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Research Article

Environmental Contamination by Agrochemicals and Its Indiscriminate Use by Dry Season Farmers in Sudan Savannah of Katsina State

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ABSTRACT

A field survey was conducted in five dry season irrigation sites consisting of Ajiwa, Zobe, Jibia, Sabke, and Sulma dams in Katsina state. The survey was carried out to find out dry-season farmers' attitudes on the use and misuse of agrochemicals. A multi-choice structured questionnaire was administered to one hundred (100) purposively selected dry-season farmers. Data collected were analysed and interpreted using descriptive statistics in the form of bar charts of the SAS package. The result showed that many dry-season farmers obtained information on the safe use of agrochemicals from pesticide retailers (90%). The market recorded the highest (98%) of farmers purchasing agrochemicals. Most dry-season farmers throw away empty pesticide containers after use (91%) while 7% and 4% respectively burn and deep bury these containers. In others, some farmers rewash these containers for household use or resell them to hawkers. Symptoms of pesticide toxicity after application were identified with the highest percentage being recorded by skin rashes (90%). Based on the findings of this study, a poor attitude toward throwing away empty containers could serve as a chance of increased chemical residues in the environment and a high risk of attack especially by the vulnerable people in the study area. It is therefore recommended that dry season farmers be encouraged to purchase agrochemicals from reputable agents to avoid purchasing adulterated or expired chemicals and dispose of empty containers appropriately and hygienically by environmental standards.

Keywords: Agrochemicals, Environmental contamination, Indiscriminate use, Dry-season farmers, Katsina State, Sudan Savannah

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INTRODUCTION

Scientists have always been concerned about toxic metals in the human body because there is a widespread belief that these could hurt health because of the release of toxic wastes into the environment. Certain metals are essential for life, while others have unknown biological functions that could be harmful or beneficial, and still others have the potential to cause diseases [Tsoumbaris and Tsoukali-Papadopoulou, 1994]. Agriculture is essential to both human existence and the economy. It forms the basis of a country's economic framework [Ofuoku, 2011]. The agricultural sector employs a sizable section of the populace and provides food and raw materials for industry. It contributes to the national GDP, supplies food for human consumption, animal feed, a means of sustenance for farmers, and assistance for international trade [Nwakile *et al*., 2017]. One of the most important parts of agriculture is crop production. The goal of agrochemicals was to improve the quantity and quality of agricultural products.

Ademoye *et al*. [2014] define agrochemicals as compounds used to control an agricultural ecology or the community of organisms within a farming area. According to Damalas [2009], these substances increase crop productivity and quality by lowering the demand for additional inputs like labour. Many pesticides have been used in recent decades to shield crops from pest damage and increase crop yields, according to Delcour and Uyttendaele [2015]. In the absence of pesticide application, Devi *et al*. [2022] indicated that pests and diseases would have destroyed approximately 78% of fruits, 54% of vegetables, and 32% of cereal crops. Consequently, it is anticipated that the market for agrochemicals used as agricultural inputs will be valued at over $300 billion by 2025, having been valued at 234.2 billion US dollars (USD) in 2019. Preharvest pest attacks are estimated to cause a little over one-third (35%) of the world's agricultural output losses Devi *et al*. [2022].

Agrochemical proponents attest to the possible advantages of their use in enhancing the financial viability of agricultural production systems and resolving issues related to food security. The significant rise in food production that has been observed, particularly since the 1930s when the Green Revolution got underway, is attributed to the use of these chemicals as observed by Devi and associates [2022]. Agriculture yields have increased over the past 40 years because of enhanced soil fertility and pest management brought about by the application of fertilizers and other chemicals [Abdul, 2018].

