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Arable Land Pollution in Ghana: A Look at Agrochemical Plastic Waste Handling among Farmers

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Authors' contributions

This work was carried out in collaboration with all authors. Author FKY designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author FKY and Author SA managed the analyses of the study. Author LXL managed the literature searches. All authors read and approved the final manuscript.

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Case Study

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ABSTRACT

The mishandling of agrochemical waste is a major environmental problem causing pollution and a threat to public health. Although the number of agrochemical companies in Ghana continues to grow exponentially, limited efforts are directed toward the proper disposal of plastic bottles after use. Consequently, the study explores the post handling activities of farmers concerning agricultural plastic waste. Using the Birim South District of the Eastern Region of Ghana as the case study, the descriptive statistics are employed to provide answers to the research questions by examining the survey responses of the 120 farmers sampled randomly from an estimated 850 farmers from 4 communities. The results suggest that farmers in the district are aware of the triple rinsing mechanism of ensuring safe disposal. Further, few farmers have had extensive training on the safe usage and disposal of pesticides. In spite, most farmers are willing to burn, bury, and reuse empty agrochemical bottles to properly dispose of after usage. The study reveals a knowledge gap in responsible usage and disposal of agrochemical bottles and the need for an appropriate management system to tackle the challenge.

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1. INTRODUCTION

Since independence, successive governments in Ghana have directed a vast amount of investments to the development of the domestic agricultural sector. According to MOFA [1] and FAO [2], out of the total area of 238.854 km² of Ghana's land, only 57% (13,628,000 hectares) is appropriate for agriculture with 6,331,000 hectares classified unproductive thus unsuitable for cultivation. Nonetheless, this can be improved with soil conservation and good farming practices. To ensure the continuous supply of food and raw materials to feed the increasing population of the country and the industries, the use of agrochemicals is necessary despite the irremediable altering pattern.

The expansion in farm sizes leads to an increase in the challenges associated with crop protection. Therefore, traditional methods of removing weeds such as hand-tilling, clearing with cutlasses, and hoes have become impractical forcing farmers to rely heavily on agrochemicals. While this increases productivity and shield farms from pests, the improper usage or disposal of these agrochemicals could lead to environmental, ecological, and health problems. Consequently, this could undermine the significance of these materials. In the past decade, the increase in the number of illegal mining activities in Ghana has contributed largely to the destruction of most farmlands. As a result, the demand for agrochemical products is on the rise steadily. However, this produces a large number of empty agrochemical containers and bottles in a form of agricultural waste that must be properly disposed of to prevent harm to the environment and humans.

In Ghana, there are prospects for agricultural wastes like residues of crops, animal, and post-harvest wastes which are normally organic in nature. They can be harvested for renewable energy like biomass and transformed into usable clean energy. This significantly displaces fossil fuels, reduces greenhouse gas emissions, and serves as a source of renewable energy. However, wastes such as agrochemical plastics and bottles if not treated, kept or disposed of properly, are likely to cause major environmental harms, resulting in the contamination of soil, air, and water resources and endangering the safety of farm produce, natural environment, as well as a public health[3].

Empty agrochemical containers are considered hazardous and a threat to the environment and human health usage due to their ability to shave residues of pesticides [4,5]. There is a risk that empty agrochemical containers may lead to poisoning when reused to store water and food and might even cause the contamination of soils and water sources. For example, several studies have shown that people who drink 2, 4-Dichlorophenoxyacetic acid (2, 4-D) polluted water are more likely to weaken their hematopoietic system, nephrotoxic and/or hepatotoxic, and reproductive disorders [4,5]. Further, reports on the potential health risk relating to pesticide contamination and disease symptoms were recorded by Gerage et.al. (2017). In their studies, they identified cause and effect relationships between disease symptoms such as vomiting, general body weakness, and acute health issues, tracing the symptoms to pesticide poising at different levels.

