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Potential Health Risks of Bio-systems Exposed to Restricted Aluminium Phosphide in Katsina State, Nigeria

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ABSTRACT

The study was carried out to assess the technical competence of handling agricultural pesticides among grain farmers in grain producing states in Nigeria. The study was conducted in Katsina State of Nigeria. Multistage sampling method was employed and four local government areas were selected for the study. The local government areas include Faskari, Funtua, Danja and Bakori. Fifty respondents were chosen at random from two villages in each local government area to make a total of 200 respondents in all. Information on the most commonly used maize preservative pesticides were obtained through structured questionnaires. The mean age of respondents ranged between 43-52%, majority of the respondents had little or no formal education. The most commonly used maize storage pesticide was aluminium phosphide (35-44%). Misuse of aluminium phosphide, a restricted pesticide in the study areas seems to be inevitable due to high level of illiteracy among the farmers.

INTRODUCTION

Pests are major agents which affect agricultural crops, which consequently raise the cost of livestock production, as well as threaten food security. In order to control or reduce the effect of agricultural pests, pesticides are used to combat the effects at pre-planting and post-harvest stage. Grains to be planted are treated with different classes of insecticides, fungicides etc. to ensure adequate germination and emergence. Food is a major sustenance for man but it could also contribute to human disease or health hazard if proper care is not taken into consideration.

Globally, pesticides contribute significantly in agricultural production, safer storage of food commodities and public health security. Some of the factors stressing food security include poverty, climate change, animal diseases, and plant pests. Maize grain losses in particular have been said to contribute to food insecurity and low farm income. The effect of post-harvest losses as one of the critical constraints to food security among farmers across Africa cannot be over-emphasised (Owusu, 2001; Owusu *et al*., 2007).

Insect pests are one of the major organisms that are responsible for reduction in quality, germination potential and quantity of maize grains/seeds in storage (Olakojo and Akinlosotu, 2004). Between 40 and 100% losses of agricultural produce had been reported without chemical treatment at household levels in Malawi (Denning *et al.,* 2009) while about 45% of the total production of rice and cocoa were lost without the use of pesticides (Tijani, 2006). However, the increase use of pesticides in crop protection results in increase possibility of feed/food contamination. When used, pesticides could contaminate the environment and accumulate in the food chain (Ogah and Coker, 2012), thereby posing a potential threat to human health as well as the environment when not properly used (Kishi, 2005).

More than 3 million people in developing countries have suffered severe acute pesticide poisoning (Larson, 2003; WHO, 2000), warranting the increasing concern about misuse of pesticides in such countries. Despite this increasing concern, few studies have been carried out on the subject to investigate pesticide sustainability (Oluwole and Cheke, 2009) as well as the potential effects this could have on bio-systems which are ignorantly or accidentally exposed to the pesticides or pesticide-treated foods. Hence, this study was designed to assess the types, sources, competence of handling as well as health risks posed on bio-systems as a result of pesticide use in Katsina State, Nigeria.

Data sources and sampling techniques

The study was carried out in Katsina State of Nigeria. Katsina is a state in the northern central of Nigeria. The largest inhabitants of the state are Hausa and Fulani people. There are 34 local government areas in the state. It is one of the states in Nigeria where crops are grown all year round, during the rainy season and along riverbanks and dams during the dry season. The state is currently leading in food production in crops such as cotton, groundnut, maize, guinea corn, rice etc. (www.katsinastate-lgac.com/history.html). The state was purposively selected due to the prevalence farming activities in the state. Four local government areas were randomly selected. The local government areas where the study was conducted are: Faskari, Funtua, Danja and Bakori. Two villages were randomly chosen from each local government areas. From the two villages selected, a total of 50 households were chosen, making the total sample size to be 200 households.

The survey was carried out with the use of a structured questionnaire, which administration process was participatory in nature. The interview was conducted for majority of the respondents in Hausa due to the high rate of illiteracy among the sampled respondents although the questionnaires were designed in English. Willingness of the majority of the respondents and the involvement of Hausa-speaking enumerators facilitated the success of the study. Each interview took about 20 minutes. The structured questionnaires were designed to collect information on demographic information, commonly used maize storage chemicals, frequency of use, level of education, attitude to chemical labels and challenges to the use of storage chemicals. In order to avoid being bias in response to the question being asked, the questionnaires used were design to avoid leading questions. For example, ‘what do you do with chemically-treated grains?’ was asked in order to find out whether the respondent sells, consumes or feeds chemically treated grains to animals immediately.

