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KNOWLEDGE LEVELS OF ENVIRONMENTAL EFFECTS OF PESTICIDES USAGE AMONG SMALLHOLDER FARMERS IN ETSAKO WEST LG.A, EDO STATE, NIGERIA

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ABSTRACT

The study evaluated the level of awareness of the risk of pesticide use on the environment in Edo North. The study was conducted among 400 farmers from twenty (20) villages in Etsako West Local Government Area of Edo State, Nigeria. Most frequently used pesticides were within the WHO class II pesticides (moderately toxic), which are considered as moderately hazardous. A few cases of highly toxic (DDVP 1000G/L EC) were reported. There was no report of DDT and Endosulfan which have been banned globally or have restricted use under the Stockholm Convention. Major drivers of pesticides purchase was affordability (50.8%). Irrespective of age, majority of the sampled farmers do not read pesticides labels before use, while farmers with no formal education (67.1%), reported they don't read pesticides labels. More, so farmers with less than 5years farming experience (76.3%) also do not read labels before use. Reliance on the success stories of co-farmers and lack of clarity of information on pesticides labels were major reasons for not reading pesticides labels. Generally, farmers' level of awareness of environmental effects of pesticides uses does not significantly depend on the age, educational background and years of farming experience at $\rho > 0.05$, $d = 0.24$), ($\rho > 0.05$, $d = 0.29$) ($\rho > 0.05$, $d = 0.28$) respectively, an indication that farmers don't just like to read labels as long as the pesticides is effective. Detailed information on the knowledge and awareness of environmental risks associated with pesticide use among farmers is essential towards policy making for reducing the risk to the environment.

Keywords: Pesticide usage, smallholder farmers, environmental effects, farming operations

INTRODUCTION

Pesticides application on crops is not an uncommon practice among farmers in Nigeria. It is indispensable because it protects crops against damage and help to increase crop yield (Mahmood *et al*., 2016). Nigeria is noted to import 135 pesticide compounds resulting to roughly 15,000 metric tons of pesticides per year (Erhunmwunse *et al.*, 2012). Although the use of pesticides has been vital in agriculture as it helps to boost crop productivity and invariably food security, their uses have created huge environmental concerns (Sang *et al.*, 2022). About 584 tonnes of the approximately 147,446 tonnes of pesticides imported into Nigeria for agricultural usage in 2018 were reportedly dangerous (FAOSTAT, 2020). There has been lack of appropriate regulation as regards pesticides application, and their presence in food has also raised concerns across the globe (Čuš *et al.*, 2022) as their usage have implications for surface and groundwater quality (Erhunmwunse *et al.*, 2012). Osibanjo and Aiyejuyo (1995) for example showed evidence of underground water pollution by some pesticides in Nigeria. Their study shows that total DDT and heptachlor found in Ibadan ground water exceeded the WHO limits for these chemicals in drinking water. Similarly, Okeniyia *et al* (1999) investigated the levels of organochlorine and polychlorinated residues in some rivers in the northern part of Nigeria. The study found that high concentrations of organochlorine and polychlorinated pesticides in the water sample were as a result of the extensive use of Lindane in fishing and Aldrin in cultivated farmland. Aikpokpodion *et al.* (2010), also revealed that the application of Endosulfan-35EC significantly increased the acidity, magnesium and iron content of the soil samples, reduced the concentration of calcium, potassium and sodium in the treated soils in parts of Ibadan, Nigeria. An average of 3.91ng/g soil of Endosulfan was present as residue in the soil, six months after application. There was 85% population reduction of nematode as a result of Endosulfan application. Hazards emanating during the application of pesticides are majorly as a result of lack of information, knowledge and awareness, poor legislation and sales by unregistered vendors in the open market (World Health Organisation, 1990). More so, inappropriate handling and ignorance by farmers, further complicates pesticide usage (Jallow *et al.*, 2017). Smallholders farmers' is usually a big concern as majority of them are ignorant and not likely to avoid risks associated with pesticides applications (Mengistie *et al.*, 2017), compared to larger-scale farmers (Williamson *et al.*, 2008). Several studies on knowledge awareness of smallholder farmer's pesticides use had shown that unsafe use of pesticides is prevalent in developing countries (Damte and Tabor, 2015; Mengistie *et al.*, 2017). Studies on pesticides in Nigeria mainly focused on usage implications on human health (Ojo, 2016; Oshatunberu *et al.*, 2023) and environment (Olalekan *et al.*, 2019; Raimi, *et al.*, 2022). In this study, we specifically focused on farmers' general awareness on pesticide usage. This takes into consideration different pesticides used, frequency of usage, drivers of pesticides use and predominant crops of usage, understanding pesticides label before use, Knowledge of environmental impact of pesticides use, handling, storage and disposal of used cans. This general awareness provides vital information that can contribute to educational and regulation recommendations aimed at curbing its health and environmental implications. Hence, the aim of this study is to determine the knowledge levels of environmental effects of pesticides usage among smallholder farmers in parts of Edo North, Edo state, Nigeria.

MATERIALS AND METHODS

Research Design: The study adopted an exploratory research design, which was suitable for investigating a phenomenon with little or no in-depth previous research. This design allowed the researcher to gather preliminary data, identify problems, and develop hypotheses. The study also adopted a cross-sectional design, which enabled the researcher to collect data at a single point in time.

Population of the Study: The population of the study was smallholder farmers in Etsako West Local Government Area, Edo State. The population was selected based on their occupation as smallholder farmers. This study is known for agriculture at small scale and where the use of pesticide is a common practice.

