INDICES OF TOXIC EXPOSURE TO PESTICIDE IN SELECTED FARM SETTLEMENTS IN SOUTH-WEST NIGERIA

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Abstract
Pesticides use has helped in increasing crop production. However, indiscriminate use like inadequate protective measures, poor pesticide storage practice and application have been found to cause accidental poisoning of farmers and consumers. This study was carried out to explore the pattern of pesticide use among farmers in selected vegetable farms settlements while also assessing the level of their knowledge and awareness on risks and hazards associated with pesticides use. Cypermethrin and glyphosate were the most commonly used pesticides. It was also observed that farmers engaged in pesticide use without any form of standard protective clothing, were not aware of long term chemical and physiological effects associated with improper pesticide handling. Among the farmers about 7% and 29% had access to sprayers for pesticides. In one of the study centres, 71% of the farmers harvested vegetable between 1-2 days post pesticide application while 14% harvested between 3-4 days. About 7% of farmers in a settlement suffered skin irritation, 43% suffered eye irritation, 29% suffered both skin and eye irritation. The study revealed that farmers were exposed to pesticides due to insufficient protection. There is therefore need for them to be educated and monitored on hazards associated with pesticide use, importance of protective clothing, pre-harvest interval of vegetables. In this situation, educational interventions in form of training on pesticide handling and safety precautions are recommended.

Keywords: Pesticide use; Hazards; Farm settlement; Pre-harvest interval; Vegetable

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1.0 INTRODUCTION

Pesticides are important in the production of adequate food supply and for the control of insect-borne diseases for an increasing world population. They are useful in the reduction of pre and post-harvest crop loss due to pests (Eskenazi *et al*., 2008; Chowdhury *et al*., 2014) thereby increasing yield and income of the farmers (Oerke and Dehne, 2004; Cooper and Dobson, 2007). However, they remain as residues in plants. These residues can be traced mainly to pesticides applied directly to crops growing in the field, as compared to pesticide residues transferred to the plants from the soil (Adachi and Okano, 2006). According to International Labor Organization, exposure to pesticides and other agrochemicals constitute about 14% of all occupational injuries and about 10% of these injuries are fatal (ILO, 1996). According to the World Health Organization (WHO) and the United Nations Environmental Program (UNEP), one to five million cases of pesticide poisoning occur among agricultural workers yearly out of which about 20000 fatalities are recorded (WHO, 1990; United Nations, 2002). The primary reasons for accidental poisoning among agricultural workers can be traced to lack of adequate knowledge and awareness about pesticide storage, protective measures and inappropriate use. Impact resulting from pesticides application is felt by agricultural workers who apply these pesticides and bystanders, also the consumers of food containing pesticide residues in the food chain (Chung and Chen, 2011). In South west Nigeria particularly among farm settlers there is a dearth of information regarding responsible pesticide use and adverse events in farmers. This study was designed to provide information that will guide policy makers and safeguard the health of farmers and consumers of farm produce.

2.0 MATERIALS AND METHODS

2.1 Description of study area

The study was carried out in Oyo state, South-western part of Nigeria. The state is between longitudes 4° E and latitudes 8° N, covering a total land area of about 27, 249 square kilometers. The population has the distribution ratio of almost 1:1 male to female. Agriculture is the main occupation of the people of Oyo State. The State is characterised by dry and wet seasons/high relative humidity typical of equatorial climate. The dry season is usually from November to March while the wet season is from April to October. Almost all through the year, average temperature is between 25°C and 35°C. The vegetation pattern of Oyo State is characterised by rain forest in south and guinea savannah in the north. Thick forest in the south is replaced by grassland intermingled by trees in the northern part of the state.

The State enjoys three agro-ecological zones namely derived savannah, rainforest, and savannah. The rainforest which is usually known for high relative humidity, enhances tree and arable crops cultivation. Grains and arables are the major crops cultivated at the Savannah zone. The derived savannah combines the characteristics of both rainforest and derived savannah.

2.2 Data Collection

Three (3) agricultural zones were selected within Oyo State, namely Akufo, Ilora and Ogbomoso. Forty-two (42) questionnaires were administered to the vegetable farmers.

2.2.1 Study tool: the questionnaire

A structured questionnaire having both open-ended and close-ended questions was developed for this study. The questionnaire was divided into four sections. The first section which was the demographic section contained questions regarding age, gender, place of residence, education level, size of farms, type of crops planted and mode of farming.