The data collected were analysed with the use of descriptive statistics including frequency, charts and percentages.

RESULTS AND DISCUSSION

Tables 1, 2 and 3 show demographic information of respondents, levels of education of respondents and commonly used maize preservative pesticides in the study areas respectively. Figure 1 show mode of storage of pesticide-treated grains in the study areas, while figures 2 and 3 show frequency of use of pesticides by respondents and consultation with changed agents for training of the use of pesticides respectively.

Table 1: Demographic information of respondents in the study areas

Local Government Areas	Mean Age (years)	Modal Age (years)	Male (%)	Female (%)
Faskari	48.00	42.00	92.86	7.14
Funtua	52.00	48.00	85.71	14.29
Danja	44.00	58.00	90.00	10.00
Bakori	43.00	53.00	80.00	20.00

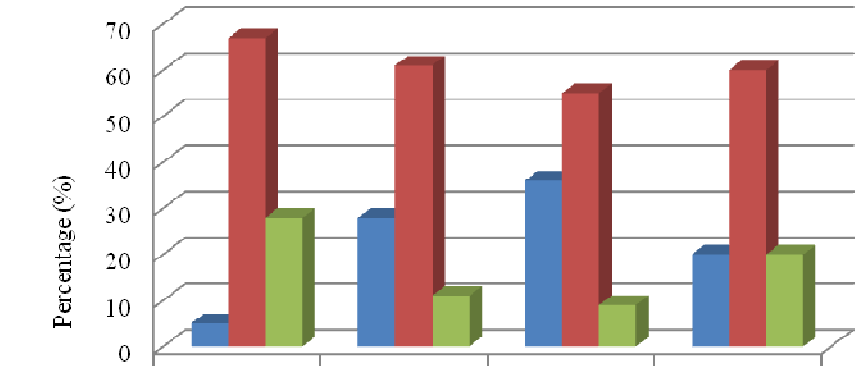
Table 2: Educational status of respondents in the study areas

Local Government Areas	No Formal Education (%)	Primary school education (%)	Secondary school education (%)	Quranic education (%)	Tertiary education (%)
Katsina					
Faskari	35	29	12	6	18
Funtua	14	36	29	0	21
Danja	27	27	27	9	9
Bakori	40	40	10	10	0

Table 3: Commonly used maize storage pesticides in Katsina State, Nigeria

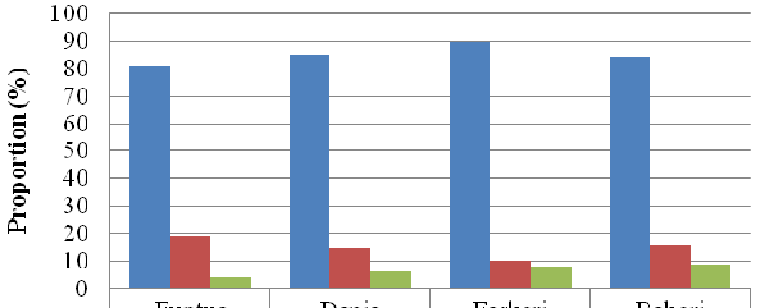
	Local Government Areas			
Storage pesticide	Funtua	Danja	Faskari	Bakori
Aluminum phosphide (%)	43	36	44	35
Pirimiphos methyl (%)	14	17	17	13
Pirimiphos methyl 25%EC (%)	19	4	14	9
Dichlorvos (%)	14	0	11	4
Aldrin (%)	0	0	0	0
Mefonoxam (%)	0	13	6	0
Permethrin (%)	5	9	0	17
Devec* (%)	0	4	8	13
Nil (%)	5	17	0	9
Unidentified (%)	0	0	0	0

*active ingredient not known



	Faskari	Funtua	Danja	Bakori
None	5	28	36	20
Frequently	67	61	55	60
Occasionally	28	11	9	20

