more than 20 years of farming experience, with the mean value being 24 years. It may therefore be concluded that the respondents were rather experienced in intensive farming.

Table 1: Distribution of Respondents by their Demographic Characteristics

Personal characteristics	Frequency	Percentage	Mean
Age			
31-40	14	13.7	50
41-50	37	36.4	
51-60	39	38.2	
>60	12	11.7	
Sex			
Male	87	85.3	
Female	15	14.7	
Years spent in school			
≤ 5	20	20.1	
> 5	82	79.9	
Marital status			
Single	3	2.9	
Married	85	83.3	
Widow/widower	5	4.9	
Divorced	9	8.8	
Household size			
≤ 5	22	21.6	9
> 2	80	78.4	
Size of farmland			
≤ 2	92	90.2	1.6
> 2	10	9.8	
Mode of land acquisition			
Inheritance	74	72.5	
Purchased	15	14.7	
Rent	6	5.9	
Gift	7	6.9	
Years of farming experience			
11-20	40	39.2	24
21-30	47	46.1	
31-40	13	12.7	
> 40	2	2.0	
Total	**102**	**100.0**	

Source: Field survey, 2023

3.2 Distribution of Respondents based on Insect pests and Pesticide used for the Control

Table 2 below shows that farmers cultivate various crops in the study area, with maize (78.4%) and yam (74.5%) as the commonest crops followed by tomato (36.3%), cassava (31.4%), and cashew (22.5%). This implies that farmers in the study area are into multiple cropping system as they cultivate at least one crop species in the study area.

Also it was also shows that farmers identified grasshopper (82.4%) and fall armyworm (79.4%) as the major insect pests affecting their crops. In addition, farmers also identified grasshopper (78.4%) as the most important insect pest followed by fall armyworm (21.6%). This indicates that farmers perceive grasshopper as the most destructive insect pest in the study area. Concerning the severity of pest attack, Table 2 shows that 54.9% and 45.1% of the respondents respectively described the severity of pest attack on their crops as very severe and severe. In addition, Table 2 below shows that 85.3% and 14.7% of the respondents respectively observed that pest occurrence was seasonal in the study area, with the dry season being the peak season for pest infestation in the study area. However, the respondents also identified November (49.0%), March (26.5%), and July (24.5%) as the months when pest infestation was at its peak. This variation might be due to the difference in crop species cultivated by the farmers since different crops have different growing seasons.

Concerning the symptoms of pest attack, Table 2 below shows that farmers identified leaf defoliation (69.6%), drying of the crop (22.5%), and leaf and tassel damage (7.9%) as the major symptoms of pest attack on their crops. This indicates that farmers in the study area are experiencing serious challenges with insect pests infesting their crops.

Furthermore, Table 2 below shows that the respondents mentioned various pesticide brands including DD Force (69.6%), Paraforce (69.6%), Gammalin 20 (32.4%), Tari (30.4%), Caterpillar killer (30.4%), Karate (23.6%), as the major insecticides used in the study area. In addition, the table below also shows that farmers acquired information on the use of pesticides from extension agents (36.3%), farmers (31.4%), friends and relatives (18.6%), agro-dealers (13.7%). Also it shows that farmers mostly purchased pesticides from agro-dealers (65.7%) followed by extension agents (34.3%). Finally, it was observed that farmers mostly prefer DD force (93.1%), Paraforce (80.4%), Tari (62.9%), and Gammalin 20 (51.9%) insecticides for controlling pests in their crops. In addition, farmers also prefer Caterpillar insecticides (49.9%) for controlling pests on their crops. On the other hand, the respondents also cited various reasons for preferring a particular pesticide brand including affordability, availability, effectiveness, cheapness, and active ingredients.

Table 2: Distribution of Respondents based on Insect Pests and Pesticide used for control

Types of crop grown	Frequency	Percentage
Maize	80	78.4
Yam	76	74.5
Cassava	32	31.4
Tomato	37	36.3
Cashew	23	22.5
Types of insect pest		
Grasshopper	84	82.4
Army worm	81	79.4
Insect pest considered most important		
Grasshopper	80	78.4
Army worm	22	21.6
Severity level of attack by insect pest		
Very severe	56	54.9
Severe	46	45.1
Insect pest manifestation on the farm		
Dry season	87	85.3
Rainy season	15	14.7
Month of the year that insect pest most severe		
March	27	26.5
July	25	24.5
November	50	49.0
Symptoms of the insect pest on the target crop		
Filtration of leaves	71	69.6
Drying up the crop	23	22.5
Eating the leaf and tarcel	8	7.9
List of insecticides		
DD force	71	69.6
Caterpillar	31	30.4
Paraforce	71	69.6
Tari	31	30.4

Gammalin 20	33	32.4
Karate	24	23.6
Knowledge source about insecticides		
Extension agents	37	36.3
Farmers	32	31.4
Friends and family	19	18.6
Agro-chemical shop	14	13.7
Source of insecticides		
Agro-chemical shop	67	65.7
Extension agent	35	34.3
Insecticides preferred to use		
DD force	95	93.1
Caterpillar killer	51	49.9
Paraforce	82	80.4
Taxi	64	62.7
Gammalin 20	53	51.9
Preference of the choice of insecticides		
Very cheap	102	100.0
Very active	102	100.0
Total	**102**	**100.0**

Source: Field survey, 2023.

***: Multiple Response**

3.3 Distribution of Respondents by Pesticide Application Procedures, Calibration, Training, and Experience

The distribution of respondents according to methods used in pesticide application procedure, calibration, training, and experience is presented in Table 3. It was found that 47% of rural farmers assessed the amount of pesticide to be applied through consulting with other farmers, whereas 42.2% relied on instruction labels and 10.8% depended on sellers' recommendations. Therefore, it may be concluded that multiple sources of information on pesticide application influenced farmers' decisions in the study area. In relation to the number of spray mixture loads applied in the farmland, 53.9% of the respondents indicated that they used 11-15 loads of pesticide mixture, whereas 25.6% used 6-10 loads. Besides, the results demonstrated that 7.8% of the farmers sprayed the plots using more than 20 loads, while 7.8% applied less than 5 loads of pesticide mixture. Another 2.9% of respondents used 15-20 loads. It may be surmised that the number of loads depended on the size of the plot and the prevalence of insect pests.

Concerning the spraying equipment used in the study, the results demonstrated that 83.3% of the farmers used knapsack sprayers, whereas 11.8% opted for pressure pumps and 4.9% used mist blowers. It may be concluded that knapsack sprayers were the dominant means of pesticide application. In relation to equipment ownership, the results demonstrated that 93.1% of the respondents owned spraying equipment, whereas 6.9% hired it. Thus, it was found that most farmers purchased spraying equipment rather than hired it.