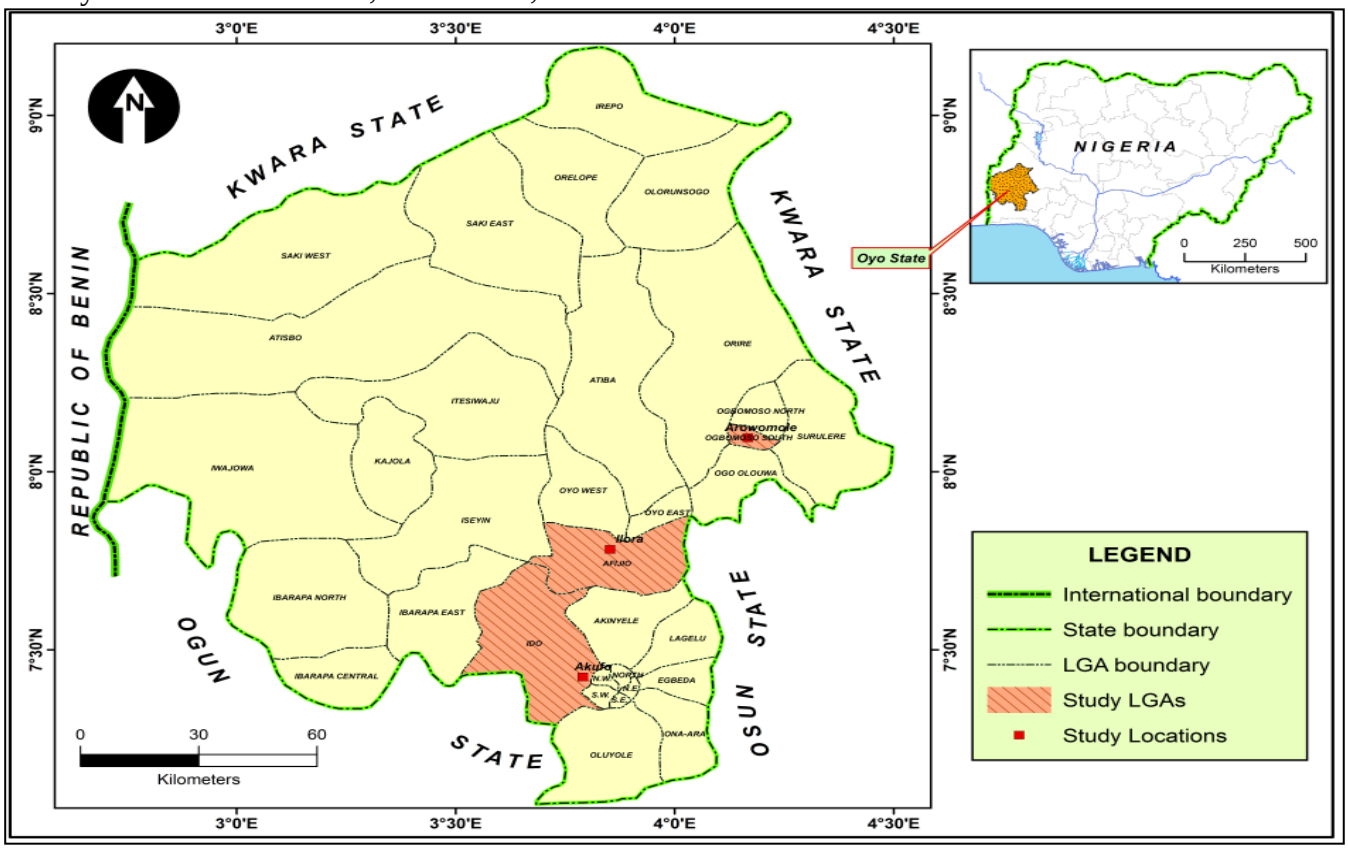

Fig. 1: Map of Oyo state showing the study areas [LB2] of the local governments
Key: Local Government Areas

The second section of the questionnaire entailed a list of questions related to pesticide practices which include names of the most common pesticides used, number of years of pesticide use, pesticide concentration applied, pesticide preparation places, disposal of the empty pesticide containers; waiting period before harvest and observed symptoms connected with pesticide use. In the third section of the questionnaire, questions relating to procedures adopted by the farmers were considered and these among others were the use of protective clothes, reading and following label instructions, habits during and after the application of pesticides. Assessment participants' pesticide knowledge was evaluated using the final section.

2.3 Statistical analysis

Data analysis was done with SPSS (Statistical Package for Social Sciences) program, version 20. Frequencies, and percentages were used to express the descriptive results for categorical variables.