The need for food has increased during the past few decades because of the rapid growth in the human population, leading to an intensification of agriculture. As a result, the usage of agrochemicals increased. However, according to Tadesse and Asferachew [2018] research, agrochemicals can potentially be harmful to the environment and public health if used incorrectly. Intense food crop cultivation and sustainable food safety might result from crop output throughout rainy and dry seasons. Conversely, a large portion of the crops cultivated during the dry season are vegetables. Crop growth is hindered by many biotic factors (weeds, insects, and microorganisms) and abiotic (soil fertility) difficulties, which have been addressed by the extensive use of fertilizers and pesticides (Lamichhane *et al*., 2016). The rise in diseases and pest populations has led to the reckless usage of synthetic chemicals. According to Nonga *et al*. [2011], the problem may be particularly troublesome in areas where irrigation (dry season) farming is practiced.

The environment is negatively impacted by using agrochemicals. An estimated 20,000 agricultural laborers die because of pesticide poisoning, which affects between 1 and 5 million people year worldwide according to Aktar *et al*. (2019). Remarkably, emerging nations account for 75 percent of global pesticide mortality, although using only 25 percent of the pesticides produced worldwide [Jeyaratnam, 1990]. It is probable that any freshwater body, such as rivers, lakes, and wells, will include pesticide residues as pollutants that leak off soil surfaces or through aquifers. Both surface and underground waters in Nigeria have been found to contain pesticides. According to Okeniyia *et al*. [2009], waste waters discharged by clean-up equipment after pesticide use, runoff and percolation, wastewater from agro-allied industries, residues from pesticide use that are directly applied to fish farms, agricultural production areas, and others end up in natural waters.

Devi *et al*. [2022] classify chemical pesticides into the following general categories: herbicides, bactericides, fungicides, and rodenticides. They are part of important chemical groups like dithiocarbamates, carbamates, triazines, organochlorines, and organophosphates. Pyrethrins and neonicotinoids are the newest additions, which are said to be safer substitutes. Whether intentionally or accidentally, pesticides have been used on our environment, resulting in their persistence and effects on ecosystems and non-target organisms. Acute and chronic pesticide poisoning is usually caused by eating contaminated food. In a study conducted by Malhat *et al*. [2015], honey samples included pyrethroid and organochlorine contaminants. According to Rather *et al*. (2019), food contamination is a matter of serious concern, as the high concentration of chemicals present in the edibles poses serious health risks. One possible source of these toxins is the increasing use of pesticides that the Stockholm Convention on Persistent Organic Pollutants (POPs) restricted or outlawed. However, Muhammad *et al*. [2020] report that the Nigerian government banned the production and importation of over twenty pesticides because of the risks they posed to human, animal, and environmental health. These included Aldrin, Binapacryl, Captafol, DDT, Dieldrin, Dinoseb, Ethylene dichloride, Heptachlor, Lindane, Parathion, Phosphamidon, Monocroptophos, Methamidophos, Chlorobenzilate, Toxaphene, Endrin, Merix, Endosulfan, Delta HCH, and Ethylene oxide. In addition to learning how dry-season farmers see the use and misuse of agrochemicals in their farming practices, the study aimed to identify potential pathways through which these chemicals could contaminate the environment (soil and food).

MATERIALS AND METHODS

Study Areas

Ajiwa Dam

Ajiwa Dam is situated in the Sudan Savanna ecological zone of Nigeria, in Batagarawa Local Government Area of Katsina State. The dam lies between latitudes 12°30'–13°00' North and longitudes 7° 30'–8° 00'' East [Sulaiman *et al*., 2021]. It is approximately 968.544 km2 in size. Fishing and irrigation were the two main reasons for building the dam [Figure 1]. The location is roughly 518 meters above sea level with a 12-meter height and 60-meter spillway, the reservoir boasts 1678 km^3 of catchment area and a lift pump capable of 1040 kmh^{-1}. Tomato, pepper, onion, hot pepper, garden egg, amaranthus, roselle, and cabbage are some of the crops that are grown with irrigation. Additionally, the farmers farmed cereal crops like wheat, maize, and rice.