Sample Size: The sample size was determined using the formula for calculating sample size when population of target study is not known (Shete *et al.*, 2020). The formula is:

n = (Z^2 x P(1-P))/D^2

Where:

n = sample size Z = standard normal deviation at 95% confidence level (1.96) P = proportion of population estimated to have knowledge, perception, and usage of pesticides (For the purpose of this study, 50% is our target) D = margin of error (5%).

Using the formula, the sample size was:

n = (1.96^2 x 0.5 x 0.5) / (0.05^2) n = 384

Though the calculated sample size is 384 smallholder farmers, for the purpose of increasing the representativeness of the population, the sample size was increased to 400 per town. Hence 400 questionnaire was purposively distributed in the 20 farming villages (Fig. 1&Table 1). Purposive sampling technique is a sampling technique where specific respondents were selected to collect specific information out of the data. In this case the target population is smallholder farmers with previous knowledge of pesticides application. The respondents were required to meet certain criteria for the objectives of this study involving the pesticide usage.

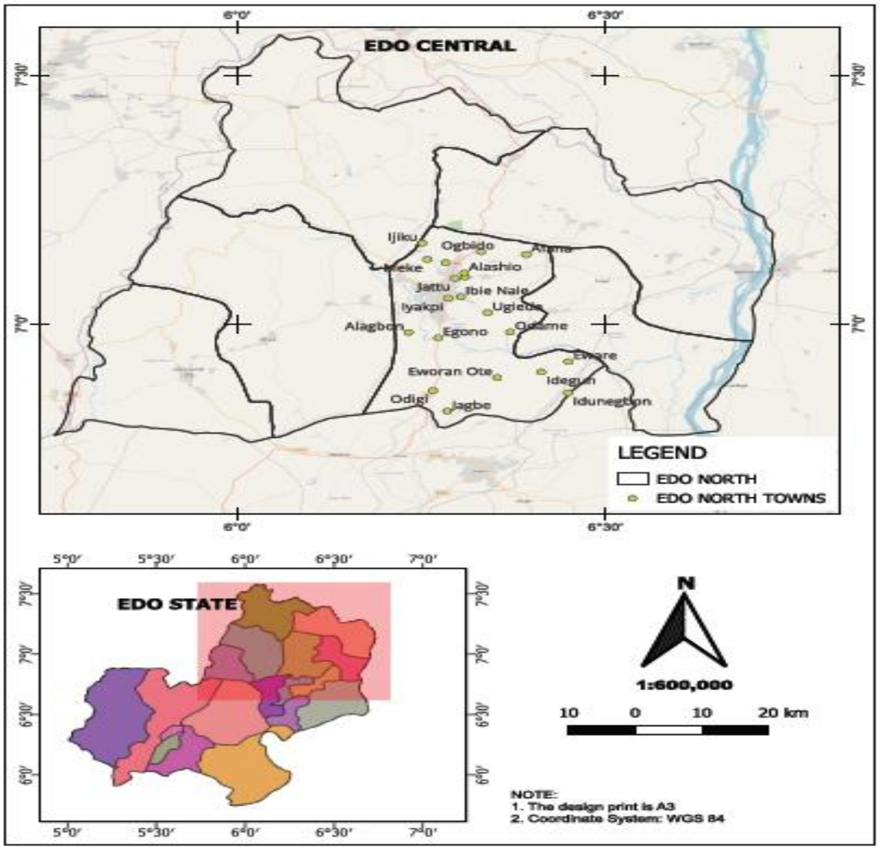

Fig. 1: Edo State, showing the Study area

Table 1: Villages/Quarters Surveyed in Edo North, Edo State

	Community/Quarter	Number of questionnaire distributed	% of questionnaire successfully filed and retrieved
1	Ijiku	20	100
2	Ogbido	20	100
3	Meke	20	100
4	Awa	20	100
5	Jattu	20	100
6	Ikpe	20	100
7	IbieNale	20	100
8	Alashio	20	100
9	Iyakpi	20	100
10	Afana	20	100
11	Ugieda	20	100
12	Alagbon	20	100
13	Odame	20	100
14	Eware	20	100
15	Idegun	20	100
16	EworanOte	20	100
17	Odigi	20	100
18	Jagbe	20	100
19	Idunegbon	20	100
20	Egono	20	100
	Total	**400**	

The questionnaire was divided into three sections, Parts A, B, and C. Part A included questions related to socio-demographic information such as farmer's gender, age, educational level, predominant crop cultivation, duration of farming experience, average annual income from farm produce etc. Part B is a question related to their knowledge of pesticides including common types of pesticides used by farmers, What factor informs your choice of the pesticide type, crops for which pesticides are used, sources of information on pesticides, pesticide use practices and safety management of pesticides, while Part C is a question about their awareness/knowledge on the environmental effects pesticide usage. Respondents were asked to select the correct and appropriate answers for the questions on knowledge and awareness of environmental impacts of pesticides usage.

Statistical Analysis: The data were prearranged and entered in the MS-Excel spreadsheet and then analyzed using Statistical Package for the Social Sciences (SPSS) version 20. Chi-square test was applied to test for probable associations between variables. The results were presented in frequencies, and percentages for specific variables, and as mean ± SD for continuous variables. The significance levels were set at $P \leq 0.05$.