3.0 RESULTS AND DISCUSSION

3.1 Field study

A total of forty two farmers (fourteen farmers per location) from the studied sites were interviewed in the present study.

3.2 Gender Classification, Educational Status, Frequency of Planting and Mode of Farming in Farm Settlements

More than 50 % of the vegetable farmers in Ilora and Akufo were men, while in Ogbomoso, 79 % of the farmers were women (Figure 2). Application of pesticides by female can be more dangerous if protective measures are not observed during and after pesticide application because of the likelihood of pesticide being transferred through her skin contact to other family members especially in a pregnant woman. In a study conducted by Nickerson, it was showed that among farmers applying pesticides with low volatility, dermal exposures usually cover about 90% of total pesticide exposures (Nickerson, 2006). Of particular concern was the consequence of such exposure during the reproductive cycle, from preconception to breast feeding (Bradman *et al*., 2003; Eskenazi *et al*., 2007). There is also the possibility of developmental defects, poor birth outcomes, childhood cancer and congenital anomalies (Rice and Barone, 2000). If the pesticide is left on the skin for 8 hours or longer, it can result in dermal penetration which varies between 2% and 20% (Nickerson, 2006). Studies have also revealed that the maternal body burden is actually transferred to children through breast feeding, with the pesticide concentrations decreasing with the number of times a mother has breastfed (Sanborn *et al*., 2004). The meta-analyses of children living within the environment where pesticides are always applied before pregnancy, during pregnancy, and during the first 3 years of the child's life showed higher risks of childhood leukemia (Bailey *et al.*, 2011).

Figure 3 shows the educational status of farmers in the selected vegetable farm settlements. The proportion of farmers who had non-formal education in Ilora and Ogbomoso farms were 42% and 37% respectively. The rest of farmers in these farm locations had both primary and secondary education. About 43% of the farmers in Akufo farm settlement had tertiary education (Figure 3). The proportions of farmers in this settlement with both primary and secondary education were about 36% and 21% respectively.

The proportion of farmers who planted vegetables all year round were 86%, 65% and 72% for Akufo, Ilora and Ogbomoso farm settlements, respectively (Figure 4). In Ilora and Akufo farm settlements, 72% and 57% of the respective farmers combined hired labour with self labour for the farm activities, while 50% of farmers in Ogbomoso farm settlement combined hired labour with self labour. A large proportion of farmers in Ogbomoso farm settlement (43%) depended on hired labour (Figure 5).

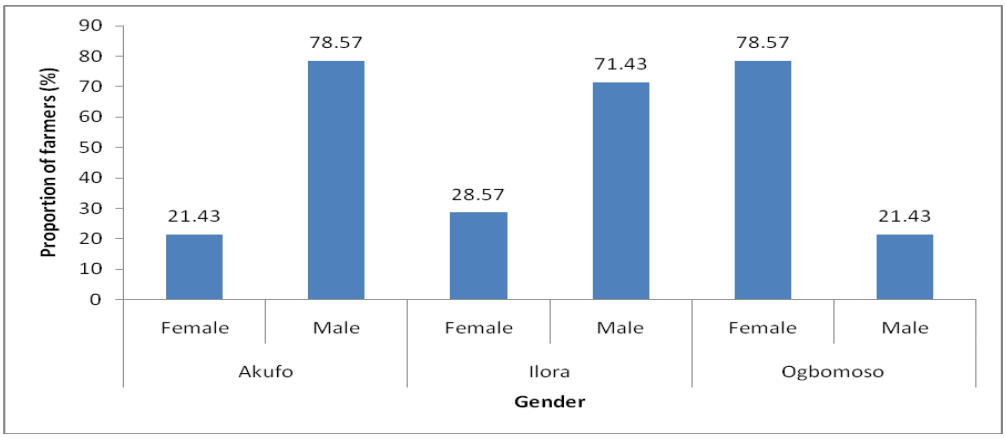

Fig. 2: Gender classification of farmers in selected vegetable farms of Oyo state