Figure 1: Frequency of use of maize storage pesticides in Katsina State



	Funtua	Danja	Faskari	Bakori
At home in sacks	81	85	90	84
On the farm	19	15	10	16
Use/sell immediately	4	6	8	9

Figure 2: Mode of storage of pesticide-treated maize grains in Katisna State, Nigeria

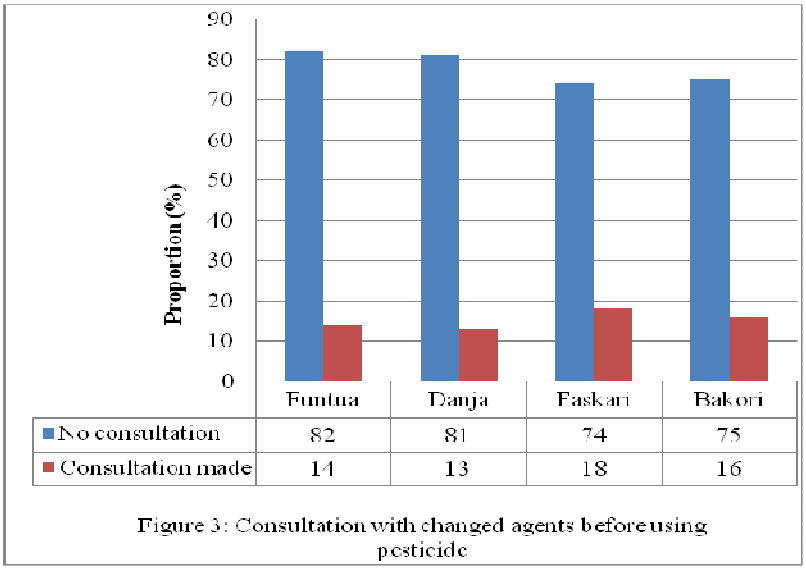


Figure 3: Consultation with changed agents before using pesticide

Faskari Local Government Area of Katsina State

92.86% of the respondents (maize farmers and traders) in the study area were male. The mean and modal ages for the respondents were 48 and 42 years respectively (Table 1). 35 percent of the respondents had no formal education, 29% had primary school education, 12% had secondary school education, while 6% and 18% had quaranic education and tertiary education respectively (Table 2). The most commonly used maize storage chemical was aluminium phosphide (44%), followed by pirimiphos methyl (17%), while the least used was mefonoxam (6%) (Table 3). 67 percent of the respondents were frequent users, 28% were occasional users, while 6% were non-users of maize storage chemicals (Figure 1).

Funtua Local Government Area of Katsina State

The mean and modal ages of the respondents were 52 and 48 years respectively while 85.71% of the respondents were male (Table 1). 14 percent of the respondents had no former education, 36% had primary school education, 29% had secondary school education, while 21% had tertiary education (Table 2) . The most commonly used maize storage chemical was aluminium phosphide (43%), followed by pirimiphos methyl 25%EC (19%), permethrin powder (5%) was the least used. (Table 3). 72% of the users of maize storage chemicals out of which 61% were frequent users, 11% were occasional users, while 28% were non-users (Figure 1).

Danja Local Government Area of Katsina State

Majority of the respondents were male (90.0%). The mean and modal ages for the respondents were 44 and 58 years respectively (Table 1). 27 percent of the respondents had no former education, 27% had primary school education, 9% had quaranic education, 27% also had secondary school education, while 9% had tertiary education (Table 2). In terms of frequency of use of maize storage chemicals, 55% were frequent users, 9% were occasional users, while 36% used none (Figure 1). 35% of the respondents used aluminium phosphide, 17% used pirimiphos methyl, while the least used maize storage chemical was Devec Ec (4%) (Table 3).

Bakori Local Government Area of Katsina State

The majority (80%) of the farmers and traders interviewed in Bakori Local Government Area were male. The mean and modal ages for the respondents were 43 and 53 years respectively (Table 1). 40% of the respondents had no former education, 40% had primary school education, 10% had quranic education, while 10% of the respondents also had secondary school, (Table 2). Aluminium phosphide (35%) was the most commonly used maize storage chemicals used by the respondents in the study area, followed by Devec Ec (13%) and pirimiphos methyl (13%) (Table 3). 60% of the respondents were frequent users of storage chemicals, 20% were occasional users, while 20% were non-users (Figure 1).

