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Original Research Article

Knowledge and attitudes of safe agrochemical handling by users in Plateau State, Nigeria

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Agrochemical use has been increasing in both developing and the developed nations. The unsafe handling and use of agrochemicals can lead to accumulation of hazardous chemicals in the body, with resultant adverse effects on health. This quantitative cross sectional study sought to understand the knowledge and attitudes of agrochemical users towards safe chemical handling. Study was conducted among 260 farmers in Plateau State, Nigeria. Data on background knowledge and attitude of agrochemical users were collected using a structured paper based, interviewer-administered questionnaire. A Chi square test was used to assess the relationship between demographic characteristics and engagement in safe agrochemical handling showed a statistically significant relationship between marital status and engagement in safe agrochemical handling X^2 (2, N = 260) = 7.34, p <. 05 and level of education X^2 (4, N = 260) = 35.12, p <. 05. Results of Binary logistic regression indicated that the variable training on safe agrochemical handling with an odds ratio 8.31 was a good predictor for safe agrochemical handling. Descriptive statistical analysis revealed that the most practiced precautions by participants were washing work clothes separately (56.9%) and taking a shower soon after application of agrochemicals (53.6%). However, an important finding in this study however is the low level of adoption for the use of Personal Protective Equipment. Priority should be given to developing safety educational and certification programs for farmers with emphasis on the safe handling practices.

Key words: Safe handling, agrochemicals, health.

INTRODUCTION

Since the 1940s, agrochemical use has been increasing in both developing and developed nations (Saina et al., 2017). Their use has been linked to several health and environmental hazards for people, due to direct contact during application, pesticide drift from fields, or contamination of food or drinking water. Globally, there are significant health problems associated with the inappropriate handling of agrochemicals. On an annual basis, the European Union uses more than 200,000 tons of agrochemicals (FAOSTAT, 2015). Africa uses about 75,000-100,000 tons of agrochemicals, which is about 4% of the global agrochemical market (Alabi et al., 2014).

The unsafe handling and use of agrochemicals can lead to excessive exposures and accumulation of hazardous chemicals in the body; this accumulation can lead to adverse effects on health and different symptoms associated with these effects have been reported by agrochemical users (Ojo, 2016).

In Nigeria, agrochemicals are used for various agricultural services such as weed control, pest control, and improvement in farm produce; these are usually applied by farmers who have little or no knowledge regarding some of

the health implications of these chemicals (Ndaghu, 2017). The use of agrochemicals has helped with meeting the food needs of a growing global population for many countries, including Nigeria, because these chemicals eliminate various pests that prevent crop growth (Jaabiri Kamoun, 2018). While researchers have reported on various effects that agrochemicals have on different organs, little is known on the knowledge and attitudes of the agrochemical users regarding the safe handling of these chemicals.

Many organizations and individuals involved in agricultural activities in Nigeria do not pay much attention to safe chemical handling (Ågerstrand, 2017). Researchers have showed the importance of safe chemical handling for the prevention of chronic noncommunicable diseases (Ågerstrand, 2017) and injury (Anderson, 2015). Most agrochemical users and agricultural-based organizations do not understand the importance of safe chemical handling. A recent review of the literature revealed that the nature of the relationship between primary prevention activities and knowledge of chemical handling is unclear (Moradhaseli, 2017). The problem is that while the potential importance of safe handling of chemicals is known, in addition to the health issues resulting from the use of agrochemicals, nothing is known about the possible mechanisms through which attitudes and knowledge agrochemical handling can influence safe chemical handling. This work sought to understand the knowledge and attitudes of safe chemical handling by agrochemical users (i.e., farmers) in Plateau State, Nigeria.

MATERIALS AND METHODS

This study is quantitative. It described the knowledge, attitudes, and practices of agrochemical users in Plateau State on safe handling of agrochemicals. Plateau State is one of the states in the North-Central geopolitical zone of Nigeria with Jos town as its capital. The background knowledge of farmers and their practices (dependent variables) of safe handling of agrochemicals in relation with their demographic characteristics (independent variables) were assessed. The independent variables included age, gender, duration of agrochemical use, geographical location, educational level and average number of visits to a health facility for health issues related to agrochemical use. Other independent variables were prior training on safe agrochemical handling and the use of PPE.

This study used a cross-sectional study design because the study population was described based on both exposure and outcome measures simultaneously and the research questions required a single evaluation of the study population. The population of farmers for this study was defined as those engaged in agricultural (arable) farming excluding pastoral and mixed farming.