Zobe Dam

The approximate coordinates of the Zobe Dam are 12°22' N and 7°30' E, and it is situated in Katsina State, northern Nigeria, approximately 65 km south of the city Saidu *et al*. [2019]. The Federal Ministry of Water Resources [FMWR] oversees the operation of the dam, which is owned by the Federal Government of Nigeria and run by the Sokoto Rima River Basin Development Authority [SRRBDA]. The initial purpose of the dam was to provide irrigation water, hydropower, and drinking water. With a catchment area of 2,527 km^2, the Zobe Dam impounds the Karaduwa River. A full supply level of 177 x 106 m3 can be stored in the dam, which has a length of about 15 km and a surface area of 36.9 km^2. According to the Federal Ministry of Water Resources [FMWR] (2020), the Dam has a maximum height of about 20 meters. Farmers cultivate maize, wheat, pepper, okra, tomato, lettuce, cabbage, and chili pepper.

Jibia Dam

The Jibia township lies approximately on Latitude 13°57'08'' to 13°71'27'' N and Longitude 7°15'48'' E to 7°18'15'' E. Jibia Local Government Area is bordered by Katsina and Batsari Local Governments Areas (LGAs) to the South, Kaita LGA to the East, and Zurmi LGA in Zamfara State to the West plus Maradi State in the Niger Republic to the North [Sani *et al.*, 2029]. The project was constructed and commissioned in 1991 with a total irrigation land of about 3,500 ha (gross) and 3,000 ha net. Irrigation water from the compensation reservoir is released into main trapezoidal-shaped canals and subsequently into precast parabolic canals of various sizes and discharge capacities, having a total length of 192 km. irrigation water is pumped into six (6) portioned land (Hydrological boundaries F1-F6) to supply water to irrigation plots and sub-canals, 114 km of drainage channels, and 50 km of service roads [Sani *et al*., 2023]. The dry season lasts between October and May and during this period, farmers grow crops such as wheat, cowpea, maize, groundnut, cassava, and assorted vegetables that include onion, cabbage, lettuce, garden egg, amaranthus, and tomato.

Sabke Dam

Sabke Reservoir lies 35 kilometers northwest of Daura, Katsina state, at a height of 451 meters above sea level. Situated on Longitude 13º4' E and Latitude 8º10' N. To build the reservoir, two significant seasonal rivers in Mashi and Maiadua local governments were dammed in 1999: Babbar Ruga on the west bank and Bulbula on the east bank. But lesser streams, including spillover from Daberam Dam, sustain these two rivers. The reservoir can hold 31.60 million cubic meters of water in an active state and 56 million cubic meters in a flood state [Bala and Abdullahi, 2011]. Farmers near this dam complex raise a variety of crops, including cabbage, amaranthus, hot pepper, tomato, and pepper. Maize is one of the most widely grown grain crops.

Sulma Dam

Kafur LGA is in southern Katsina State, between latitudes 7°29' and 7°55' N and longitudes 12°22' and 12°52' E. It is located approximately 5 kilometers off Kafur-Dabai Road. According to Abdullahi *et al*. [2018], the dam was built to supply domestic water and irrigation services to the locals and communities nearby. This dam facility is used by farmers who actively grow maize, tomatoes, cabbage, and onions.