Hypothesis testing:

The result of the analysis of variance of types of pesticide used in the study areas presented in Table 4 indicated that F tab < F cal for the rows i.e. the type of pesticides used. Therefore, alternative hypothesis is accepted, i.e. there is significant difference in the types of pesticides used. However, for the column i.e., the local government areas, F tab > F cal, which implies that null hypothesis is accepted, i.e. no significant difference is observed in the local governments with respect to the type of pesticides used.

Table 4: Analysis of variance of types of pesticides used in the study areas

Source of Variation	*SS*	*df*	*MS*	*F*	*F crit*	Significance
Rows	1160.03	9.00	128.89	11.83	2.25*	
Columns	3.68	3.00	1.23	0.11	2.96NS	
Error	294.07	27.00	10.89			
Total	1457.78	39.00				

MS=mean square; SS= sum of square; df=degree of freedom, NS=not significant

The results of the study revealed that larger percentage of the maize farmers and traders in the study areas were male, with little or no formal education. Misuse of pesticides in the study areas was obvious as between 81-90% of the respondents stay together in the same residential building with pesticide-treated grains inside perforated sacks. Food poisoning and exposure through inhalation may not be curtailed in such situation. One major factor contributing to this misuse is ignorance. Most of the illiterate farmers/traders could not read the instruction on the labels of the pesticide, and they did not see reason to consult with an extension agent for guide. Education indeed plays a major role in agricultural development as well as food security of developing nations.

Agriculture can really not thrive in developing countries in the hands of illiterate farmers. The result of this study is similar to what was obtained in Kaduna State and Kano State, Nigeria (Adejumo *et al*., 2014a; Adejumo *et al.,* 2014b). Okoedo-Okojie and Onomolease (2009) also earlier reported that education has a significant role to play on the promotion, transfer, and adoption of knowledge that boost agriculture. However, misuse of pesticides is not limited to only pesticide applicators, as respondents indicated adulteration of chemicals as one major constraint to their use of pesticides.

Proper awareness of harmful effects of agricultural pesticides should be intensified in developing countries in order to reduce the rate of food poisoning in Nigeria, claiming several innocent lives (Akunyili, 2008; Njoku, 2010). No one can tell how far the effect of this misuse of pesticide might reach as some responded that they sold the chemically-treated grains immediately or whenever they needed money to buy farm inputs, while some fed them to animals. Vast majority of the farmers and traders indicated that they stored chemicallytreated grains in their residential houses, where children and other innocent family members could be exposed to pesticide hazards, bearing in mind that the most commonly indicated storage chemical (aluminium phosphide) is a restricted pesticide which has been banned in some countries. The result of the finding confirms that pesticide application and regulation policy in the study areas are poorly implemented.

Aluminium phosphide, being the most commonly used grain storage pesticide in the study areas is a highly toxic, low cost rodenticide, which upon moisture liberates phosphine gas which is rapidly absorbed by inhalation, dermally or gastrointestinally (Jones and Volans, 1999). It is considered toxic in various organs like heart, liver and kidney of mammals (Okolie *et al.,* 2004). It has been reported to produce chromosome damage in agricultural workers (Tucker *et al.,* 2003; Perez *et al.,* 2009). Its wide use however is attributed to its low cost, ease of application, lack of residues, as well as potency (Zuryn *et al.*, 2008). It is however highly toxic to organisms that undergo oxidative respiration.

CONCLUSION

It is not unlikely to attribute suspected food poisoning in Nigeria to agricultural misuse of pesticides in food preservation. Poisoning of aluminium phosphide has been reported to affect almost all vital organs (Bumbrah *et al.,* 2012). Also, the role education plays in sustainable, improved agricultural production as well as food security in developing countries cannot be over-emphasised. Hence, proper attention should be focused on how to control food poisoning due to use pesticide in developing countries, where pesticides are used uncontrollably without proper education and awareness of their harmful threat.

COMPETING INTEREST

Authors declare that no competing interest exist concerning the publication of this manuscript.

AUTHORS' CONTRIBUTION

Adejumo and Ologhobo designed the study. Adejumo, Babalola and Ajala handled the questionnaire. Adejumo and Adebiyi handled the data analysis, while authors read and approved the manuscript.

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