According to the study results, all respondents used the same pump for spraying either herbicides or insecticides against pests. In accordance with the farmers' responses, the equipment was washed before and after use to avoid negative interactions of pesticides. Therefore, it may be suggested that farmers relied on washing the same pump for spraying different kinds of chemicals to ensure safety.

Concerning the use of instruction labels, the study results revealed that 41.2% of the respondents read labels when applying chemicals. Therefore, it may be suggested that literacy impacted farmers' capacity to apply pesticides correctly. At that, the analysis of farmers' beliefs about the usefulness of labels revealed that 47.1% held a view that labels were fairly useful, whereas 42.2% deemed them not useful at all and 10.8% believed that labels were very useful. Consequently, it may be concluded that rural farmers differed in their approaches to using pesticide instruction labels during application, which might impact the safety of pesticide use in the study area.

Table 3: Distribution of Respondents by Pesticides Application Procedures, Calibration, Training and experience

Determination of quality of insecticides to apply	Frequency	Percentage
Seller instruction	11	10.8
Contact farmer	48	47.1
Instruction label	43	42.2
Loads of spray mixture on the farm		
≤ 5	8	7.8
6-10	26	25.6
11-15	55	53.9
15-20	3	2.9
> 20	8	7.8
Equipment used for spraying on the farm		
Lenapsack	85	83.3
Pressure pump	12	11.8
Mist blower	5	4.9
Mode of acquisition of the equipment used		
Personally own	95	93.1
Hired	7	6.9
Used group to spray herbicides		
Yes	102	100.0
No	0	0.0
Read instruction labels on chemical before use		
Yes	42	41.2
No	60	58.8
Adherence to labels on Pesticides		
Very useful	11	10.8
Fairly useful	48	47.1
Not considered useful	43	42.2
Total	**102**	**100.0**

Source: Field survey, 2023

3.4 Distribution of Respondents by Storage and Disposal of Pesticide

The distribution of respondents by pesticide storage and disposal practices is presented in Table 4. The results show that 52% of the rural farmers stored insecticides at home before and after use, while 30.4% stored them in a separate store and 17.6% kept them on the farm. This indicates that home storage was the most common practice among the respondents in the study area.

The findings further revealed that 58.8% of the rural farmers washed and reused empty chemical containers for other purposes, whereas 41.2% disposed of the containers after use. This suggests that the reuse of chemical containers was more common than outright disposal among the respondents.

In addition, all the rural farmers reported that they cleaned their spraying pumps with water only after use. Regarding the disposal of unfinished leftover spraying mixture, 54.9% of the respondents emptied or cleaned it on their farms, 24.5% disposed of it in streams, and 20.6% emptied it near wells used for drinking water. These results indicate that most respondents disposed of leftover spraying mixtures within their farming environment, while a substantial proportion disposed of them near water sources.

Table 4: Distribution of Respondents by Storage and disposal of Pesticide

Storage and disposal of Pesticide	Frequency	Percentage
Where insecticides stored before and after use		
At home	18	17.6
On the farm	53	52.0
In store	31	30.4
Empty chemical container disposal		
Destroy and bury	0	0.0
Throw away	42	41.2
Wash and re-use	60	58.8
Spray pump cleaning after use		
Rinse with water only	102	100.0
Wash with detergent	0	0.0
Do not wash at all	0	0.0
Where to clean or empty unfinished leftover spray mixture		
On the farm	56	54.9
In stream	25	24.5
Near well (drinking water)	21	20.6
Total	**102**	**100.0**

Source: Field survey, 2023

3.5 Distribution of respondents by Frequency of Pesticide Application

The frequency of pesticide application of the respondents is presented in Table 5 below. It was found that most of the rural farmers (67.6%) had been applying pesticides for 10-15 years. In addition, 15.7% of the respondents had been applying pesticides for 16-20 years, 10.8% of them for 21-25 years, and 5.9% for more than 26 years. This implies that the majority of the rural farmers had extensive experience in pesticide application. Consequently, the respondents' level of knowledge on pesticide application practices in the study area was high.

In addition, the study found out that all the respondents had changed from one pesticide to another. Among the respondents who had changed from one pesticide to another, 58.8% of them had been using the new pesticide for not more than five years. On the other hand, 41.2% of the respondents had been using the new pesticide for more than five years. Therefore, it was established that there are varying trends of pesticide use among the rural farmers in the study area.

The main reasons for changing from one pesticide to another included the high cost of the previously used pesticide and the unavailability of the previously used pesticide. Indeed, 54.9% of the respondents changed from one pesticide to another because of the high prices of the previously used pesticide. On the other hand, 45.1% of the respondents gave the unavailability of the previously used pesticide as the reason for changing from one pesticide to another. This suggests that the changing trends of pesticide use among the rural farmers are influenced by economic factors.

With regard to the frequency of spraying, the study found out that 72.5% of the respondents apply pesticides every six times a month. On the other hand, 27.5% of the respondents apply pesticides every three times a month. This suggests that the frequency of pesticide application depends on the level of attack of insect pests on the farms.

In addition, 72.5% of the respondents take two days to spray their farms while 27.5% of them spray their farms in one day. With regard to the time spent spraying the farms, 72.5% of the respondents spend 12 hours a day spraying while 27.5% of them spend six hours a day spraying. It was therefore established that the time spent spraying the farms depends on the size of the farm and the level of attack of the insect pests.

Table 5: Distribution of Respondents by Frequency of Pesticide Application

Frequency of insecticide application	Frequency	Percentage
Years of spraying insecticides to control a target insect pests		
10-15	69	67.6
16-20	16	15.7
21-25	11	10.8
> 25	6	5.9
Change the use of particular insecticide		
Yes	102	100.0
Name of the new insecticides		
DD Force	7	6.9
Paraforce	62	60.8
Atrazine	33	32.4
Years of using the new insecticides		
≤ 5	60	58.8
> 5	42	41.2
What informed changes of pesticides		
Increase in cost	56	54.9
Insect resistance	0	0.0
Unavailability	46	45.1
Time of spraying in a season		
12 times	28	27.5
24 times	74	72.5
Times of spraying per month		
3 times	28	27.5
6 times	74	72.5
Days taken to spray entire farm		
1 day	28	27.5
2 days	74	72.5
Hours taken to spray farm per day		
6 hours	28	27.5
12 hours	74	72.5
Total	**102**	**100.0**

Source: Field survey, 2023

3.6 Distribution of respondents by the use of insecticides on crops for storage

Table 6 presents the distribution of respondents based on the use of pesticide use for storage of crops. The result revealed the types of crops stored, chemicals used for storage, the purpose of applying these chemicals, the period of the year when insecticides are used, and the interval between insecticide application and the consumption or sale of the produce.