All the three senatorial zones of Plateau State were included in the study. Simple random sampling was used to select one LGAs each from the senatorial zones and the sample for this study was proportionately derived from the sample frame using the table of random numbers from the lists corresponding to the selected LGAs. Permission to access and use the list was sought from the relevant authorities in the State's Ministry of Agriculture.

Working with Raosoft sample size calculator (Raosoft Inc., 2004), with an estimated population of farmers in Plateau State as 150,000 while accepting a 5% random error, 95% confidence interval and 80% response distribution, the recommended minimum sample size was given as 246. Considering the need to accommodate unforeseen challenges with recruitment, questionnaire administration, collation, poor response, and possibly badly filled questionnaires, this figure was buffered to 260 farmers from Plateau State.

The list of selected farmers and their contact details was retrieved from the Plateau State Ministry of Agriculture. Farmers were located by contact tracing in each of the selected LGA from the senatorial zone of the state. The farmers were recruited with no personal identifiers except for the study identity numbers, which was indicated on each questionnaire to help identify farmers that had been visited.

This study was carried out using a structured paper based, interviewer-administered questionnaire. A modified survey instrument developed by Saina et al. (2017) was used for data collection. The questionnaire was pilot tested to ascertain its suitability for the local population of farmers in Plateau State. Analysis was done using the SPSS software version 23. Data generated was analyzed using various statistical analysis strategies such as; descriptive statistics, one-sample *t* test, independent sample *t* test, ANOVA, linear multiple regressions and binary logistic regression.

RESULTS

Our study shows that out of the 260 farmers enrolled in the study, 23 (8.8%) were less than 20 years, 50 (19.2%) were between the age group 21-30 years, while age groups 31-40, 41-50 and > 50 years had a total number of 77 (29.6%), 52 (20%) and 58 (22.3%) farmers respectively. Most of the farmers were males 192 (73.8%) while females were 68 (26.2%). In addition, a total of 199 (76.5%) were married, 55 (21.2%) were single, 1 (0.4%) was separated and 5 (1.9%) had lost their spouse. A total of 46 farmers (17.7%) had no formal education, 43 (16.5%) had elementary school education, 101 (38.8%) had secondary school education, 51 (19.6%) had attended tertiary institution for obtaining a first degree while 19 (7.3%) had postgraduate degree. The farmers involved in the study had varying years of experience in the use of agrochemicals, 78 (30%) had <10 years' experience with agrochemicals, 85 (32.7%) had between 11-20 years experience while 51 (19.6%) and 25 (9.6%) had between 21-30 and 31-40 years experience in the use of agrochemicals as shown in Table 1.

The results from Chi square tests which addressed the relationship between engagement in the safe handling of

Table 1. Demographic Characteristics of Study Participants

Demographic characteristics	Frequency (N=260)	Percentage (%)
Age group		
≤20	23	8.8
21-30	50	19.2
31-40	77	29.6
41-50	52	20.0
>50	58	22.3
Gender		
Male	192	73.8
Female	68	26.2
Marital status		
Single	55	21.2
Married	199	76.5
Separated	1	0.4
Widow/widower	5	1.9
Educational level		
Non formal	46	17.7
Elementary	43	16.5
Secondary	101	38.8
Tertiary	51	19.6
Post graduate	19	7.3
Years of experience as a farmer		
≤10	78	30.0
11-20	85	32.7
21-30	51	19.6
31-40	25	9.6
>40	21	8.1

agrochemicals and the demographic characteristics of farmers that use agrochemicals for independence show that 156 (81.3%) of male farmers engaged in safe agrochemical use while 57 (83.8%) female farmers engaged in safe agrochemical handling (p = 0.636). On the other hand, 22 (95.7%) of farmers that were less than 20 years engaged in safe agrochemical handling while those older than 50 years had the highest number of farmers who did not engage in safe agrochemical handling 13 (22.4%) with p = 0.412. Based on the marital status of the farmers, 51 (92.7%) of the farmers that were single engaged in the safe handling of agrochemicals while 4 (7.3%) of the farmers that were not married did not engage in safe handling of agrochemicals. This work also revealed that 156 (78.4%) of married farmers were engaged in safe agrochemical handling when compared with 43 (21.6%) that were not engaged in safe agrochemical handling (p = 0.026).

There was a statistically significant relationship between marital status and engagement in safe agrochemical handling X^2 (2, N = 260) = 7.34, p <. 05 and level of education X^2 (4, N = 260) = 35.12, p <. 05. However, there was no statistically significant relationship between engagement in safe agrochemical handling and gender X^2 (1, N = 260) = 0.225, p > .05, age group X^2 (4, N = 260) = 3.959, p > .05, professional training as a farmer X^2 (1, N = 260) = 0.046, p < .05 and training on the use of agrochemicals X^2 (1, N = 260) = 0.885, p > .05 respectively as shown in training on the use of agrochemicals as shown in Table 2.