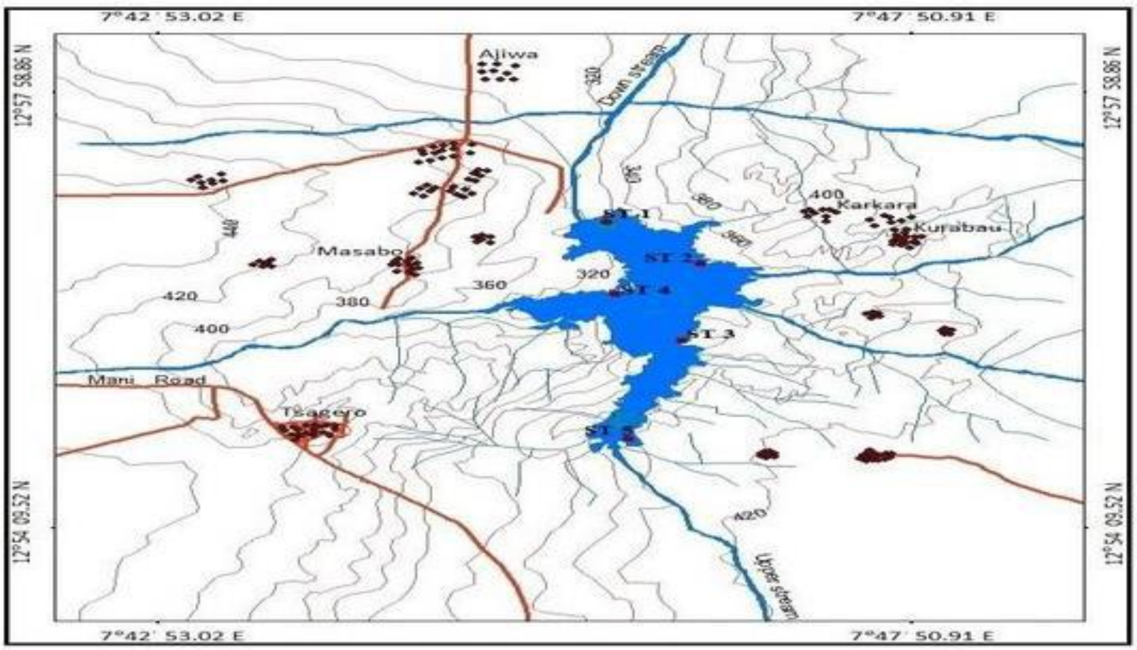

Figure 1: Ajiwa dam showing sampling sites

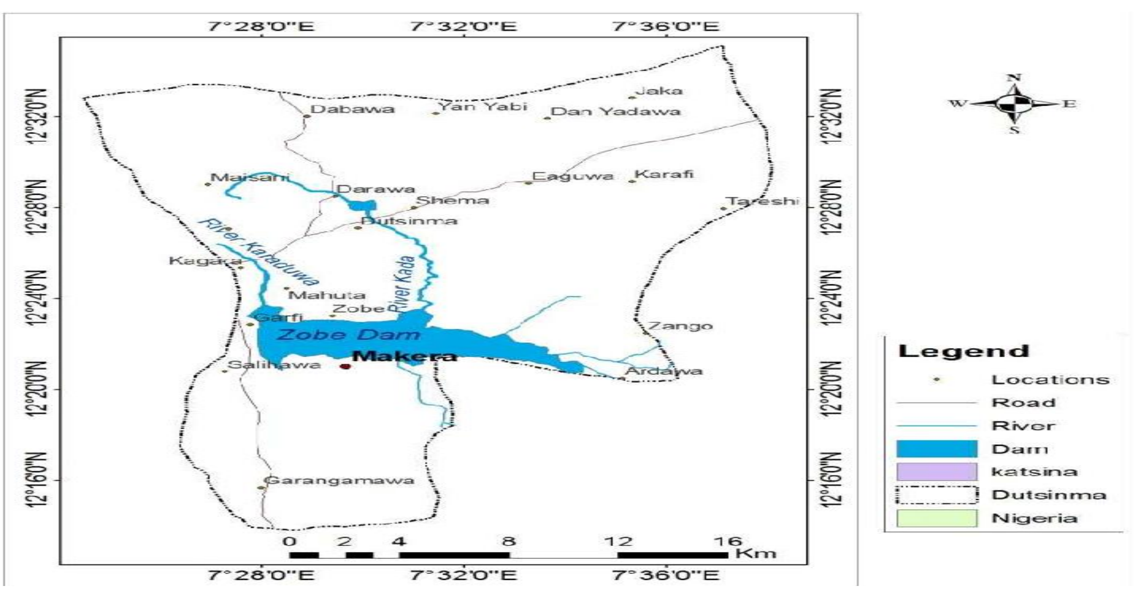

Figure 2: Zobe dam showing sampling sites

Samples and Sampling Technique

A total of one hundred dry-season farmers from three dry-season farming communities across five irrigation sites were interviewed. The towns involved in the study comprised Ajiwa Dam [Figure 1], Masabo, Tunga, and Makera; Zobe Dam [Figure 2], Makera, Kitibawa, and Garhi; at Jibia Dam, Bakin Gada, F_1 and Garin Sama; at Sabke dam, Kwarin Gaugai, Dagogo and Riniyal; and Sulma dam, Layin Habu, Unguwar Zaki and Unguwar Audu. The respondents were purposively selected due to their engagement in dry-season farming of vegetables and cereal crops. A multichoice structured questionnaire was administered by a trained enumerator designed using (https://kc.kobotoolbox.org). Farmers were interviewed on their farms during farming activity. Data were collected on information about farmers' use and misuse of agrochemicals in their dry season work. Measured data were analysed using descriptive statistics of SAS statistical package results presented in bar charts.

RESULTS

Sources of Information on the Safe use of Agrochemicals

The results of multi-choice questions on different sources of information about agrochemicals available to dry-season farmers in the surveyed area showed that 30% of dry-season farmers obtained information from friends. The lowest percentage (5%) obtained information from Agricultural extension agents. Furthermore, ninety percent (90%) of dry season respondents surveyed obtained information on the safe use of agrochemicals from chemical vendors (retailers) whereas only 4% regarded the internet as their source of information. Anchor suppliers recorded 54% of respondents sourcing information on the same matter. The result is shown in Figure 3.

Sources of Agrochemicals