The findings show that all respondents stored maize and cowpea, indicating that these were the most common crops kept in storage in the study area. In addition, 78.4% of the rural farmers stored sorghum, while 21.6% stored millet and cowpea. This suggests that each respondent stored at least one or more crops after harvest.

With respect to the chemicals used in crop storage, the result revealed that 49.9% of the respondents used Tari, 31.4% used DD Force, and 18.7% used Aluminum phosphate (Phostoxin). This indicates that different storage chemicals were used by the farming households. The choice of chemical appears to depend on factors such as affordability, availability, and the type of crop being stored.

The study further revealed that all respondents applied chemicals to their stored crops in order to prevent pest infestation. This shows that insecticide use was a common preservation practice among the rural farmers.

Regarding the period of pesticide use, the majority of the respondents (78.4%) reported applying chemicals in March, while 21.6% applied them in November. This suggests that pesticide were used mostly during periods when pest infestation was perceived to be high in stored crops.

On the interval between pesticide applications and the consumption or sale of produce, 78.4% of the respondents preserved their crops for 3-6 months before use or sale, whereas 21.6% preserved them for 1-2 months. This variation may be influenced by the type of crop stored and the farmers' intended storage duration. However, the result shows that rural farmers in the study area relied on different insecticides to protect stored crops, especially maize and cowpea from pest attack, with storage duration and timing of application varying across respondents.

Table 6: Distribution of respondents by the use of Pesticide on crops for storage

Use of Pesticide on crops for storage	Frequency	Percentage
Names of crops stored		
Maize	102	100.0
Yam	102	100.0
Millet	22	21.6
Cowpea	22	21.6
Sorghum	80	78.4
Chemical used in storage of the crops		
Dichlorvos (sold locally as DD Force, Sniper)	32	31.4
Phostoxin Tablets	19	18.7
Tari	51	49.9
What period of the year do the pesticides commonly used?		
March – June	80	78.4
October - November	22	21.6
Interval between the application of pesticides, sales and consumption		
1-2 months	22	21.6
3-6 months	80	78.4
Total	**102**	**100.0**

Source: Field survey, 2023

3.7 Distribution of Respondents by their Medical History/Symptoms of Exposure/Health Complaints.

The distribution of respondents according to medical history, symptoms of exposure, and health complaints is as presented in table 7. This section focused on discussing smoking and alcohol use, chemical spillage or accident experienced, immediate action taken, awareness of product hazards, possession of antidote, unusual feeling after spraying, Hospital visit, complaints at hospitals, and admission history of the rural farmers in the study area.

It was found that 30.4% of the respondents smoked while in the farm either on or off the farm activity. Among those who smoke, 89.2% indicated that they smoked for not more than 10 years while 10.8% said they smoked for more than 10 years. On the other hand, 66.7% of the respondents

stated that they drank alcohol. Out of those who drank, 32.4%, 21.6% and 12.7% indicated that they drank for 11-20 years, not more than 10 years and more than 20 years respectively.

On chemical spillage or accident experienced, the study revealed that 66.7% of the respondents had experienced major spillage or accidents when handling chemicals on the farm. Of those who had experienced spillage or accident, 66.7% rinsed the whole affected area with water. In addition, 66.7% of the respondents were aware of the harmful effects of the chemicals and at the same time indicated that they kept antidote handy. From this, it can be concluded that even though most of the respondents were aware of the effects of the chemicals, spillage or accident was common among them.

In relation to unusual feeling after spraying insecticides on the farm, all the respondents experienced unusual sickness after spraying insecticides on the farm. Chest pain and excessive sweating were the most common symptom reported by 36.3% of the respondents. This was then followed by severe headache and restlessness which were reported by 35.3% of the respondents. Other symptoms reported include, weakness/unusual tiredness (26.5%), dizziness (24.5%), stomach ache (19.6%), convulsion (8.8%) and vomiting (6.9%). From the above statistics, it can be concluded that spraying insecticides on the farm was a major contributor to health hazards among the rural farmers of the study area.

From the findings, it was further revealed that 56.9% of the respondents had visited a hospital in the past 5 years while 43.1% had not. In terms of the number of visits, the result showed that 32.4% of the respondents visited the hospital twice, 23.4% visited the hospital 3 times and only 1% reported one visit to the hospital. In relation to complaints at the hospitals, the result revealed that 56.9% of the respondents visited the hospitals for routine examinations while 55.9% complained of body weakness or pain. Other complaints included; malaria fever (47%), seto-seto (41.2%), and surgery (11.8%).

On the admission history, the study further revealed that 24.5% of the respondents had been admitted to the hospitals in the past five years while 65.5% had not. In terms of the number of admission days, the result revealed that 75.5% of the respondents had not been admitted to the hospitals. On the other hand, 19.6% were admitted once and 4.9% were admitted twice. In addition, the result revealed that among those admitted to the hospitals, 15.7% were admitted for one day while 8.8% were admitted for 2-3 days. From this analysis, it can be concluded that chemical exposure was a major contributor to health hazards among the rural farmers in the study area.

Table 7: Distribution of respondents by their medical history / symptoms of exposure / health complaints

Medical history/symptoms of exposure/health complaints	Frequency	Percentage
Smoking		
Yes	31	30.4
Years of smoking of the respondents		
≤ 10	91	89.2
11-20	11	10.8
Taking alcohol		
Yes	68	66.7
Years of drinking alcohol of the respondents		
≤ 10	22	21.6
11-20	33	32.4
> 20	13	12.7
Had any major chemical spillage/accidents		
Yes	68	66.7
Times of such experience		
2-3 times	15	14.7
4-6 times	54	52.9
Immediate action taken to reduce effect of the chemical		
Rinse with water	68	66.7
Awareness of the detail and hazardous nature of the product handled		
No	68	66.7
Keeping of the necessary antidotes		
No	68	66.7
Antidotes familiar with		
No	68	66.7
Experience unusual feeling after spraying		
Yes	102	100.0
Symptoms experienced after spraying		
Severe headache	36	35.3
Feeling dizzy/dazed	25	24.5
Feeling weak or unusually tired	27	26.5
Vomiting	7	6.9
Nausea	0	0.0
Restlessness	36	35.3