RESULTS AND DISCUSSION

Respondent's Socio-demographic Profiles

The results for the respondents' socio-demographic survey (Table 2) showed that the majority of the farmers were male with 248 individuals (62.0%), while 152 individuals were female (38.0%). This is expected as the study area is a patriarchal and Muslim dominated society where the male population pride themselves as head and household providers. Similar finding has been reported by Waichman *et al.*, (2007) in Brazilian Amazon, with male population dominating farming activities by 97.4%. The majority of the farmers were within the age bracket 31 years - 40years (40%), followed by farmers within the age bracket of 41 years to 50 years (29.5%). The fact that the population aged farmers (61yeras >) declined is also expected owing to aging process and in most cases due to chromic sickness especially back pain as associated with aging. Mengistie *et al.* (2017). Similar finding was reported by Mergia *et al.*, (2021) in Ethiopia. Tang and MacLeod (2006) also found that older workers are, on average, less productive than younger workers and that labor force aging has a modest negative direct impact on productivity growth in Canada. Generally, the active workforce, 228 (57%) are married with families, while the remaining 134 (33.5%) are either single or never married. Divorced population both males and females constituted 38 (9.5%) of the sampled population. Meanwhile, the educational level of sampled farmers showed that majority of farmers are first school leaving certificate holders (35%), while those not having formal education were 100 (25%). Farmers with secondary school education were 80 (20%). A total of 59 (14.9%) of the sampled farmers are graduates from universities and polytechnics, while only 5.3%, acquired additional postgraduates degrees and/or diplomas. The educational qualification of sampled farmers has implications for modern agriculture practice, especially with respect to pesticides applications. For example Khan *et al.*, (2015), shows that farmers' awareness of the effects of pesticides usage is often influenced by socio-economic characteristics, such as formal education and level of technical knowledge regarding pesticide use. With respect to years of farming experience, 49.5% of sampled farmers have six (6) to ten (10) experience, followed by farmers with over 10 years farming experience 29.8%. This is line with observation by Kaur and Garg, (2014) that in developing countries the use of pesticides have become an integral part of everyday farming, and play a major role in increasing agricultural productivity to meet the food demands of teeming population. The average income from farm produce per season showed that majority of sampled farmers records approximately ₦ 300,000 to 600,000per farming season with 214 individuals (53.5%), the second-highest income group being < ₦300,000 per season (37.5%). In Fig 2, it can be seen that predominant source of information to farmers on available pesticides is from co-farmers (48.5%). Similar trend was reported by Waichman et al. (2007) in Brazil and Nalwanga and Ssempebwa (2011) in Uganda. Their studies conclude that success stories on a particular type of pesticide by colleagues was the main source of pesticides information to farmers.

Table 2: Socio-demographic characteristics of the respondents

Variables	Frequency (n = 400)	Percentage
Gender		
Male	248	62.0
Female	152	38.0
Age group		
30 years and below	64	16
31 – 40 years	160	40
41 – 50 years	118	29.5
51 – 60 years	56	14.0
61 – 70 years	2	0.5
70 years and above	0	0
Marital status		
Married	228	57.0
Never married	134	33.5
Divorced	38	9.5
Highest educational qualification		
No formal Education	100	25
School Certificate	140	35
Secondary school	80	20
B.Sc./HND	59	14.8
Postgraduate qualifications	21	5.3
Mean income level per season		
Less than N300,000	150	37.5
N300,001 – N600,000	214	53.5
N600,001 – N999,000	36	9.0
Farming experience level		
< 5years	83	20.75
6-10years	198	49.5
10>	119	29.75
Pesticides usage (Years)		
< 5years	108	27
6-10years	116	29
10>	176	44
	400	100