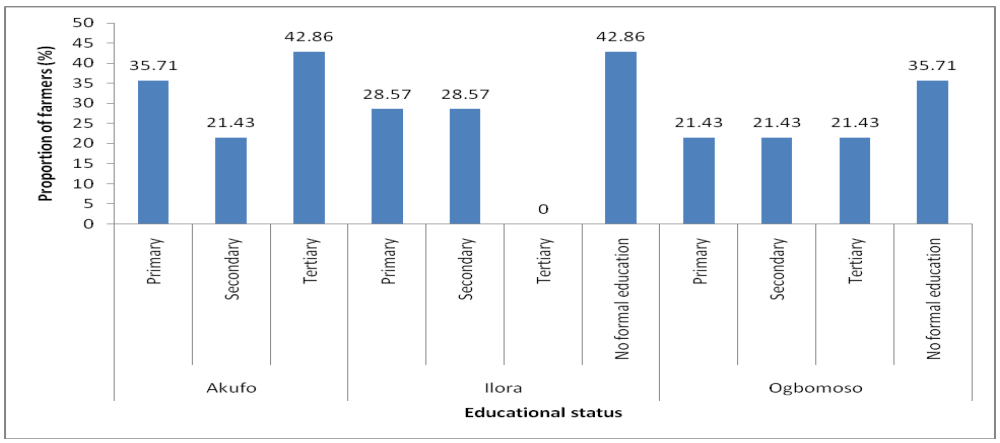

Fig. 3: Educational status of farmers in selected vegetable farms of Oyo state

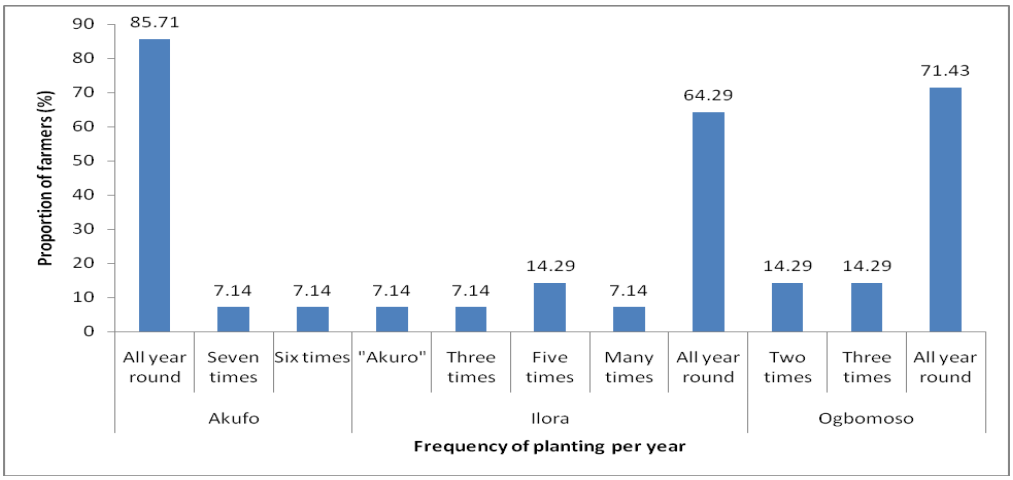

Fig.4 Frequency of planting of vegetable in selected vegetable farms of Oyo state

Key: ‘‘Akuro’’- a farm located near the bank of a river or a water logged area

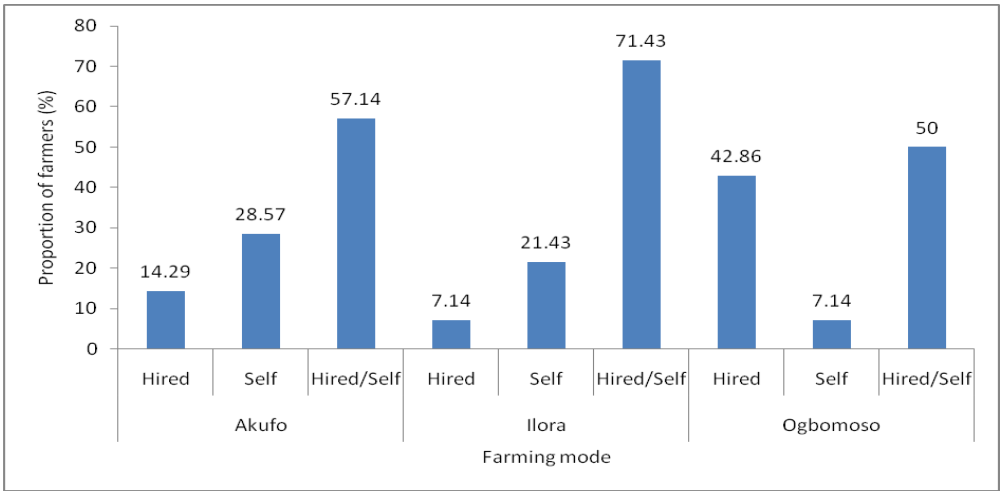

Fig. 5: Mode of farming engaged by the vegetable farmers in Oyo state

3.3 Duration of Pesticide Use, Method of Application, Fate of Leftover Pesticide and Waiting Time after Pesticide Use

Out of all the farmers in Ilora farm settlement, 58% had been using pesticides for more than 11years. About 43% of those in Akufo farm settlement had been using the pesticides for more than 11years, and 43% of the farmers in Ogbomoso farm settlement had been using the pesticide between 6-10years (Figure 6).