Convulsion	9	8.8
Difficult sleeping	0	0.0
Difficult thinking	0	0.0
Stomach ache	20	19.6
Diarrhoea	0	0.0
Pain in the chest	80	78.4
Excessive seating	37	36.3
Ever visited hospital within last 5 years		
Yes	58	56.9
No	44	43.1
Number of times visited hospital		
Didn't visit at all	44	43.1
No 1 times	1	1.0
2 times	33	32.4
3 times	24	23.5
Complaints tendered when visited the hospital		
Seto selo	42	41.2
Malaria fever	48	47.0
Body weakness/pain	57	55.9
Surgery	12	11.8
Normal check up	58	56.9
Admitted within the last 5 years		
Yes	25	24.5
No	77	75.5
Number of time admitted		
Not at all	77	75.5
1 time	20	19.6
2 times	5	4.9
3 times		
Days/week spent each time		
No time spent	77	75.5
1 day	16	15.7
2-3 days	9	8.8

Source: Field survey, 2023

***: Multiple Response**

3.8 Distribution of respondents by Habits during Spraying/Use of Protective and Management of Clothes

The distribution of respondents according to practices during spraying, use of protective materials, and management of clothes was presented in figure 1. It is evident from the figure that farmers used different protective measures during pesticide application. Most farmers (87.2%) used slippers while 65.7% used overalls. The use of cover shoes and jackets was moderate (47.0%), while 24.5% and 20.6% of farmers used caps or hats and goggles respectively. Few farmers used rubber boots (11.8%) and leather or light gloves (9.8%). This indicates that while farmers used various protective materials, the usage of full personal protective equipment was low.

It was also revealed from figure 1 that most farmers (88.2%) changed clothes later after spraying whereas 11.8% changed clothes immediately after spraying. A large majority (87.3%) washed their clothes after spraying whereas 12.7% did not wash the clothes after spraying pesticide. In addition, most farmers washed the clothes near the village stream (83.3%) followed by farmers who washed clothes outside the village (10.8%) compared to farmers washing clothes near village wells or drinking water sources (5.9%).

Finally, all the respondents reported that they did not eat or take alcohol while spraying insecticides. It can thus be concluded that while farmers practice some of the safe handling measures of insecticides, they do not observe safe handling of clothes and use of personal protective equipment fully.

Figure 1: Distribution of Respondents by use of Personal Protective Equipment / Habits during Spraying and Management of Clothes

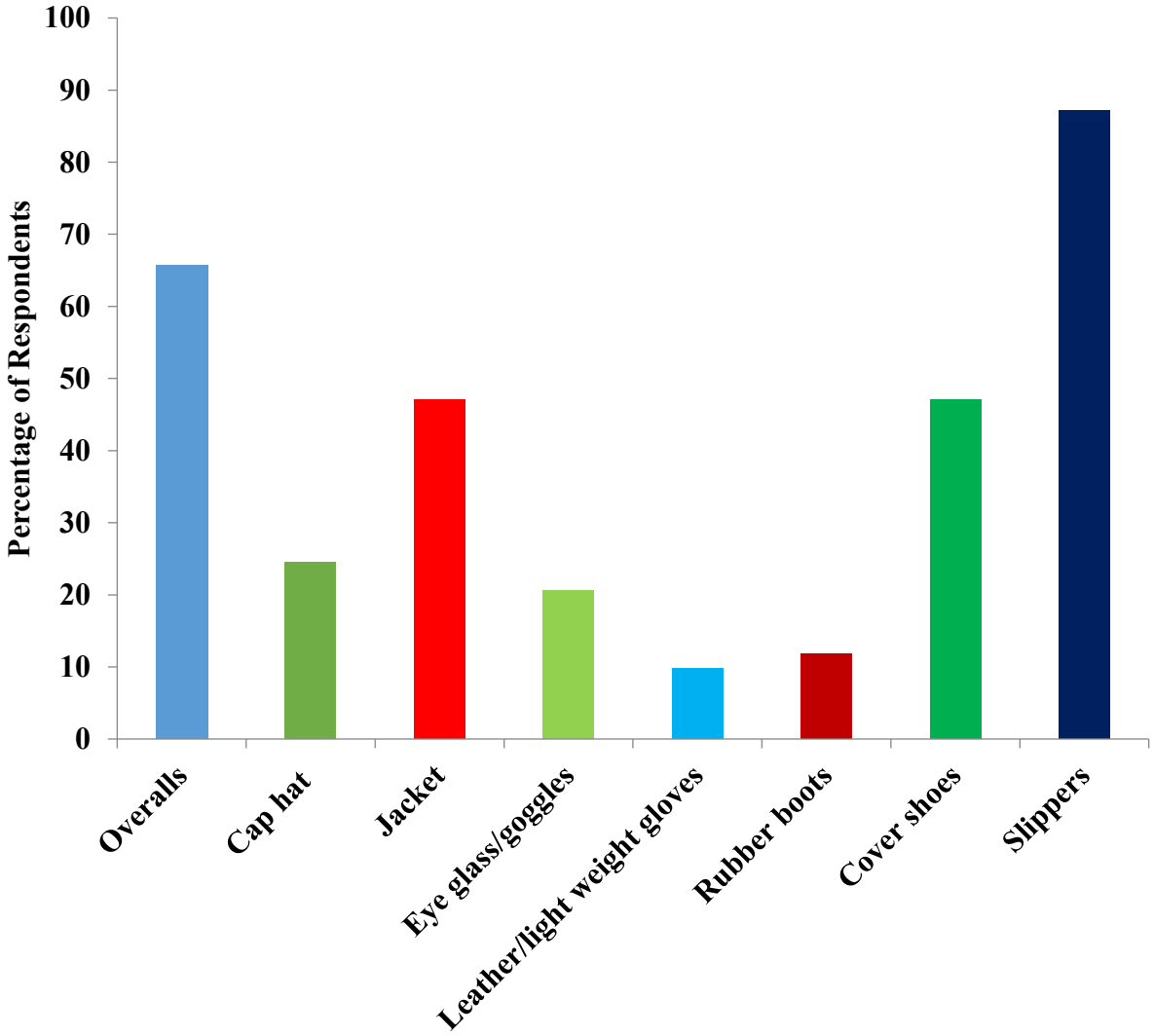
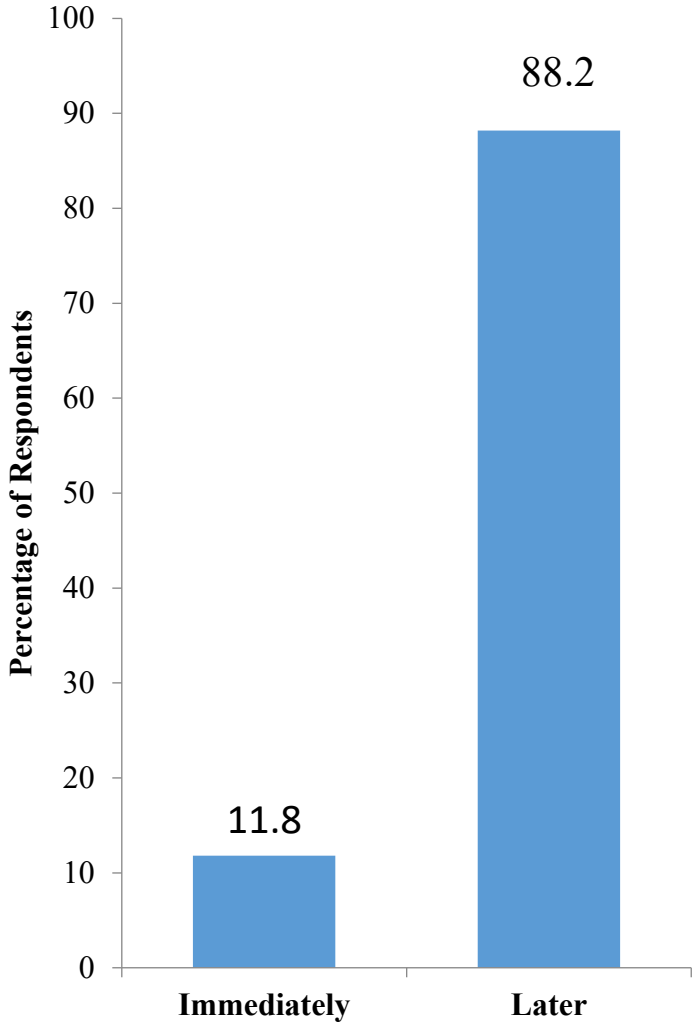
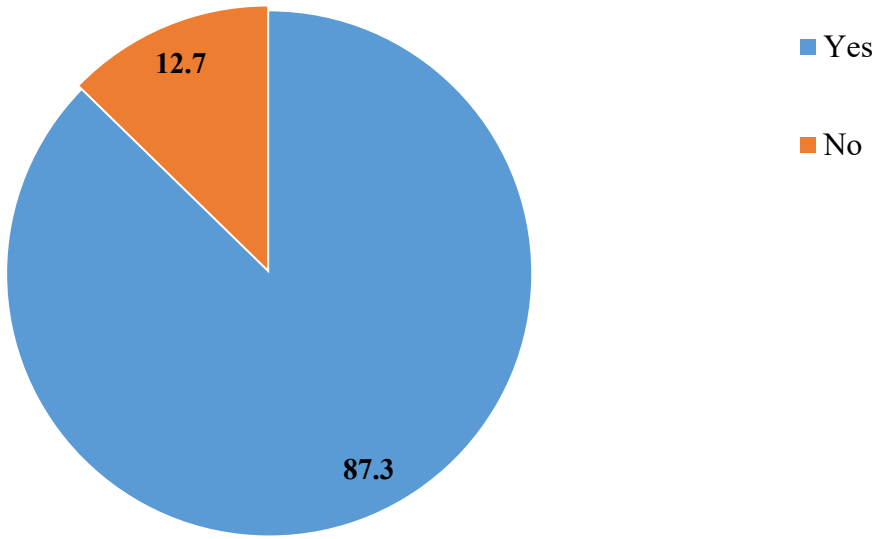