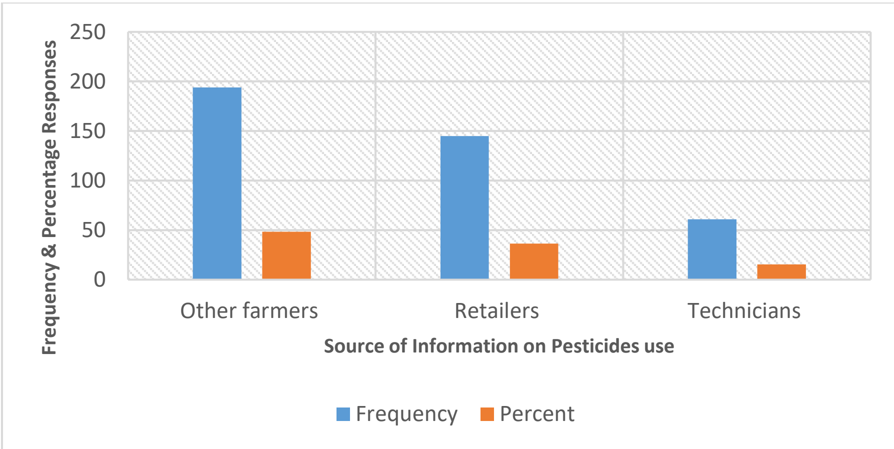

Fig. 2: Sources of information on pesticide use

Common Pesticide use by famers and frequency of usage

Lists of the types of pesticides commonly used by farmers in the study area are presented in Table 3. Most farmers reported using more than three pesticide types during one farming season and weed control herbicides in the case of cassava cultivation. They also reported that different pesticides serve different purposes, including pest control during farming season, pre-harvest and post-harvest spraying as most of the farmers interviewed believe that this strategy would conserve crops until delivery to the markets. What is of note is that some of the sample farmers still use Dichlorvos: DDVP 1000G/L EC which is considered highly toxic according to the WHO classification (WHO, 2019). Dichlorvos is considered high effective in pest control (Binukumar and Gill, 2010) as used in fish farming to eradicate *crustacean ectoparasites* (Varo *et al.*, 2003), and this might suggest the reason why some farmers still use it despite its toxic nature. This has implications for public health and the environment when comes in contact with soil, water body of found in crops. Of all the pesticides used by farmers, Best Cypermethrin 10% EC is considered most effective for pest control. A total of 15.5% farmers reported using Best, which according to the WHO classification is considered moderately toxic. This is followed by Attacke (13.8%), NOPEST (13.5%), DDForce (10.5%). Few cases of class Ib (highly toxic) were reported (Dichlorvos: DDVP 1000G/L EC) in the study area. In studies by Oesterlund *et al.* (2014) in Uganda and Waichman *et al.,* (2007) in Brazil, similar findings were reported. Though, class II pesticides may still classified as moderately hazardous and they are known to have an extremely negative impact on human wellbeing and the environment due to overuse and misuse. There was no report of DDT and Endosulfan which have been banned or have restricted use globally under the Stockholm Convention, unlike findings of Negatu *et al.,* (2016), around the Rift Valley Region in Ethiopia, DDT and Endosulfan were reported to be used by small-scale irrigated farmers, and Mengstie *et al.*, (2015) in Ethiopia around Meki and Ziway were vegetable farmers reported the use of banned pesticides (DDT). Force up glyphosate herbicides (1.5%) was rare used in weed control, as they reported that contact with crops could result to death. Instead farmers employ the services of labourers to clear their farms. In Fig 3, frequency of pesticide usage are presented. Sampled farmers indicate that within each farming season, the probability of application is between once in two months (31%) and on monthly basis (28%) depending on the severity of pest attacks and . Other farmers also responded to applying pesticides fortnightly (24.5%). On the whole, the application depends on attack and farmer's perception that the pesticide will preserve the crops until delivery to the markets. According to sampled farmers, some of the pests for which pesticides are used were beetles, army worms and aphids. While beetles and aphids affect most vegetables during vegetative growth, army worms attack crops right from vegetative growth through harvesting. Worm infestation is most damaging during fruiting (Aniah *et al.,* 2021). Furthermore, some of the sampled farmers reported that when a pesticide is not effective for a given pest, the product is replaced by a 'stronger product' of high toxicity, disregarding whether the new product is appropriate for a given crop or not. Similar observation was also reported by Waichman *et al.,* (2007).

Table 3: Use (%) of different pesticides/herbicide used by farmers in Edo north, Edo State

Pesticides	Active Ingredient(s)	WHO Classification	Frequency of use (n= 400)	% of use
Best	Cypermethrin 10% EC	II	62	15.5
Attacke	Lambda-Cyhalothrin	II	55	13.75
Perfect Killer	Chlorpyriphos 20% EC	II	38	9.5
DD Force	Dichlorvos:DDVP 1000G/L EC	1b	42	10.5
Sniper	DichlorvosDDVP 1000 EC	Ib	54	13.5
NOPEST	Dichlorvos 1000EC	Ib	26	6.5
Marshal	Lambda-Cyhalothrin 2.5%	II	18	4.5
DB BX Force	DichlorvosDDVP 1000 EC	Ib	14	3.5
Rocket	Chlorpyriphos 20% EC	II	18	4.5
Avesthrin	Cypermethrin 10% EC	II	12	3.0
chloview	Cypermethrin 20% EC	II	10	2.5
Cypeforce	Cypermethrin 10% EC	II	16	4.0
Rainbow	Chlorpyriphos 480g/L EC	II	13	3.25
Piriforce	Chlorpyriphos 480 EC	II	7	1.75
Syrux	Imidacloprid	II	9	2.25
Assail	Forece-up glyphosate	II	6	1.5

DDVP:-Dichlorovinyl dimethyl phosphate; EC: Emulsifiable Concentrate; 1a, extremely hazardous; Ib, highly toxic; II, moderately toxic; III, slightly toxic; U, unlikely to present acute hazard in normal use (WHO., 2019).

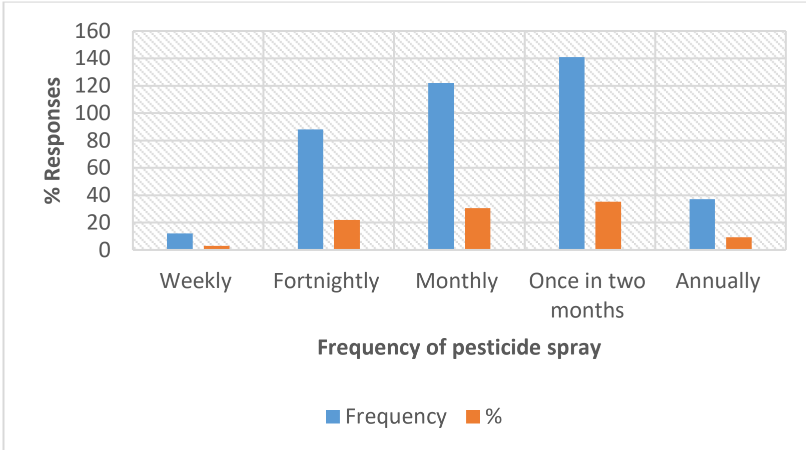

Fig. 3: Frequency of pesticide application in Edo north, Edo State

Drivers of pesticides use and predominant crops of usage

In Table 4, the drivers of the choice of pesticides and the predominant crops which farmers use pesticides on are presented. Affordability and efficacy of pesticides were the main drivers of pesticides types, with 203 (50.8%) and 187 (46.8%) responses respectively. In a similar study, Hu (2020) found that farmers pay relatively low costs for pesticides and reap all of the benefits in terms of immediate yield increases, while the long-term costs of damage to health and environment are borne by society at large. Poverty among sampled farmers might also drivers of pesticides choice. Sampled farmers indicated that they apply pesticides mostly on cassava 109 (27.3%), followed by maize (23.5%) and then groundnut (15.3%). Others include yam (14%), vegetables (13.3%) rice (5.3%), while tomatoes (fruit) was the least (1.5%).