A multiple regression analysis was carried out to evaluate the relationship between the following demographic characteristics: age, gender, marital status, years of experience as a farmer, educational level, training on agrochemical use and senatorial zone as a predictor of attitude towards safe agrochemical handling. The results of the regression indicated that the model explained 7.4% of the variance and that the model was a significant predictor of attitude towards safe agrochemical handling, F (7, 252) = 2.873, p = .007. While gender and senatorial zone contributed significantly to the model (B = .13, p <. 05 and B= .07, p < .05), age, marital status, years of experience, educational level and training on the use of agrochemicals did not Table 3.

Binary logistic regression was performed to predict the impact of a number of factors on the likelihood that farmers will be aware of safe agrochemical handling. The model contained three independent variables (gender, training as a farmer and training on the safe use of agrochemicals). The full model containing all predictors was statistically significant, X^2 (3, N = 260) = 16.14, p <. 05, indicating that the model was able to distinguish between farmers who reported that they knew and did not know about safe agrochemical handling. The model as a whole explained between 6% (Cox and Snell R square) and 13.1% (Nagelkerke R squared) of the variance agrochemical safe handling awareness, and correctly classified 90.8% of cases.

Table 2. Relationship between Individual and Professional Characteristics and Engagement in the Safe Handling of Agrochemicals among Farmers

Demographic Characteristics	Engagement in the safe handling of agrochemicals		X^2	Df	P
	Yes	No			
Gender					
Male	156 (81.3)	36 (18.8)	0.225	1	0.636
Female	57 (83.8)	11(16.2)			
Age group					
≤20	22 (95.7)	1 (4.3)	3.959	4	0.412
21-30	42 (84.0)	8 (16.0)			
31-40	62 (80.5)	15 (19.5)			
41-50	42(80.8)	10 (19.2)			
>50	45 (77.6)	13 (22.4)			
Marital status					
Single	51 (92.7)	4 (7.3)	7.335	2	0.026
Married	156 (78.4)	43 (21.6)			
Others	6 (100.0)	0 (0.0)			
Educational level					
Non formal	24 (52.2)	22 (47.8)	35.121	4	0.000
Elementary	38 (88.4)	5 (11.6)			
Secondary	86 (85.1)	15 (14.9)			
Tertiary	47 (92.2)	4 (7.8)			
Postgraduate	18 (94.7)	1 (5.3)			
Professional training as farmer					
Yes	87 (81.3)	20 (18.7)	0.046	1	0.829
No	126(82.4)	27(17.6)			
Trained on use of agrochemicals					
Yes	93 (84.5)	17 (15.5)	0.885	1	0.347
No	120 (80.0)	30 (20.0)			

As shown in Table 4, only one of the independent variables made a statistically significant contribution to the model (Training on safe handling of agrochemicals) with an odds ratio of 8.31. This indicated that farmers who had undergone safety in handling of agrochemicals were over 8 times more likely to be current with safe handling of agrochemicals when compared to those who were not aware (Table 4).

DISCUSSION AND CONCLUSION

Safe agrochemical handling is of importance to both users of agrochemicals and the community, bearing in mind the reported public health issues that may arise from its unsafe use (Saina et al., 2017). Education, awareness, and training of agrochemical users on safe handling can provide measures for the prevention of some of the public health issues. In Nigeria, health issues associated with agrochemical use are particularly concerning because of the high mortality rate (10,000 people/year) reported among agrochemical users (Jeyaratnam, 1990), This is despite the fact that only a few of the global agrochemicals are used in Nigeria. The high mortality has been attributed to several factors such as the use of the cheap and lethal agrochemicals in this environment and unnecessary exposure to these chemicals while applying them (Erhunmwunse et al., 2012; McConnell and Hruska, 1993; Ojo, 2016; PECAN, 2013).

Many types of research have been conducted in locations where highly mechanized agricultural tools, such as planes or tractors, were used and the findings then applied to countries like Nigeria, were these agrochemicals are applied manually (McConnell and Hruska, 1993).