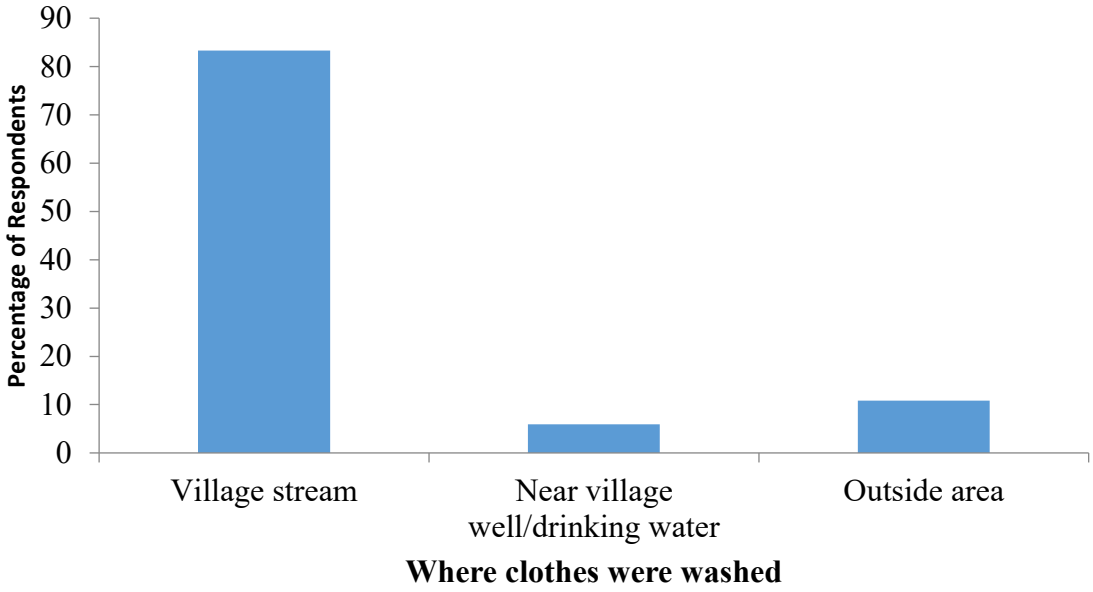
Figure 1: Percentage of the Respondents on Personal Protective Equipment Used for Pesticide Application