In Ilora farm settlement, 7% of farmers used sprayers to apply pesticides on vegetables. Majority of the farmers (64%) were used sprayers and leaves interchangeably, and some used bare hands to pour the pesticide mixture if sprayer was not available. This practice is unsafe because it has been postulated that cutaneous exposure to a glyphosate-containing herbicide contributes to Parkinsonism (Anadon *et al.*, 2009). The skin is the largest organ in the body and pesticides can penetrate faster when it is wet, cut, or irritated (Anadon *et al.*, 2009). Pesticides can come into contact with the body during handling, transporting and processing to cause various types of skin diseases.

Also, 7% of the farmers used watering can for pesticide application. The proportion of farmers using leaves alone to spray the pesticides on the vegetables was 7%. In Akufo farm settlement, 71% of the farmers used sprayer and leaves interchangeably, while 29% of the farmers have access to sprayers to apply the pesticides. The proportion of farmers in Ogbomoso farm settlement that used leaves alone to spray pesticides on plants was 86% since they had no access to sprayer. Only 7% of the farmers used sprayer on the farm and another 7% of them used leaves and sprayer interchangeably (Figure 7). Pesticide application plays an important role in pest management. The choice of appropriate equipment used for applying pesticide and the technique of its application are vital for success of pest control operations.

It was observed in Figure 8 that 71 %, 64 % and 50 % of farmers in Akufo, Ilora and Ogbomoso respectively usually dispose the expired pesticide. About 14% of farmers in Akufo farm settlement reused the expired pesticide but increased the dosage and frequency of use. In Ogbomoso farm settlement, 50% of the farmers buy the quantity that was just enough for use and there would be no left over. The use of expired pesticides is of great concern because they may pose new issues of toxicological effect like environmental damages, which are not similar with unexpired product. Some of the pesticide formulations are more toxic after shelf life expiry while some remain toxic but there may be variation when compared with fresh respective formulation (Satyavani *et al.*, 2011).

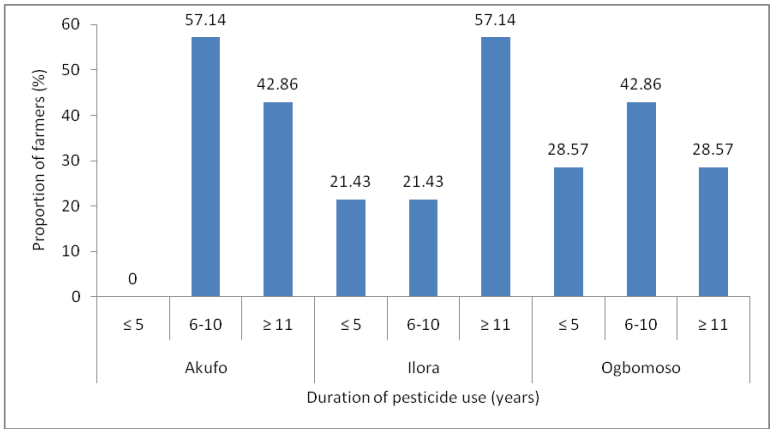

Fig. 6: Duration of pesticide use by farmers in selected vegetable farms of Oyo state

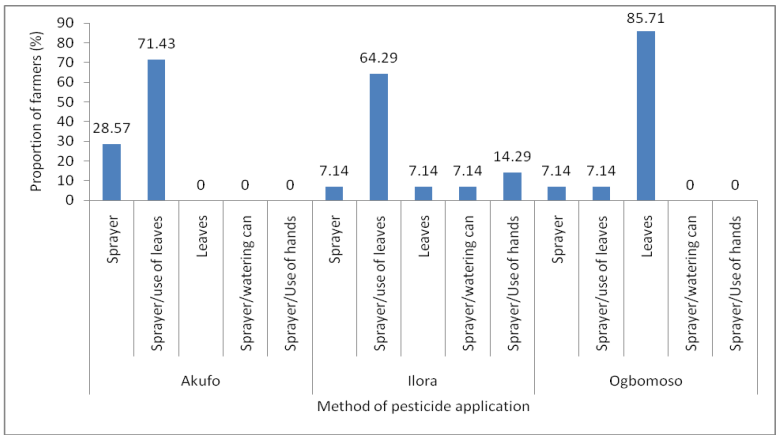

Fig. 7: Method of pesticide application by selected vegetable farmers in Oyo state