Findings from this study suggest that majority of agrochemical users are between ages 30-40 years. This was also the case in Kenya as reported by Saina, et al, 2017. The use of agrochemicals by young farmers may be related to the fact that they are usually more active and energetic making adaptation to farming easy. Additionally, the rise in the younger population may also be attributed to the non availability of jobs in Nigeria, which now leads more of the younger ones to seek ways of generating income. The Nigerian government has also emphasized agriculture as a means for improving the economy of the land. This work also revealed that majority of the farmers were males who were married, which is similar to the study carried out by Ndaghu et al. (2017) in Adamawa state (another state in Nigeria) among farmers and reported a high number of male farmers compared to female farmers. This suggests that males may have a greater contribution to farming activities. The finding of more farmers with secondary

Table 3. Relationship between Demographic Characteristics of Farmers and Attitude Towards Agrochemical Handling

Model	Coefficient			*T*	*P*	95% CI of B	
	Unstandardized		Standardized			LL	UL
	Beta	SE	*Beta* (β)				
(Constant)	4.345	.176		24.723	.000	3.999	4.691
Age in yrs.	-.003	.002	-.121	-1.348	.179	-.008	.001
Gender	.126	.054	.148	2.330	.021	.020	.233
Marital status	-.049	.041	-.080	-1.187	.237	-.131	.032
Years of experience as a farmer	.000	.002	.017	.200	.842	-.004	.005
Educational level	.006	.021	.020	.297	.767	-.036	.049
Have you been trained on the use of agrochemicals?	-.065	.050	-.086	-1.293	.197	-.164	.034
Senatorial zone	.073	.028	.159	2.594	.010	.018	.129

Note. SE = Standard Error. * $p < .05$; LL = Lower level, UL = Upper Level

Table 4. Relationship between Gender, Training on Agrochemical Use and Professional Training on Awareness of Safe Agrochemical Handling

							95% CI of e^B	
							LL	UL
	B	**SE**	**Wald**	**df**	***P***	e^B		
Gender	-.482	.509	.899	1	.343	.617	.228	1.674
Training on safe agrochemical use	2.117	.848	6.234	1	.013	8.306	1.576	43.768
Trained as a Professional farmers	.327	.653	.251	1	.616	1.387	.385	4.992
Constant	-4.013	.737	29.633	1	.000	.018		

Note. SE = Standard Error, LL = lower level, UL = upper levels and CI = confidence interval, e^B = Exponential of B

school education is however different from the work of Ndaghu et al. (2017) who reported more farmers with primary school certificate in the far North. This study also suggests that a vast number of the farmers had been involved with the use of agrochemical for between 11-20 years, which was the same as the work of Ndaghu et al. (2017).

Results of this study suggest that farmers in this environment had a good knowledge of the safe use of agrochemicals, as the majority of them were knowledgeable about the possible effects of these chemicals on health and environment. This was also the case for Saina et al. (2017) who carried out a similar study in Kenya and observed that majority of the farmers had a good knowledge of safe agrochemical handling which was attributable to participation in training courses taken by the farmers. The work of Moradhaseli et al. (2017) in Iran also supports the findings of good knowledge of safe agrochemical handling although his work reported some level of negligence by the farmers in applying the knowledge. Although this study reported good knowledge of safe agrochemical use, the work of Ndaghu et al. (2017) in Nigeria and that of Jallow et al. (2017) in Kuwait reported poor knowledge of safe agrochemical handling. In addition, Jallow et al. (2017) reported that majority of farmers in Kuwait knew that pesticides were harmful to health; however, the level of education of farmers regarding handling of pesticides was still very poor.

The high level of knowledge reported in my work may be attributable to the fact that majority of the farmers had reported they received training on the use of agrochemicals while working as farmers in Nigeria. In addition, having the knowledge of the names of different agrochemicals being used as reported in this work by 81.5% and 85.8% of farmers respectively suggests that farmers were knowledgeable and 67% of farmers read the instructions for each agrochemical before its use. This good knowledge reported in my work may also be due to the level of education of the farmers enrolled in this study as more than half: 38.8% and 19.9% had completed secondary and post graduate studies respectively.

Findings of this study will provide information necessary for public health organizations and regulatory agencies to make better-informed decisions and policy recommendations focused on preventing health and environmental hazards associated with the use of agrochemicals. The knowledge and practice gaps identified in this study could be used for designing knowledge-based training programs for farmers. Participation in training programs would lead to increased levels of knowledge about safety precautions while handling agrochemicals. It is necessary to have in place training programs that will help

the farmers practice safe agrochemical handling and the use of PPE. In addition, the Ministry of Health could play a key role in health monitoring of the farmers involved with the handling of agrochemical, which have been known for their toxicity to health. (Atreya et al., 2012; Li et al., 2014)

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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