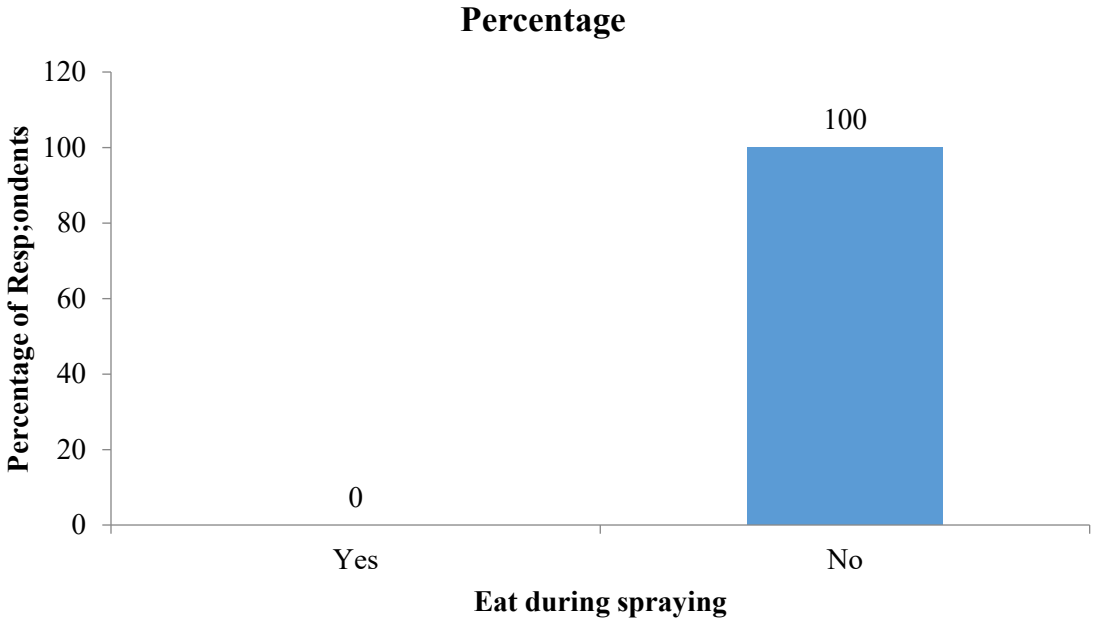


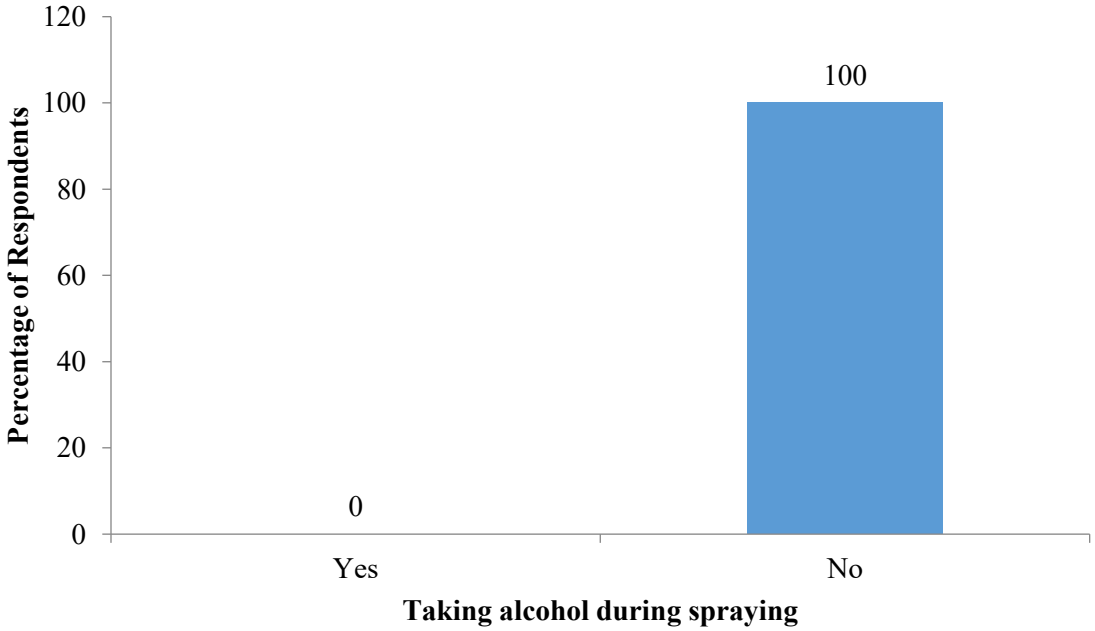
Time of changing clothes after spraying exercise



Percentage of the Respondents on washing clothes after spraying chemicals




Percentage
120
100
80
60
40
20
0
Percentage of Resp;ondents
100
0
Yes
No
Eat during spraying


120
100
80
60
40
20
0
Percentage of Respondents
100
0
Yes
No
Taking alcohol during spraying

3.9 Relationship between rural farmers' personal characteristics and their pesticide application procedure in the study area

Figure 2 present the Relationship between rural farmers' personal characteristics and their pesticide application procedure in the study area**.** It was revealed that the study hypothesis is stated in null form.

Ho_1: There is no significant relationship between rural farmers' personal characteristics and their pesticide application procedure, was tested using Pearson Product Moment Correlation (PPMC). The findings showed that selected socio-economic characteristics were significantly related to pesticide application procedure. Specifically, age ($r = 0.357$, $p < 0.000$), years spent in school ($r = 0.361$, $p < 0.000$), household size ($r = 0.440$, $p < 0.000$), and farming experience ($r = 0.263$, $p < 0.001$) all had significant positive relationships with how farmers applied pesticides.

The result suggests that older farmers, those with more years of schooling, those from larger households, and those with more farming experience were more likely to demonstrate better knowledge and practices in pesticide application. Age may influence farmers' productivity and practical ability in pesticide use, while education improves understanding of proper application methods. Similarly, larger household size may provide more labour support, and greater farming experience may enhance farmers' skill and familiarity with pesticide use in crop production.

Overall, these findings indicate that personal characteristics play an important role in shaping pesticide application procedures among rural farmers in the study area. Therefore, the null hypothesis was rejected, while the alternative hypothesis, which states that there is a significant relationship between selected socio-economic characteristics and pesticide application procedure, was accepted.

HA: There is significant relationship between selected socio-economic characteristics of the respondents and their pesticides application procedure.