Table 4: Drivers of pesticides usage types and some target crops in Edo north, Edo State

Variable	Frequency (n=400)	Percentage %
Drivers of pesticides type		
Affordability	203	50.75
Efficacy	187	46.75
Knowledge of minimal Environmental effects	10	2.5
Some Target Crops		
Cassava	109	27.3
Maize	94	23.5
Vegetables	53	13.3
Yam	56	14
Groundnut	61	15.3
Rice	21	5.3
Tomatoes	6	1.5

Farmers' understanding of pesticide labels before use

The pesticide label is one of the most important sources of pesticide information, providing all relevant information for the safe use of the pesticide leading to reduced environmental and health risk (Waichman, *et al*., 2007). Using age, educational background and years of farming experience, farmers were asked whether they read products labels or not before use, and if the answer was no, we asked why not. From those who indicated they do read labels before use, questions were further asked on whether they understood what they read or not. In Table 5, farmers between the age brackets 30years and below, don't read pesticides labels (64.8%), compared to the 35.2% of the same age bracket who read pesticides labels before use. In terms of educational status, majority of sampled farmers with no formal education or having basic education reported not to have read pesticides labels before application. Farmer's age and level of education are important to pesticide use control. Unfortunately, the active and young adult farmers in the study area do not read labels, and instead rely of the success stories from other farmers. These farmers also see no need to read label on the ground that they are either illiterates or that information on the labels are technical for comprehension. Unfortunately, even some educated farmers do not see reasons to read label before use, citing non clarity of information and having no need to read hence the pesticide of choice is effective. Similar observation was reported by Mengistie *et al.* (2017), Jallow *et al*., (2017); Aniah *et al.*, (2021) and Mergia *et al.,* (2021). Also, majority of farmers with less than 5years farming experience do not read labels before application, with a mean score of 76.3 as compared to the 23.7 of farmers with similar farming experience who read product labels before use. Although the mean values of farmers who do not read and those that read differed either by age, educational background and years of farming experience, these differences were not significant at $\rho > 0.05$, d = 0.05 for age of farmer who do not read labels and those that read labels compared), $\rho > 0.05$, d = 0.38 for educational status of farmer who do not read labels and those that read labels compared and $\rho > 0.05$, d = 0.21 for years of experience of farmer who do not read labels and those that read labels compared. The above trend is an indication that reading of pesticides labels and understanding the information about each type of pesticides has little or nothing to do with age, educational status and years of experience of farmers in the study area. Similar finding was reported by Waichman *et al*, (2007). In Fig. 4, most of the sampled farmers relied on the success stories of a particular pesticides (28%) before purchase, hence do not bother to read the products labels. In addition, lack of clarity of information on the products labels was reported by farmers, 26%, followed by the perception there is no reason to read label so long the product is effective for pest control. Damalas and Khan, (2016), also reported that the majority of farmers (73%) were not reading the instructions printed on bottles/containers of pesticides due to clarity of information of the label. The above findings is a great cause for concern, and perhaps portrays the general ignorance of the importance of reading pesticide labels for the purpose of reducing exposure to risk in the study area.

Table 5: % of farmers that read pesticides labels before use in Edo north, Edo State

Category	% of farmers that read label before use		*P-value*
	Do not read	Read Label before use	
Age of farmers			
30 years and below	64.8	35.2	$\rho > 0.05$, d = 0.05
31 – 40 years	56.2	43.8	
41 – 50 years	51.3	48.7	
51 – 60 years	57	43	
61 – 70 years	58.8	41.2	
70 years and above	62.1	37.9	
Educational background			
No formal Education	67.1	32.9	$\rho > 0.05$, d = 0.38
School Certificate	58.6	41.4	
Secondary school Cert	56.1	43.9	
B.Sc./HND	32.8	67.2	
Postgraduate qualifications	12.2	87.8	
Years of farming experience			
< 5years	76.3	23.7	$\rho > 0.05$, d = 0.21
6-10years	52.4	47.6	
10>	48.2	51.8	

Note: Difference is statistically significant at 0.05 level of confidence (one-tail)