There were many sources identified by dry-season farmers as means of purchasing agrochemicals for use. The result of the multi-choice question (Figure 4) clearly showed that 98% of respondent obtained agrochemicals from the market for use in their dry season activity. Similarly, only 5% of dry-season respondents got agrochemical supplies from extension agents. Twenty-four percent (24) of dry season farmers purchase agrochemicals from Agrochemicals stores in their town while 25% purchase from Anchor suppliers. None of the respondents purchase agrochemicals from cooperative societies and research centres.

Methods of Disposing Empty Chemical Containers

The result of the multi-choice question on the method of disposing of empty pesticide containers identified by dry-season farmers in the study area is presented in Figure 5. The result showed that only 4% of dry-season farmers deeply bury empty containers after use while 7% burn in an open fire. The result further revealed that 91% of dry-season farmers throw away empty agrochemical containers when exhausted. Only 10% return these containers to the point of purchase. Equally, 62% of respondents utilize other means of disposing of empty containers. These other means were identified as selling to hawkers visiting their towns and farms or washing for domestic or mosque use.

Symptoms of agrochemical attack

The result of the multi-choice question on whether after chemical application by farmers experience ill-health. These sicknesses may be mild headache, nausea, difficulty in breathing, skin rashes, vomiting, and body weakness (Figure 6). The result showed that 20% and 19% of dry season farmers respectively said headache and nausea were symptoms of poisoning they experienced after chemical spray. Similarly, twenty-four (24) percent reported difficulty in breathing while 80% identified skin rashes as symptoms of pesticide attack, they feel after spray application. Only 15% of dry-season farmers reported body weakness as a symptom of an attack.