All the farmers in Ilora, Akufo and Ogbomoso used glyphosate before farming for weed clearing and insecticide (cypermethrin) after planting whenever pests appear on the vegetable. They did this without observing the waiting period before harvesting of such vegetable. Pre-harvest application of pesticide is a dangerous agricultural practice because it may lead to excessive amount of residues in food crops, especially in vegetables thereby causing adverse health impacts. In the present study, 29% of farmers in Ilora farm settlement harvested vegetable between 1-2 days, 43% harvested between 3-4 days and 29% harvested after 5 days of pesticide application. In Akufo farm settlement, 71% of the farmers harvested vegetable between 1-2 days, 14% harvested between 3-4 days and same for after 5days. About 64% of the farmers in Ogbomoso farm settlement harvested vegetables between 1-2 days after application of pesticide, 21% harvested between 3-4 days and 14% harvested after 5 days (Figure 9). The application of pesticide close to harvesting time could probably be one of the factors responsible for the contamination of soil, sediments, water and vegetables with pesticide residues. Waiting time between pesticide application and harvesting of crops is a very important point to be considered by farmers. There are different waiting times or periods for different pesticides and this should be strictly followed by farmers. But due to illiteracy, carelessness and lack of awareness, some farmers even apply pesticides on the day of harvesting. Studies have shown that out of the total number of farmers that had been using pesticides for over five years, 60% wait less than two weeks after spraying pesticides before harvesting the crop (DFTQC, 2004).