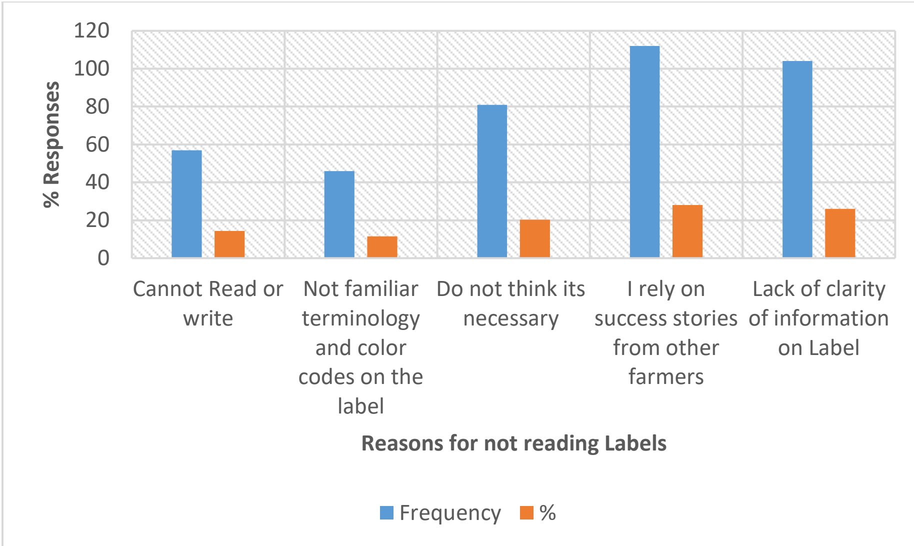

Fig. 4: Farmer's reasons for not reading pesticides labels before use

Pesticide usage handling among farmers

An important dimensions to environmental and public health safety that is critical in pesticides usage is the preservation and disposal of used pesticides cans. Methods of storage of pesticides and disposal practices are presented in Table 6. About 41.8% of the sampled farmers keep pesticides products inside their homes. This followed by farmers who kept unused pesticides in stores or food bans (27%). Others (23%) and (8.6%) store pesticides inside plantation fields and tools storage shacks respectively. The fact that majority of sampled farmers keep pesticide chemicals inside their homes can be traced to their poor level of awareness of the health effects of pesticides, and has implications for public health as children can be exposed to these chemicals, either through skin contact or ingestion. Farmers who reported discarding of their used pesticide cans alongside other household wastes were 30.5%. This might be attributed to the absent of waste sorting facility in most homes in Nigeria. Disposal into empty farmland was 24.5%, while burning of used plastic cans was 22%. Other disposal methods were burying of used cans inside pits and disposal into available water bodies, 19% and 4.0% respectively. The predominant storage and methods of disposing used pesticide cans have implications for water pollution. Children and adults can be exposed to pesticide through dermal contact or ingestion. Severe threat to human health, through multiple mechanisms, including dermal exposure, respiratory exposure and oral exposure, among others (Kim *et al.*, 2017; Rani *et al.*, 2021). Furthermore, pesticide can move into water bodies via point source and nonpoint source. For example, irrigation and rain also facilitate transportation of pesticides into ground/underground water especially those which are soluble in water (Sharma *et al.*, 2019). Studies have detected pesticides in surface water, groundwater, and drinking water (Klarich *et al.*, 2017; Dragon *et al.*, 2018).

Table 6: storage of pesticides is carried out and Disposal of empty packages

Variable	Frequency (=400)	%
Pesticides Storage		
Inside the Homes	167	41.8
Store or Food Ban	108	27
Inside Plantation Area	92	23
Tools Storage Shack	33	8.3
Disposal of empty cans after use		
Burned	88	22
Mix up with other HHW	122	30.5
Discharge into forest/empty land	98	24.5
Buried in pits	76	19
Discharge into water body	16	4.0

Influence of farmers socio-demographic factors on awareness levels

Although the mean values of farmers with knowledge of environmental effects of pesticides and those who are not aware differ either by age, educational background and years of farming experience, statistical differences were not established at $\rho > 0.05$, d = 0.24 (for age of farmer with knowledge of environmental effects of pesticides and those who are not aware compared), $\rho > 0.05$, d = 0.29 for educational status of farmer with knowledge of environmental effects of pesticides and those who are not aware and $\rho > 0.05$, d = 0.28 for years of experience of farmer with knowledge of environmental effects of pesticides and those who are not aware compared (Table 7). The above trend is an indication that knowledge of the environmental impacts of pesticides usage has little or nothing to do with age, educational status and years of experience of farmers in the study area.

Table 7: Relationship between Socio-economic variables and Famer's Level of Awareness in Edo north, Edo State

Category	% awareness on environmental impacts		*P-value*
	Not Aware of environmental impact of pesticides use	Aware of environmental impact of pesticides use	
Age of farmers			
30 years and below	58	42	
31 – 40 years	57.4	42.6	
41 – 50 years	61.5	38.5	$\rho > 0.05$, d = 0.24
51 – 60 years	45.7	54.3	
61 – 70 years	39.8	60.2	
70 years and above	32.8	67.2	
Mean	**49.2**	**50.8**	
Educational background			
No formal Education	61.5	38.5	
School Certificate	59.4	40.6	
Secondary School	56.2	43.8	
B.Sc./HND	29.3	70.7	$\rho > 0.05$, d = 0.29
Postgraduate qualifications	17.4	82.6	
Mean	**44.8**	**55.2**	
Years of farming experience			
< 5years	62.3	37.7	
6-10years	39.2	60.8	$\rho > 0.05$, d = 0.28
10>	27.6	72.4	
Mean	**43**	**56.9**	

Note: Difference is statistically significant at 0.05 level of confidence (one-tail)

CONCLUSION AND RECOMMENDATIONS

Intensive application of pesticides or poor handling and improper disposal can have negative effects on human health and environment. Hence the safety measures are key towards preventing these the detrimental effects of pesticide usage. In this study, the results show that middle-aged people are more engaged in farming activities than the youth, unfortunately most of whom do not read information on pesticides containers before application. Illiteracy and poverty are prevalent among farmers, and due to ignorance, they mainly rely on the advice of co-farmers on the effectiveness of each pesticide type and more so majority of samples farmers do not get information agriculture extension, unit of the state Ministry of Agriculture and Natural resources on biosafety measures. This is also seen in the driving factor of pesticide types. Handling and disposal of pesticides and used containers also buttressed the level of illiteracy among farmers. In view of the above, there is need for educational programmes (formal and informal) and training in pesticide usage (Biosafety) to assist farmers in enhancing their knowledge and skills, and to encourage them to adopt safety measures in the course of application, storage and disposal

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Author's Contributions:

Ogbomida E.T, Emeribe C.N, Aganmwonyi I, and Akukwe T.I, conceived and designed the study, developed the questionnaire, analyzed the data, and wrote the manuscript; Akinmoladun, A; Ehigiegba, T.A; Olatunji, B.O; and Ndem, P.A were responsible for data collection, data entry, and administrative support. Nwobodo, T.N and Eberechukwu Jennifer Eze participated in all parts of the work. All authors have read, reviewed and approved the final manuscript before submission.