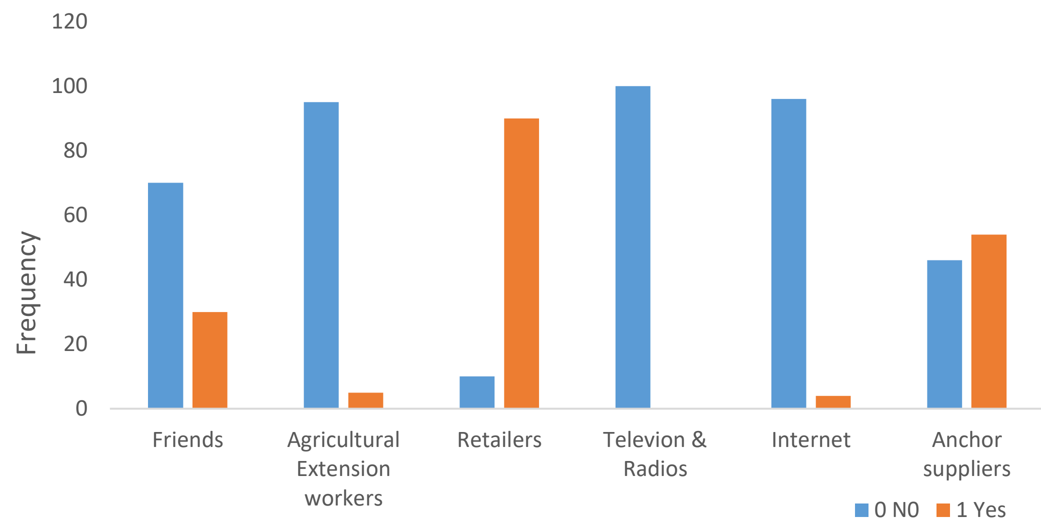

Figure 3: Sources of Information on safe pesticide usage

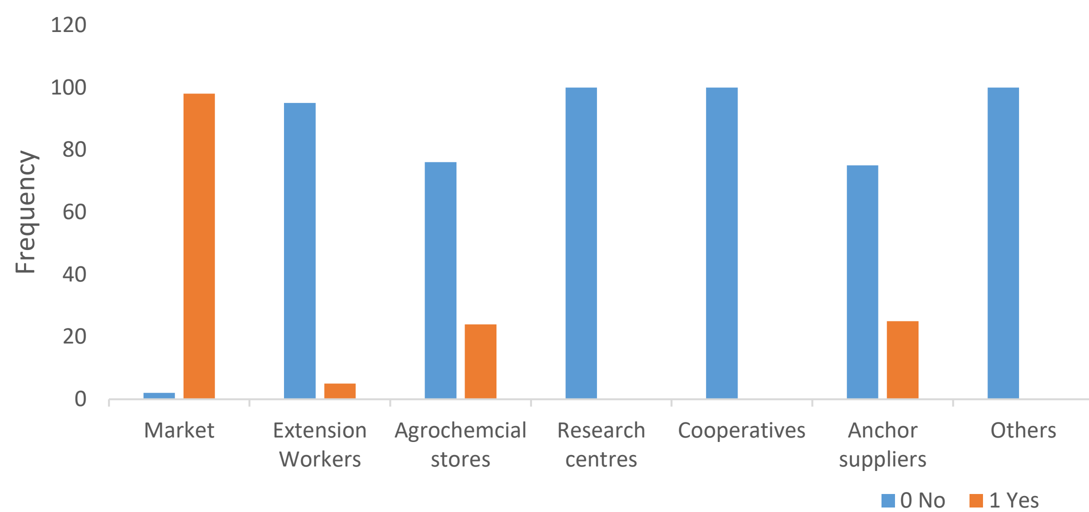

Figure 4: Sources of Agrochemicals used during dry-season farming

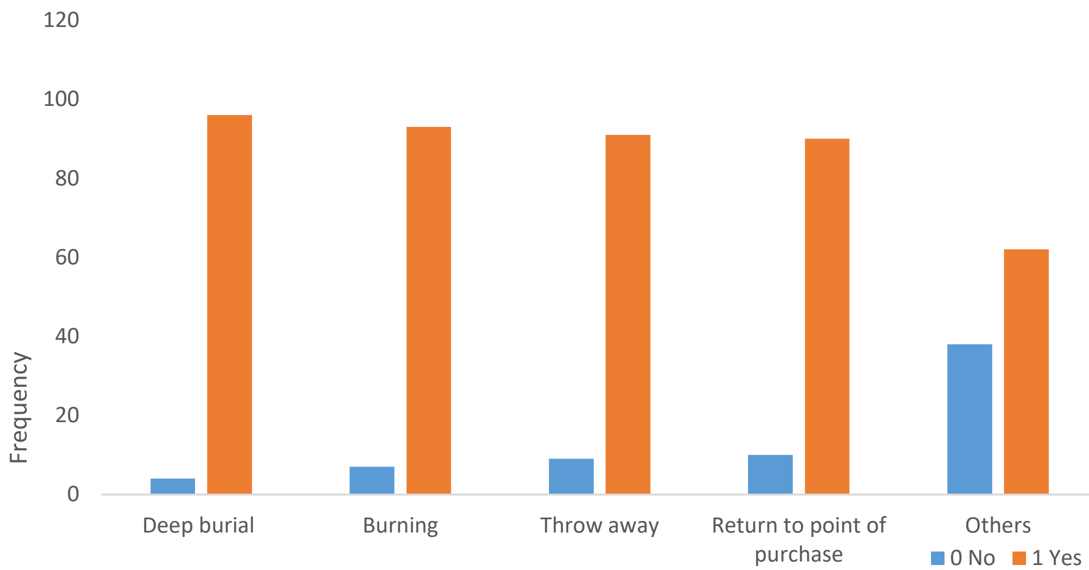

Figure 5: Method of disposing empty pesticide containers

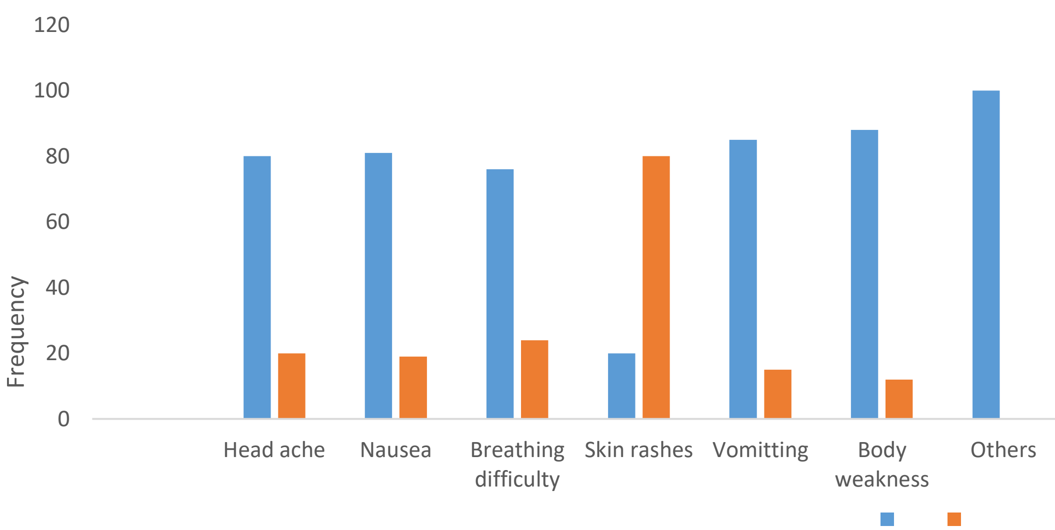

Figure 6: Symptoms of pesticides attack

DISCUSSION

Pesticides of whatever category must be handled with caution. Otherwise, both acute and chronic poisonings may likely be encountered by users. The ability to keep away from endangering humans and environmental contamination lies in the educational status of pesticide end users. Their ability to read and write helps considerably. The result obtained in this study showed that the safe use of chemicals by dry-season farmers is dominated by many sources. Information obtained from friends often became distorted before reaching beneficiaries. The highest percentage recorded by retailers showed that dry-season farmers receive secondary information instead from agricultural extension agents (AEAs) or pesticide manufacturers. This agreed with the opinion of Devi *et al*. [2022] who said end users in developing countries rely on information provided by pesticide retailers. Similarly, it could be due to an insufficient number of AEA in the area.