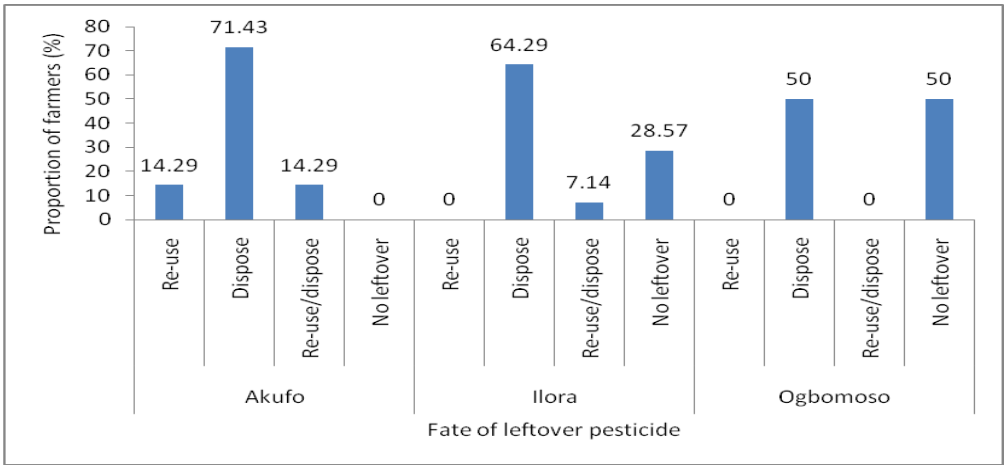

Fig. 8: Fate of leftover pesticides

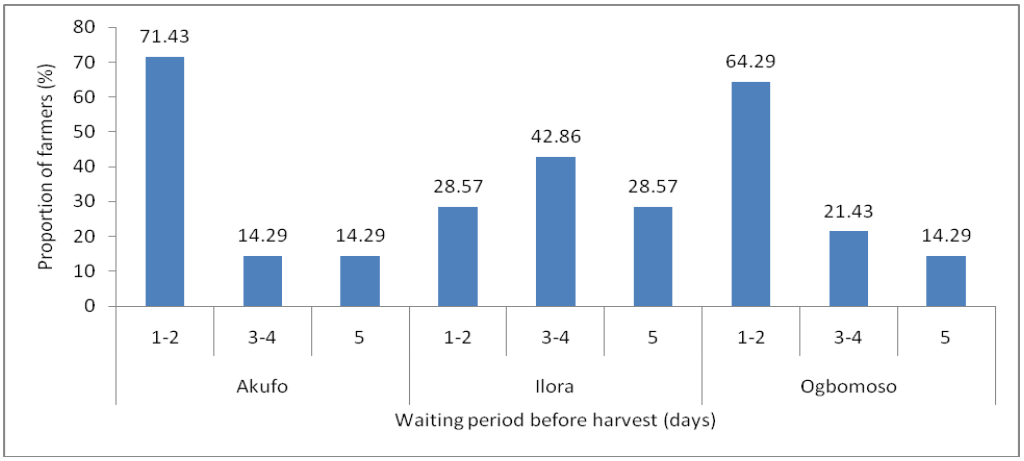

Fig. 9: Waiting period (days) before harvest of vegetables

3.4 Safety Measures during Pesticide Application and Health Impacts on Farmers

When pesticides are applied, they may be inhaled, absorbed through skin contact or consumed in food and water thereby adversely affecting humans. Therefore, safety measures during and after pesticide application should be adopted for prevention against harmful impacts of pesticide. The common safety options include the use of long boots, overalls, hand gloves and nose masks. Most of the farmers in the farm settlements under study were not aware of long term physiological and chemical effects accompanying improper agrochemical handling. Of the total farmers interviewed in Ilora and Ogbomoso farm settlement, none of them used any protective wears (Figure 10). In Akufo farm settlement, 43% of the farmers put on boot during pesticide application and the rest of the farmers used no protective wear at all and did not even change their clothes after applying pesticides. These agree with a study by Yeboah *et al.* (2004) and Mensah *et al.* (2004) in which about 82% of farmers in Ghana were illiterates and did not always use any form of standard protective clothing. The study revealed that about 41.5% of these farmers claimed that they change their clothes before and after using pesticide. However, less than 5% made effort to wash these clothing before putting them on again. This attitude can enhance dermal exposure which can eventually lead to systemic poisoning. Also, it was reported that in Bangladesh, most pesticide users were not aware of the use of protective clothing during handling, transporting, storing and spraying of pesticides. Although 93% users wore only shirts as partial safety measure during and after pesticides application while not following proper methods of application. A

similar trend was reported in Bangladesh where about 72% of farmers in Bangladesh wore ordinary shirt or T-shirts as a pre-protective measure before going to spray pesticides (Miah *et al*., 2014). It was also appalling to observe that none of these Bangladesh farmers used mask, eye glass and gumboot, which were to be considered as indispensable safety measures. Our study revealed that some of the farmers were involved in unhealthy practices; they drank from surface water near their farms and ate without washing their hands with detergent. These practices put them at high risk of being affected by the pesticides. Also, soil can be a key source of exposure in young children who engage in hand-to- mouth activity.

Figure 11 shows that 7% of Ilora farmers suffered skin irritation, 43% suffered eye irritation, 29% suffered both skin and eye irritation and 21% suffered no visible effect after each pesticide application. In Akufo farm settlement, 58% of farmers suffered both skin and eye irritation, 21% suffered skin irritation and another 21% suffered eye irritation. In Ogbomoso farm settlement, 72% of the interviewed farmers suffered eye irritation after each pesticide application and 28% suffered both skin and eye irritation. Fianko *et al*. (2011) revealed that the most significant symptoms after pesticide application include blurred vision, headache, dizziness, fever, nausea and vomiting. This is a signal that pesticides can have severe effects after some years of exposure through continuous and unprotective application.

A study in Bangladesh showed that half of the respondents confirmed that consumption of pesticide-contaminated vegetables resulted in various ailments such as cancer, uneasiness, stomach-ache, appetite loss, digestion problem and ulcer. Respondents also affirmed they experienced sexual dysfunction, urinary incontinence among other urogenital problems (Miah *et al*., 2014). In our study, though farmers were reluctant to speak about such kind of problems, 32% of them acknowledged that after prolonged pesticide exposure due to use they started losing their sexual urge gradually. Most of the farmers were not aware of the environmental impacts of these pesticides. They are also ignorant of the hazards it poses to their health or the long term chemical and physiological effects or damages. They lacked understanding of the pesticides properties and how to protect self from poisoning. The general belief expressed was that if one does not die immediately then pesticides present no harm. Ignorance of the existence of chronic pesticide poisoning has grown widely, also, the resistance and resurgence of these pesticide are not understood by farmers. They just apply pesticides anytime the need arises. Survey by Khan *et al*. (2010) revealed that farmers' attitude towards pesticide use was that they considered pesticides as medicine rather than a source of poison.