Following these, the triple washing procedure and the total disuse of empty agrochemical containers are recommended at the international and rural levels before the practice of alternative disposable measures to preventing the generation of containers at the source of reproductive disorders [7]. To ensure the proper usage of empty agrochemical containers, a proper management strategy for cleansing or decontamination is vital. Despite all these procedures and commendations, efforts to address problems associated with empty pesticide containers have not been adequate, particularly in developing countries [7, 8]. In Ghana, the Environmental Protection Agency (EPA) is the solitary organization overseeing the use of commended pesticides. In 1996, The Pesticides Control and Management Act (528) was publicized to control the appropriate use of pesticides in Ghana. The Act mandates only the EPA to regulate all pesticides imported, exported, produced, distributed, advertised, sold, and or used in the country. The Act, divided into four sections, covers the control of pesticides, the registration of pesticide dealers, the implementation of penalties for defaulters, and general provisions.

Beyond these regulations, limited mechanisms exist to regulate the handling of agricultural waste, especially plastic waste. The lack of a precise approach or plan for the handling of these waste exposes the environment and

humans to the risk posed by these chemicals. The low level of education and research on the responsible management of agrochemical plastic waste may be one of the many reasons for the difficulties in addressing this problem as it creates a gap in knowledge about the appropriate handling of agrochemical products. Yeboah et al., [9] and Mensah et al., [10], revealed that around 82% of Ghanaian farmers have no form of education and not aware of the potential risk associated with improper handling of agrochemical products.

Several reports globally highlight the effects of unsafe handling of agrochemicals on the environment. In Ghana, between the years 1999 and 2000, disturbing levels of pesticide residues, heavy metals, microorganisms, and mycotoxins were identified as street-vendor food samples that were analyzed in Accra [11]. Measurable levels of chlorpyrifos, lindane, endosulfan, lambda, cyhalothr were found in vegetables on the Ghanaian market. Further, lettuce, cabbage, tomatoes, and onions were also found to contain Dichlorodiphenyltrichloroethane (DDT) residues [12,13,14]. Also, studies by Briassoulis et al. [15] in Thailand revealed high concentrations of organophosphate groups of pesticides in sediments due to lack of proper management in agrochemical plastic packages which has created environmental risk. Moreover, a study on the effects of pesticide residues released by pesticide packaging waste chain in Thailand by Patarasiriwong et al.[16] identified high levels of harmful chemical residues in empty pesticide containers, soil, and water samples which may cause potential threats to living organisms and the environment.

Worldwide usage of pesticides tops two million tonnes each year. Europe and the USA account for 45% and 25% respectively of this figure while the rest of the world accounts for 30%. [17]. A review by Sharma...et.al, [18] projects an increase in the use of pesticides by 3.5 million tonnes with China, the USA, and Argentina as the main contributing nations. This elaborates on the merits of pesticide usage in modern agriculture for productivity and sustainable food security. They also drew attention to the harmful effect of pesticides on the ecosystem with possible global harmful environmental issues. To resolve the accumulation of pesticide containers in agricultural lands and communities, various countries made several attempts to manage empty pesticide containers in the late 1990s. The main goals were to protect the environment and the people from exposure and to treat and dispose of used containers safely and appropriately. This would decrease wastes and increase recycling to ensure compliance with local requirements and regulations. Whereas countries like Canada, Germany, Austria, Belgium, Australia, Brazil, and the Netherlands are performing well, many countries still do not have container collection programs. The US container recycling system gathers about 317510 million containers per annum, and Canada, on the other hand, gathers and disposes of 658 tonnes of container per annum.

Per this background and the current situation in Ghana, this study examines the level of knowledge and disposal practices employed by farmers in the Birim South District of the Eastern region of Ghana.

2. METHODOLOGY

2.1 Study Area

The Case study is undertaken in the Birim South District. The study area covers approximately 299.5 km² and situated between the latitude 5°53´39.98´´N and 1°0´55.22´´ W. The area is found within the wet semi-equatorial climatic zone which experiences a considerable amount of rainfall and has a binary rainfall season annually thus from May to June followed by the second phase in September-October. Annual rainfall is between 150cm and 200cm with a relative humidity of 56% during the minor (dry) season and 70% during the main crop(rainy) season. The natural vegetation of the region is a humid deciduous forest with evergreen vegetation. The area is naturally hilly and has streams and rivers serving as a source of drinking water and irrigation for deprived communities. Ochrosols or Oxisols are the major soil types found in this area. Agriculture is the main occupation with the majority of the population cultivating crops like oil palm, pineapple, cocoa, pawpaw, and cola nut. Further, 90% and 10% of the farming population are males and females respectively.