References

Aikpokpodion, P. E. (2010). Nutrients Dynamics in Cocoa Soils, Leaf and Beans in Ondo State, Nigeria *Journal of Agricultural Science*, 1 (1): 1-9 DOI:10.1080/09766898.2010.11884647

Aniah, P.; Kaunza-Nu-Dem, M.K.; Dong-Uuro, P.P.; Ayembilla, J.A.; Osumanu, I.K.; (2021). Vegetable farmers' knowledge on pesticides use in Northwest Ghana. *Environment, Development and Sustainability* https://doi.org/10.1007/s10668-020-00916-6

Binukumar B.K, Amanjit B, Ramesh J.L, Kiran D.P (2010). Nigrostriatal Neuronal death following chronic dichlorvos exposure: crosstalk between mitochondrial impairments, α synuclein aggregation, oxidative damage and behavioral changes. *Mol Brain.* ;3:5.

Čuš, F.; Česnik, H. B.; Bolta, Š. V. (2022). Pesticide residues, copper and biogenic amines in conventional and organic wines. *Food Control*, 132, 108534. https://doi.org/10.1016/j.foodcont.2021.108534

Damalas, C.A.; Khan, M. (2016). Farmers' attitudes towards pesticide labels: Implications for personal and environmental safety. *International Journal of Pest Management*. 62, 319–325. DOI: 10.1080/09670874.2016.1195027

Damte, T.; Tabor, G. (2015). Small-scale vegetable producers' perception of pests and pesticide uses in East Shewa zone, Ethiopia. *International Journal of Pest Management*, *61*(3), 1–8. https://doi.org/10.1080/09670874.2015.1036822

Dragon, K.; Górski, J.; Kruć, R.; Drożdżyński, D.; Grischek, T.(2018). Removal of natural organic matter and organic micropollutants during riverbank filtration in Krajkowo, Poland. *Water* **10**, 1457. https://doi.org/10.3390/w10101457.

Erhunmwunse, N. O.; Dirisu, A.; Olomukoro, J.O. (2012). Implication of pesticide usage in Nigeria. *Tropical Fresh water Biology*, 21 (1) 15-25. http://www.ajol.info/index.php/tfb

FAOSTAT (2020). *Statistical Database*. Food and Agriculture Organization of the United Nations, Rome.

Hu, Z (2020). What Socio-Economic and Political Factors Lead to Global Pesticide Dependence? A Critical Review from a Social Science Perspective. *International Journal of Environment Resource and Public Health*. 3;17(21):8119. doi: 10.3390/ijerph17218119. PMID: 33153166; PMCID: PMC7663108

Jallow, M.F.; Awadh, D.G.; Albaho, M.S.; Devi, V.Y.; Thomas B.M. (2017). Pesticide Knowledge and Safety Practices among Farm Workers in Kuwait: Results of a Survey. *International Journal of Environmental Research and Public Health*, 14(4):340. doi: 10.3390/ijerph14040340. PMID: 28338612; PMCID: PMC5409541.

Kaur, H., and Garg, H. (2014). Pesticides: Environmental Impacts and Management Strategies. InTech. https://doi.org/10.5772/57399

Khan, M.; Mahmood, H.Z.; .Damalas, C.A. (2015), Pesticide use and risk perceptions among farmers in the cotton belt of Punjab, Pakistan, *Crop Protection*, 67:184-190, ISSN 0261-2194, https://doi.org/10.1016/j.cropro.2014.10.013.

Kim, K.H.; Kabir, E.; Jahan, S.A. (2017). Exposure to pesticides and the associated human health effects. *Science of Total Environment*, 575, 525–535. DOI: 10.1016/j.scitotenv.2016.09.009

Klarich, K. L., Pflug, N. C., DeWald, E. M., Hladik, M. L., Kolpin, D. W., Cwiertny, D. M., and LeFevre, G. H. (2017). Occurrence of neonicotinoid insecticides in finished drinking water and fate during drinking water treatment. *Environmental Science & Technology Letters*, *4*(5), 168-173.. https://doi.org/10.1021/acs.estlett.7b00081

Mahmood, I., Sameen, R. I., Kanwal, S., Alvina, G., & Khalid, R. H. (2016). Effects of Pesticides on Environment. In K. R. Hakeem et al. (Eds.), *Plant, Soil and Microbes* (pp. 253-269). Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-27455-3_13

Mengistie, B. T.; Mol, A. P.; Oosterveer, P. (2017). Pesticide use practices among smallholder vegetable farmers in Ethiopian Central Rift

Valley. *Environment, Development and Sustainability,* 19, 301-324. https://doi.org/10.1007/s10668-015-9728-9

Mengistie, B.T.; Mol, A.P.; Oosterveer, P.; Simane, B. (2015). Information, motivation, and resources: The missing elements in agricultural pesticide policy implementation in Ethiopia. *International Journal of Agricultural Sustainability*; 13(3): 240-256. https://doi.org/10.1080/14735903.2014.959330

Mergia, M.T.; Weldemariam ED, Eklo O.M, Yimer GT (2021). Small-scale Farmer Pesticide Knowledge and Practice and Impacts on the Environment and Human Health in Ethiopia. *Journal of Health Pollution*. 28; 11(30):210607. doi: 10.5696/2156-9614-11.30.210607. PMID: 34267994; PMCID: PMC8276729

Nalwanga, E.; Ssempebwa, J. C. (2011). Knowledge and practices of in-home pesticide use: a community survey in Uganda. *Journal of environmental and public health*. 2011; 2011 2011:230894. doi: 10.1155/2011/230894. Epub 2011 Jun 5. PMID: 21776435; PMCID: PMC3136098.