It had been revealed by many researchers that the use of highly lethal pesticides and insufficient safety precautions are common (Singh and Gupta, 2009). A study revealed that more than half a million farmers and their household were exposed to pesticide associated hazards as a result of poor handling conditions (PANUPS, 1998). Majority of the farmers lacked properly education and knowledge on pesticides use. Thus, they mostly apply pesticide without knowing the population of pests and crop condition. Pesticides are also being stored alongside food in living areas. The study by PANUPS (1998) pointed out that this storage practice is highly unsafe, as children sleeping in such rooms may accidentally consume pesticides stored in food or drink containers and also inhale pesticide fumes. It was also observed, in our study, that none of the farmers observed a safety period of 21 days harvest post application. About 22% harvested their produce three days after the last application.

Most farmers selected wrong insecticides due to lack of knowledge or negligence on their part. For instance, farmers sometimes used leftover pesticides that are recommended for other crops on vegetables. These pesticides will persist longer and contaminate the vegetables with high maximum residue limits (MRL) (Khan *et al.*, 2010). It has also been observed that majority of the farmers do not monitor

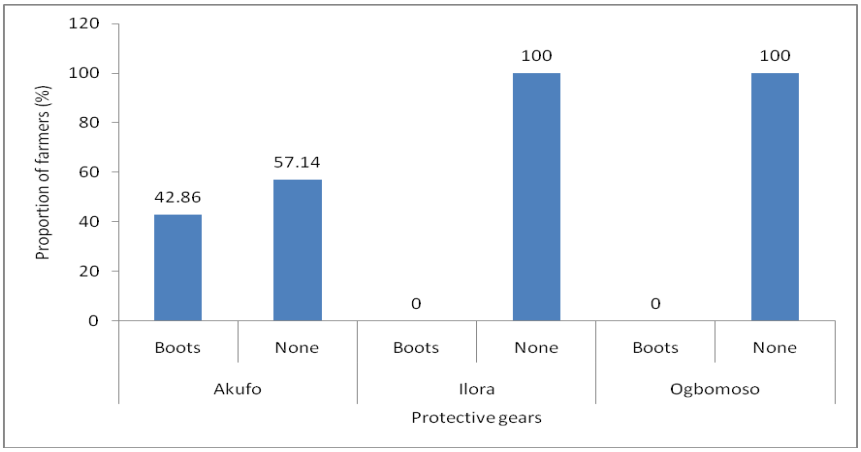

Fig. 10: The use of protective wears during pesticide application

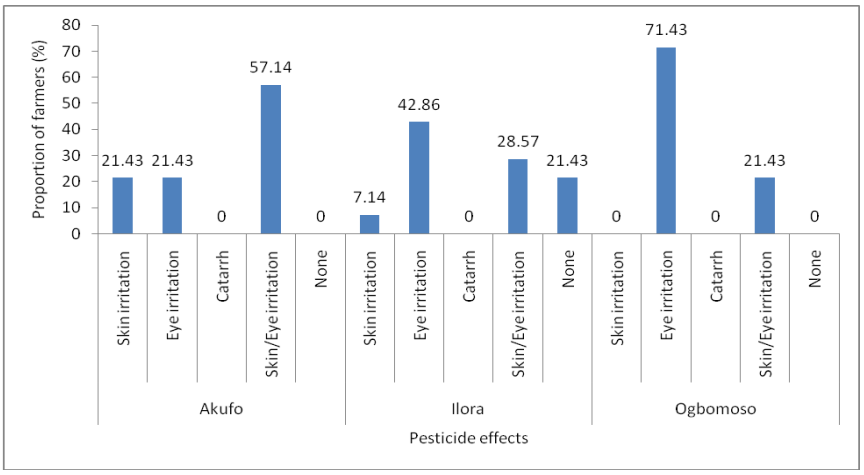

Fig. 11: Symptoms of pesticide use

their fields regularly. Thus they apply pesticides when the damage has already been done and the symptoms have become quite visible. The symptom may be the appearance of rolling of leaves by leaffolder or 'hopperburn' as a result of heavy infestation of white backed plant hopper or 'whiteheads' or 'dead hearts' due to stem borers attack (Khan *et al.*, 2010). This amounted to waste of resources on one hand and environmental pollution on the other hand.

It has also been observed that the recommended moisture in the field is not put into consideration before pesticide applications by farmers (Khan *et al.*, 2010). The method of disposing pesticides containers also pose a great risk as most farmers throw empty containers in canals and water channels or near their houses in the courtyard rather than burying them in the soil. Sometimes these containers are also used for keeping drinking water or edible oil (Khan *et al.*, 2010).

4.0 CONCLUSION

Farmers in the present study engaged in inappropriate pesticide use. There is need for education of farmers and monitoring by appropriate authorities to ensure compliance of farmers to safe pesticide use thereby preventing pesticide associated health hazards to farmers, their household and the consumers.

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