2.2 Data Collection

In the study area, agrochemicals trade and usage are high and cover-up major classes of pesticides like fungicides, insecticides, and weedicides. From four communities (Achiase, Kokobeng, Adiembra, and Akenkansu) with an estimated farming population of 850, simple

random sampling is employed to select 120 farmers. Further, the data was collated using a structured interview, survey questionnaire, and personal observations. The questionnaires administered gathered data on the demographic characteristics of the household, years in farming, education, knowledge, and practices concerning the handling of empty pesticide containers and disposal methods. Discussions with different categories of people including farmers, dealers of agrochemicals, community leaders, and agricultural extension officers were carried out.

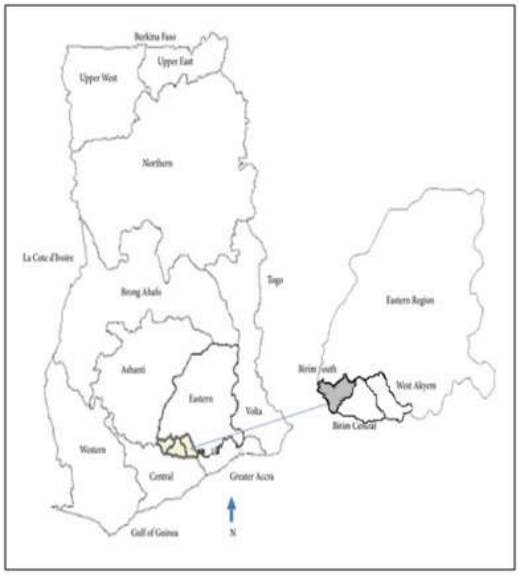

Fig. 1. Map of the case study site

3. RESULTS AND DISCUSSION

In exploring the knowledge level farmers in Birim South District of the Eastern Region of Ghana on the disposal of agrochemical wastes, the results reveal that; except for respondents' level of education with skewness -2.5 of and kurtosis of 4.5, all the variables fall within the acceptable range of normal distribution. See table 1 for details.

On the demographic characteristics of the respondents, although it is encouraging to find that younger people are involved in farming, the mean value of 2.0, symmetrical skewness and, kurtosis of -1.75 reveals that most of the farmers are above 41 years of age. Similarly, male farmers are found to be more than female farmers with a mean value of 1.38 and skewness of 0.52. However, the standard deviation of 0.45 indicates that the gap between male and female farmers is not too wide. The family size of the respondents shows that most of these farmers had at least 5 immediate family members Finally, on education, consistent with the literature, the majority of the farmers are with no formal education. The mean value of 1.8 and a standard deviation of 0.31 reveals the wide gap between primary education and those with no formal education.

Results on the application of pesticides indicate that 95% of the farmers use or have used pesticides on their farms before. This supports the assertion that the growing demand for farm produce drives the demand for pesticides. However, with a mean value of 1.55 and a standard deviation of 0.55 reveal that majority of the farmers have not received any formal training on the safe use and disposal of agrochemical wastes. While this could be explained by the lack of formal education, it also shows the ill-preparedness of the government to support farmers in this regard. Therefore, it is not surprising, when farmers who have not received any extension training on appropriate handling and use of pesticides admit to eating or drinking even when applying pesticides on the field. Furthermore, most of them claim to use personal protection equipment (PPE), but, upon further interaction, it showed that they do not use the commended personal protective equipment. Thus, they wear what they deem fit without taking standard precautionary measures.

Approximately 70% of the farmers who have received extensive training on responsible handling and use of pesticides were aware of the triple rinsing mechanism (rinse 3 times and perforate the container). This indicates that they use this mechanism when applying pesticides on their farms. On the other hand, about 30% of the farmers did not know the triple rinsing mechanism and therefore do not use it. Farmers using the triple mechanism indicated they wash the pesticide bottles as many times as they deem fit to take the maximum possible amount of chemicals out of it. This, they said, dependent on the color of the agrochemical. Therefore, it can be concluded that washing the pesticide bottle is entirely up to the expectations of the farmer in case of emulsion.