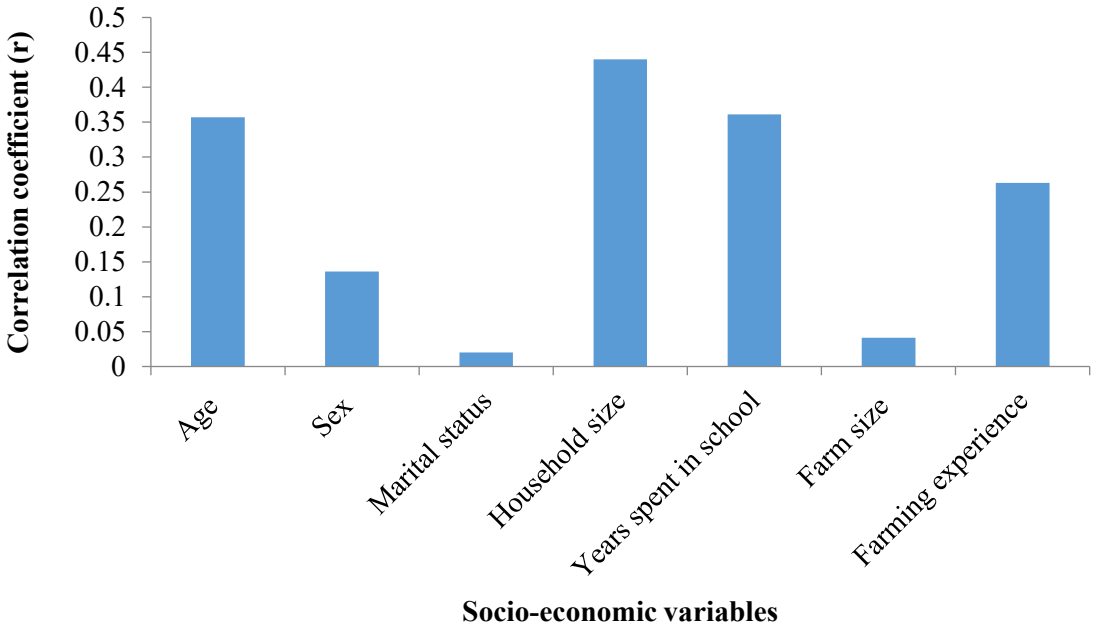


Figure 2: Relationship between rural farmers' personal characteristics and their pesticide application procedure

4. Discussion

Farmer's knowledge and practice to pesticides safe use is necessary to design evidence-based instructional materials or policy intervention for the reduction of risks posed by pesticides to the human health and the environment. In this study, most of the respondents have appropriate perceptions regarding pesticide hazards on the environment and human health. On the contraryto expectation, this did not significantly change their practices and attitude towards safe pesticide practice or nonrisk-preferring attitude. It seems to show that hazard knowledge on pesticide is not necessary a predictor for protection behavior and the existence of high risk practices is more possibly to be a consequence of the failure of the structured training and the lacking of operational knowledge for safe use practice. [20] or because economic priorities, such as maximizing crop yields, supersede personal health concerns [21]. Furthermore, a considerable proportion of respondents were illiterate or possessed limited formal education, and none had received formal training or technical support in pesticide safety. Consequently, these farmers are significantly hindered in their ability to read and comprehend pesticide labels or written safety guidelines regarding exposure prevention [22].

4.1 Socio-Demographic Characteristics of Respondents

The majority of respondents indicated farming as their occupation. The mean age of the respondents was 50 years with the largest proportion of farmers being aged 51-60 years (38.2%). Also, the majority of the respondents were male (85.3%). These findings suggest that the majority of farmers in the study area are aging and highly experienced with farming as their primary occupation. This observation is consistent with recent trends in agricultural demographics in Uganda, Kenya, Morocco, Ghana, and Nigeria where young people are migrating from rural to urban areas, leaving behind aging populations of male farmers [23]. The large percentage of the respondents with large family sizes probably exerts high pressure on farmers to maximize their yields using highly risky pesticides [24].

4.2 Crop Types, Pest Prevalence, and Pesticide Selection

Maize (78.4%) and yams (74.5%) were the most commonly cultivated crops in the study area. Grasshoppers (82.4%) and armyworms (79.4%) were the dominant insect pests controlled by pesticides. All respondents prioritized cheaper and more effective chemicals for personal use, indicating that cost-effectiveness influenced their purchasing decisions. This supports the findings of [25], who found that farmers mainly purchased products with desirable features such as affordability and effectiveness. The prevalence of grasshopper and armyworm infestation

corroborates the recent surge in insect pests in western Africa cropping systems (Giller et al., 2025). Farmers primarily relied on peer groups and agro dealers rather than formal agricultural advisory services in selecting and using pesticides, indicating the lack of professional advisors and the need for improving formal advisory services in developing countries [23,26].

4.3 Pesticide Application Procedures and Equipment

Effects of pesticide mixtures are poorly studied, particularly in Africa. In this study, farmers assessed the quality of pesticides mostly by consulting peers (47.1%) rather than reading instruction labels (42.2%). The knapsack sprayer (83.3%) was the predominant application equipment, mostly privately owned (93.1%). Disobedience to the instruction labels is a risk factor for pesticide exposure and misuse [27]. Qualitative findings identified the ineffectiveness of extension services and the availability of alternative sources of information, including personal experience, informal networks, and local pesticide dealers. Focus group participants identified limited time and financial resources as barriers to contacting agricultural extension services. One farmer noted, "It takes a whole day to get there, and we cannot leave the field." On the contrary, local pesticide dealers were always available. One dealer noted, "Most farmers do not look at the label; they ask me directly how much to spray." Similarly, a focus group participant said, "*Why look at the label if the seller will tell us what to do?"* Thus, the study confirms that while extension workers can advise farmers on appropriate pesticide use, local input dealers and informal social networks control farmers' behavior. This undermines the proper use of pesticides, leading to unsafe handling and exposure [23, 28]. Additionally, the study identified the tendency for behavioral conservatism among farmers. Focus group participants identified their preferred pesticide brand and formulation. Farmers requested the most potent ("RED") pesticide dose, while others were hesitant to embrace a safer ("GREEN") option because they were used to the previous ones.

4.4 Storage, Calibration, and Disposal of Pesticides

Unguarded storage of pesticides at home and on-farm was common among respondents in the study conducted in developing countries [29]. In this study, unguarded storage was prevalent at 52.0%, which is higher than the 43% reported in a similar study conducted in Tanzania [30]. In this study, 52.0% of respondents stored pesticides on the farm, while 17.6% stored pesticides at home. Moreover, 80% of respondents do not calibrate spraying equipment, and they lack knowledge about calibration. A high prevalence of poisoning symptoms is significantly associated with failure to calibrate spraying equipment, indicating that human exposure to pesticides occurs

due to high emission rates resulting from incorrect application practices. Furthermore, the study revealed unsafe disposal practices of pesticide containers by respondents, with 58.8% washing and reusing them for other purposes, while 41.2% disposed of them carelessly. All the respondents used water to clean their spray pumps. Storing pesticides in open places and disposing of pesticide containers and unwanted pesticide solutions carelessly around water sources poses a risk to human health and the environment. This is because water sources can be contaminated with pesticides through runoff or leaching, contaminating water sources [31, 32]. All the respondents reuse empty pesticide containers for other purposes, which is acommon practice in developing countries that exposes them to pesticide poisoning (33, 34, 35].

4.5 Frequency of Pesticide Application

Farmers possessed substantial spraying experience, with 67.6% having 10-15 years of practice. However, 100% of respondents reported altering their specific pesticide choices, primarily driven by increased costs (54.9%) and product unavailability (45.1%). "Paraforce" (60.8%) and "Atrazine" (32.4%) were the most common replacements. Spraying frequency was high, with 72.5% reporting frequent applications per season and month. This universal shift in pesticide choice, driven by cost and availability rather than efficacy or resistance management, is highly concerning. It can lead to the misuse of non-target-specific chemicals-such as using the herbicide Atrazine for insect control-thereby exacerbating environmental contamination and health risks [36].