Negatu, B.; Kromhout, H.; Mekonnen, Y.; Vermeulen, R. (2016). Use of Chemical Pesticides in Ethiopia: A Cross-Sectional Comparative Study on Knowledge, Attitude, and Practice of Farmers and Farm Workers in Three Farming Systems. *Occupational. Hygiene*; 60(5): 551–566. https://doi.org/10.1093/annhyg/mew004

Oesterlund, A.H.; Thomsen, J.F.; Sekimpi, D.K.; Maziina, J.; Racheal, A.; Jørs, E. (2014). Pesticide knowledge, practice, and attitude and how it affects the health of small-scale farmers in Uganda: a cross-sectional study. *African Health Sciences*. 14(2):420-433. doi: 10.4314/ahs.v14i2.19. PMID: 25320593; PMCID: PMC4196420.

Ojo, J. (2016) Pesticides use and Health in Nigeria. *Ife Journal of Science* 18 (4); 986-991 https://www.ajol.info/index.php/ijs/article/viewFile/156080/145706

Okeniyia, S.O.; Egwaikhide, P.A.; Akporhonore, E.E; Obazee, I.E. (2009). Distribution of Organochlorine and polychlorinated pesticides residue in water bodies of some rivers in northern Nigeria. *Electronic journal of environment, Agriculture and Food Chemistry* 8, (11): 1269-1274 https://www.researchgate.net/publication/286203719

Olalekan, R.M, Omidiji, A.O.; Williams, E.A.; Christianah, M.B.; Modupe, O. (2019). The roles of all tiers of government and development partners in environmental conservation of natural resource: a case study in Nigeria. *MOJ Ecology & Environmental Sciences*; 4(3):114–121. DOI: 10.15406/mojes.2019.04.00142.

Oshatunberu, M. A., Oladimeji, A., Sawyerr, O. H., & Raimi, M. O. (2023). Searching for What You Can't See - Evaluation of Pesticide Residues in Grain Sold at Selected Markets of Southwest Nigeria. *Current Research in Public Health*, 3(1): 10-36. DOI: 10.31586/crph.2023.566

Osibanjo, O; Adeyeye, A. (1995). Organochlorine Pesticide Residue in NigeriaMarket. *Bulletin of Environmental Toxicology*. 54, 460-465. DOI: 10.1007/BF00195121

Raimi, M.O, Austin, A.I, Olawale, H.S.; Abiola, O.S; Abinotami, W.E.; Ruth, E.E.; Nimisingha, D.S.; Walter, B.O. (2022b). Leaving No One Behind: Impact of Soil Pollution on Biodiversity in the Global South: A Global Call for Action. In: Chibueze Izah, S. (eds) Biodiversity in Africa: Potentials, Threats and Conservation. *Sustainable Development and Biodiversity*, 29. Springer, Singapore. https://doi.org/10.1007/978-981-19-3326-4_8.

Rani, L.; Thapa, K.; Kanojia, N.; Sharma, N.; Singh, S.; Grewal, A.S.; Srivastav, A.L.; Kaushal, J. (2021). An extensive review on the consequences of chemical pesticides on human health and environment. *Journal of Clean Production*. 124657. https://doi.org/10.1016/j.jclepro.2020.124657.

Sang, C.; Yu, Z.; An, W.; Borgen Sørensen, P.; Jin, F.; Yang, M. (2022). Development of a data driven model to screen the priority control pesticides in drinking water based on health risk ranking and contribution rates. *Environment International*, 158, 106901. https://doi.org/10.1016/j.envint.2021.106901.

Shete A., Shete A.S., Dube S.P., Dubewar, A (2020): Sample size calculation in Bio statistics with special reference to unknown population *International Journal FOR Innovative Research in Multidisciplinary Field* 6 (7): 236-238

Sharma, A.; Kumar, V.; Shahzad, B.; Tanveer, M.; Sidhu, G.P.S.; Handa, N.; Kohli, S.K.; Yadav, P.; Bali, A.S.; Parihar, R.D.(2019): Worldwide pesticide usage and its impacts on ecosystem. *SN Applied. Science*., 10, 1446. https://doi.org/10.1007/s42452-019-1485-1

Tang, J.; MacLeod, C. (2006), "Labour force ageing and productivity performance in Canada," *Canadian Journal of Economics*, 39(2)582–

603. DOI: 10.1111/j.0008-4085.2006.00361.x · Source: RePEc

Varo I, Navarro J.C, Amat F, Guilhermino L (2003). Effects of dichlorvos on cholinesterase activity of the European sea bass (Dicentrarchus labrax . Pesticide Biochemistry and physiology.;75:61–72.

Waichman, A.V.; Eve, E.; da Silva, Nina, N.C (2007). Do farmers understand the information displayed on pesticide product labels? A key question to reduce pesticide exposure and risk of poisoning in the Brazilian Amazon. *Crop Protection*. 26(4): 576-583. https://doi.org/10.1016/j.cropro.2006.05.011

WHO (2019). The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification https://www.google.com.ng/url?sa=i&rct=j&q=&esrc=s&source=web&cd=&ved=0CAIQw7AJahcKEwjYxcLE_ZeAAxUAAAAAHQAAAAAQAg&url=https%3A%2F%2Fwww.fao.org%2Fpesticide-registration-toolkit%2Finformation-sources%2Fhazard-classifications%2Fen%2F&psig=AOvVaw10nnmCihfUmFXaD318UfP4&ust=1689760199652597&opi=89978449

Williamson, S., Ball, A., & Pretty, J. (2008). Trends in pesticide use and drivers for safer pest management in four African countries. *Crop Protection*, *27*, 1327–1334. https://doi.org/10.1016/j.cropro.2008.04.006

World Health Organisation (1990). *WHO recommended classification of pesticide by hazard and guidelines to classification 1990-1991*? Unpublished WHO document WHO/PCS/90.1. Available on request from: Division of Environment Health, WHO, 1211 Geneva 27, Switzerland