In the situation where the pesticide is not colorless or does not produce foam or froth after adding water, farmers usually wash the bottle only once. Farmers who admitted to performing the triple rinsing procedure did do it well due to the low level of education and have resorted to

Table 1. Results of the descriptive analysis

	N	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Age	120	2.000	.0648	.7101	.504	.000	.221	-.991	.438
Gender	120	1.38	.044	.486	.236	.523	.221	-1.756	.438
Household Size	120	1.833	.0713	.7814	.611	.302	.221	-1.298	.438
Level of Education	120	1.89	.028	.312	.097	-2.552	.221	4.591	.438
The Use of Agro Chemicals	120	1.34	.043	.476	.227	.676	.221	-1.569	.438
Extension Training on the Safe Use of Agrochemicals	120	1.55	.046	.500	.250	-.204	.221	-1.992	.438
Method for disposing Empty Agrochemical Containers	120	2.10	.083	.911	.830	-.201	.221	-1.780	.438
Awareness of the Triple Rising Mechanism	120	1.52	.046	.502	.252	-.068	.221	-2.030	.438
Willingness to Remove Empty Agrochemical Containers from Farms	120	1.52	.046	.502	.252	-.068	.221	-2.030	.438
Valid N (listwise)	120								

the normal procedure of single rinsing and sometimes dual rising. These farmers also ignore the standard procedure of perforating empty containers and do not use the required quantity of water in case of rinsing to reduce the residual deposit of the pesticide. According to WHO [19] on the average, 2% of agrochemical is left in the container even after pouring it out into a spray tank and allowing it to trickle, therefore by applying the recommended rinsing procedure, the quantity of the agrochemical left in empty containers could reduce thereby resulting in an increase of original volume of chemical usage by 2%. Moreover, the farmers' practice is not corresponding to the training provided to them by agricultural extension officers. Usually, farmers fill more than half of the bottle with water and add to the spraying tank without shaking the bottle. According to agricultural extension officers, [7] triple rinsing mechanism helps to remove about 99.99% of contaminating deposit that usually sits at the bottom of the container.

It was discovered that a considerable proportion of farmers (60%–70%) are willing to remove the empty agrochemical bottles from their farms after applying pesticides while the rest indicated they discard their bottles on the farm. On how they discarded the empty bottles, 53% indicated they burn them, 25% revealed they burry they and the rest of them indicated they find alternative uses for the bottle that they gather from their farms and this includes washing them and using them as a drinking cup, using them to store seeds and as water troughs for household animals. This is very dangerous and can pose serious health risks to the farmers. The study revealed that about 90% of agrochemical containers in the market are plastic. The absence of agrochemical plastic waste collection scheme or management in the country, and the difficulty with some farmers finding alternative uses to these bottles, has led to the scattering of empty agrochemical bottles on farmlands and in the environment in general.

4. CONCLUSION AND RECOMMENDATION

The results from the knowledge level of farmers in the Birim South District of the the Eastern region of Ghana reveals that; although the majority of the farmers are relatively old, the number of young farmers is encouraging. Further, while male dominates in the number of farmers, the number of females is promising. However, most of the farmers are uneducated. Therefore, this can affect the design of training programs.

The emergence and use of Agrochemicals in modern farming are very vital in enhancing the ability of Ghana to meet its food security objectives and promote economic development, however, uncontrolled usage and improper handling have led to environmental deterioration. This study has shown there is an absence of proper management of agrochemical plastic wastes. Inadequate Knowledge regarding the use and handling of empty pesticide containers is common among farmers in the study site and this poses a potential threat to both direct and indirect users of pesticides in the form of environmental pollution. With the intervention of key stakeholders such as; the Environmental protection agency, Farmers groups, and cooperatives, Non-Governmental Agencies, Municipal and National Agricultural programs, waste management planning, and sensitization on the benefits of averting environmental pesticide pollution, an understanding of the need for action can be created. In the light of this report, it is recommended that national awareness-raising on the safe use of agrochemicals be initiated and studies on the effects of agrochemical use are conducted on human health, the environment, and farm produce.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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