Ifeanyi-obi and Corbin [2023] observed that Nigeria experiences the problem of an insufficient number of extension agents in the extension services. Olayemi and Oduntan [2020] argued that the extension worker to farmer ratio in Nigeria is very high. It was estimated at 1:3000 against a target of 1: 500. According to the African Seed Access Index [TASAI] 2020 report, Nigeria has the lowest ratio of agricultural extension workers to farmers' ratio in Africa with extension agents to farmer ratio of 1:7500. Nigeria faces the issue of having too few extension agents providing extension services, according to Ifeanyi-obi and Corbin [2023]. The ratio of extension workers to farmers in Nigeria, according to Olayemi and Oduntan [2020], is extremely high. Against a goal of 1: 500, it was calculated at 1:3000. According to the African Seed Access Index [TASAI] 2020 study, Nigeria has the lowest ratio of agricultural extension staff to farmers in all of Africa with an extension agent-to-farmer ratio of 1:7500. This gap is extremely wide enough to effectively reach out to increasing demand of rural communities and thus making direct contact difficult.

Among the dry season farmers, there were few with high levels of education. The percentage recorded by internet users (ICT compliant) showed the transformation from traditional to modern ways of sourcing current information on scientific innovations/techniques in agriculture. This corroborates the findings of Muhammad *et al*. [2014] that the reported rate of adoption of new technologies in agriculture is proportional to the educational level of respondents. This confirms that the idea of ICT permeates very well because of its reachability to support efforts by enhancing the capacity to connect without expensive trips [Olayemi and Oduntan, 2020].

The availability of agrochemicals for use by farmers depends on how farmers have access to these chemicals. The findings in this research revealed the dominance of the market [98%] over other sources of obtaining agrochemicals by farmers in the study area. Thus, high chances of selling expired products, adulterated and often at high cost predominated. The implication is associated with continued (repeated) application without achieving desired control. Instead, the amount of these chemicals will continue to build up in the ecosystem and contaminate the food chain and water bodies. This finding is in line with the observations of Muhammad *et al*. [2014] and Muhammad *et al*. [2020] who reported the market as the most dominant point of agrochemical sales in Jibia and Zobe Dams respectively.

Poor/wrong attitude of dry season farmers during and post spray application can aid in increasing the amount of pesticide residues in the environment. The presence of empty sachets and pesticide bottles (plastic) seen during the survey demonstrates why thrown away scored the highest percentage. Furthermore, vendors purchasing empty containers from farmers at their domain are likely to repackage expired, adulterated, or improperly manufactured home-manufactured products. Hence, continued application without desired results. According to Emurotu and Onianwa [2017], polluted soil poses a threat to human health through the food chain and compromises crop development and the quality yield of agricultural products.

Furthermore, among the other sources of disposal, it was found that farmers wash these containers for household uses or at times donate them to mosques for use (ablution). All these contribute to the chances of pesticide poisoning and environmental contamination. This action contravenes International Labour Office (ILO) [1991] guidelines on safe ways of handling and disposing of pesticide empty containers. Consequent upon that, the development of sicknesses which were known and others unknown. It was reported that a few pesticide exposures will cause acute poisoning associated with mild headache, poor vision, nausea, skin rashes, and irritation. Multiple exposures will cause chronic toxicity manifested in cancer development, nerve damage, reproductive inhibition, or mutation. Lead poisoning harms the kidneys, liver, heart, brain, skeleton, and neurological system in humans, according to Kinuthia *et al*. [2020]. Children are the most vulnerable, partly due to biological factors as well as enhanced exposure factors according to UNEP [2004] and Zahm and Ward [1998].

CONCLUSION

From the findings of this study, it could be concluded that dry-season farmers in the study area were left without proper guidance on the safe use of agrochemicals. Their wrong attitude of throwing away empty containers could be a source of challenge to the environment as well as to human health. The government should try as much as possible to recruit more extension agents that will assist these farmers with best practices in agrochemical usage. Instead of throwing away these containers or burning them, they should be encouraged to bring them back to a reputable agent or a government clinic where wastes from hospitals are hygienically destroyed without endangering the environment.

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