4.6 Pesticide Use in Stored Grains

For stored grain protection, the most frequently reported active ingredients comprised the organophosphate dichlorvos (locally known as DD Force or Sniper), used in 31.4%, and the fumigant Phostoxin (18.7%). The use of acutely toxic fumigants, including dichlorvos and Phostoxin, for grain protection poses a significant public health threat in Nigeria [37]. In addition to the acute hazard, there is a chronic risk of exposure to dichlorvos and Phostoxin through consumption of treated grains. The recent upsurge in the use of dichlorvos and its subsequent rejection by international buyers due to elevated residues pose a serious challenge to Nigeria’s agricultural exports [8, 38]. A three to six-month interval for the total degradation of these toxic insecticides has been reported to be insufficient, especially for long-term consumption without adverse health effects [39].

4.7 Health Symptoms and Medical History

All respondent (100%) experienced acute physiological effects after exposure to insecticides like chest pain, severe headache, restlessness, and sweating. In addition, 4 out of 6 respondents reported severe spillage, and the same proportion was completely unaware of the harmful effects of the drugs. Moreover, 56.9% of respondents visited the hospital within the past five years for various complications; 55.9% of them were body pains and weakness, while 6.9% were malaria patients. The symptoms are similar to those identified by [22] among Tanzanian farmers exposed to profenofos with acute toxicity. In particular, the study found three major symptoms of exposure: effects on the nervous system (severe headache, visual disturbances, muscle weakness, restlessness), respiratory system (painful cough, shortness of breath), and skin (irritation and blistering). Indeed, almost all respondents experienced acute poisoning after insecticide exposure and became ill. Moreover, the results suggest that the respondents did not understand the potential risks and harmful effects of the chemicals. Recent systematic reviews of literature also show that exposure to organophosphates and pyrethroid insecticides is a significant risk factor for developing acute poisoning, primarily affecting the respiratory and nervous systems [40]. Hence, the high spillage reported by farmers necessitates developing occupational health and agro-nursing intervention programs.

4.8 Safety Practices and Protective Measures

The use of personal protective equipment (PPE) was found to be highly inadequate among the participants. Only 9.8% of the farmers used gloves while applying the pesticide, 87.2% wore only slippers while applying the pesticide, 65.7% used overalls, 47% used a jacket, while 87%2 of the farmers reported washing their contaminated clothes in the village stream after spraying. On the other hand, none of the respondents indicated that they eat or take alcohol during spraying. This suggests that farmers prefer simple and easy protective measures but avoid those that are laborious and require special equipment. Focus group discussion also revealed that lack of appropriate safety equipment due to the hot weather was the main reason why farmers do not use PPE. The focus group discussion identified two barriers to the use of PPE among farmers in the tropics. The first barrier was related to hot weather, where farmers report that wearing PPE is challenging under hot weather as illustrated by this excerpt from the focus group discussion: *"It is too hot to wear all that; we cannot work like that."* The second reason why farmers do not use PPE is the recurring cost of the equipment, as illustrated by this excerpt from the focus group discussion: *"We do not want to spend money on masks and gloves every season."* The qualitative data provided

corroborates with the statistical analysis which showed that the use of PPE was protective against poisoning symptoms with Prevalence Rate Ratio of 1.3, 95% Confidence Interval: 1.0-1.6. The finding that most farmers use slippers to apply pesticide and wash their clothes in the village stream following spraying represents a major occupational hazard and a major hazard to the environment. Contaminated water from the streams is a major source of infection to the villagers who use the same water for domestic purposes [41, 42, 43].

4.9 Relationship Between Demographic Factors and Application Procedures

Pearson product-moment correlation (PPMC) analyses revealed significant positive associations between pesticide application procedures and age ($r = 0.357$, $p < 0.001$), household size ($r = 0.440$, $p < 0.001$), years of formal education ($r = 0.361$, $p < 0.001$), and farming experience ($r = 0.263$, $p = 0.001$). Sex, marital status, and farm size showed no significant relationships. These correlations suggest that older, more experienced farmers with larger households and higher education levels possess distinct, and potentially more entrenched, pesticide application procedures. While education might intuitively be expected to improve safety practices, in this context, it may correlate with longer exposure histories and more intensive farming practices. This aligns with findings that demographic and occupational history significantly influence pesticide-handling practices and subsequent risk perceptions in African farming communities [40].

5. Conclusion and Recommendation

The negative effects of pesticides have been well reported. However, there is often a lack of awareness about occupational and environmental safety measures when handling such chemicals. In this regard, the present study was conducted among farmers in Surulere Local Government Area, Oyo State, to determine their level of knowledge and practices on pesticide safety. The results indicate that many farmers lack knowledge about pesticides and engage in unsafe practices when handling the chemicals. In particular, the study identified unsafe handling practices, including the improper use of personal protective equipment, unsafe storage and disposal of empty pesticide containers, and a general lack of safety precautions.

Therefore, there is a need to develop safety education and certification programs for farmers to address the identified issues. Such programs should cover health and environmental hazards, safe storage and disposal, risk reduction, and relevant laws. Moreover, to ensure that farmers have access to adequate information about pesticides, their dealers should receive appropriate training. Lastly, regulatory agencies should be formed to monitor pesticide sales and farmers' activities at

the local level. The authorities should restrict the importation, sale, and use of highly hazardous pesticides.

Declarations:

Competing interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported

Funding: The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Clinical Number: Not Applicable

Data Availability Statement: The datasets generated during the current study are available in the Zenodo repository https://zenodo.org/records/22271942)

Ethical Approval (Human Studies)

This Study was Reviewed and approved by Department of Crop and Environmental Protection and Ladoke Akintola University of Technology Teaching Hospital, under protocol/approval number **LTH/OGB/EC/2023/554**. All Procedures involving human participant for questionnaire were conducted in accordance with the ethical standards of the institution.

Accordance / Ethical Guidelines Statement

The study was conducted in accordance with the Declaration of Helsinki and applicable Nigerian National Research Ethics guidelines (National Health Research Ethics Committee of Nigeria, NHREC). Ethical approval was granted by Ladoke Akintola University of Technology Teaching Hospital, under protocol/approval number **LTH/OGB/EC/2023/554**

Consent to publish

Not Applicable, study was a questionnaire with no identifiable individual data (no case reports, photos that could identify someone and under 18 years were not participated.

Consent to participate

Informed consent was obtained from all participants prior to their participation in the study. Participants were informed of the study's purpose and voluntarily consented to complete the questionnaire, also under 18 years were not included in this study.

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