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Pesticide Use and Health Hazards among Small-Scale Commercial Vegetable Growers in the Nsawam Adoagyiri Municipality in the Eastern Region of Ghana

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Abstract
This study examined pesticide use practices and related health hazards in a specific region in Ghana. A cross section survey design was conducted among a sample of 150 small-scale commercial vegetable growers in the Nsawam Adoagyiri municipality in the Eastern region of Ghana. Information on demographic characteristics, pesticide practices and knowledge of health hazards in the interview schedule was administered to the respondents. Univariate and bivariate analyses were then conducted. The results of the study indicate that the mean score for all the various technical competencies of the vegetable farmers is 4.10 on the Likert scale of 1 to 5 and this could be attributed to training they received on pesticide use from extension agents. Not surprising, the respondents generally reported low levels of symptoms from health hazards with mean scores of headaches (1.5), excessive sweating (1.37), dizziness (1.22), diarrhea (1.06) and vomiting (1.04). However, the mean scores for eye irritation (2.65) and skin irritation (2.61) suggested they were common among many respondents based on not using personal protective clothing, including hand gloves (95.3%), face masks (98%), or overalls (96%). It is recommended that small-scale commercial vegetable growers' access to and usage of personal protective clothing be promoted to reduce skin and eye irritation.
Keywords: Pesticides, health hazards, commercial vegetable growers, small-scale farms

1.0 Introduction

The World Health Organization (WHO) estimates that 1-5 million cases of pesticide poisoning occur every year, resulting in 20,000 fatalities among agricultural workers, most of them in developing countries (WHO, 2004). In comparison with other hazardous occupations, agriculture mortality rates over the years have remained high in the world. Farm workers exposed to pesticides are at risk of occupational diseases (International Labour Organization, 2011; Médecins Sans Frontières, 2005). Although developing countries are known to consume less than 20% of the world production of agrochemicals, about 1.1 million (70%) total acute cases are reported among the working population (Médecins Sans Frontières, 2005). A higher proportion of pesticide poisonings and illness occurs in remote agricultural areas where there are inadequate occupational safety standards, insufficient enforcement of pesticide-related legislation, poor labeling of pesticide containers, illiteracy, inadequate protective clothing and washing facilities as well as user's lack of knowledge of pesticide hazards (International Labour Organization, 2011). The inappropriate utilization of pesticides could be associated with the farmers not adequately trained on pesticides usage (Ackerson and Awuah, 2010). Once farm workers are exposed to pesticides, the agrochemicals enter their blood streams through the eyes, nose, mouth and contact skin. Adverse health effects of pesticides may temporarily cause acute effects, such as eye irritation, excessive salivation, or chronic diseases like cancer and reproductive disorders. Restlessness, loss of memory, and convulsion are effects of pesticides on the central nervous system (Magauzi, Mabaera, Rusakaniko, Chimusoro, Ndlovu, Tshimanga, Shambira, Chadambuka & Gombe, 2011; Médecins Sans Frontières, 2005).

For the past two decades, Ghana has exported a vast amount of fresh vegetables. The European Union imported nearly 90,000 tones of fresh produce from Ghana in 2007, which earned the Ghanaian horticulture industry 80 million pounds (Jaeger, 2011; Environmental Protection Agency, 2006). According to the Statistical Research and Information Directorate of the Ministry of Food and Agriculture's projection, the area used for vegetable crop production in Ghana in 2010 was 70,000 Ha (MoFA, 2011). It was also estimated that 87% of farmers use synthetic chemical pesticides to control pests and diseases on vegetables in Ghana (Dinham, 2003; Obuobie, Keraita, Danso, Amoah, 2006). While many concerns have been raised about the production practices employed by vegetable producers, research has provided little or no information regarding the practices of pesticide use in

many parts of Ghana (Dinham, 2003; Obuobie, Keraita, Danso, Amoah, 2006). The Nsawam Adoagyiri municipality in the Eastern region of Ghana has approximately 385 small-scale commercial vegetable farmers registered with the Ministry of Food and Agriculture (MoFA). The vegetable growers are noted to be increasingly using pesticides on their farms. Although there were no reported official statistics regarding pesticide health hazards among vegetable farmers, there have been incidences of skin and eye irritation among quite a few of these farmers (Personal communication with MoFA Extension Officer, 2015). More specifically, there is no data on these small-scale vegetable farmers' pesticide use practices in the Nsawam Adoagyiri municipality. The main objective of this study is to examine the farmers' pesticide use and practices as well as the related health hazards. This study addressed the following questions:

a) What are the socio-economic characteristics of these small-scale commercial vegetable farmers?
b) What pesticide practices do these farmers employ in their vegetable production?
c) Do these farmers engage in pesticide practices that pose threats to their health?

2.0 Literature Review

2.1 General Overview of Pesticides

Pesticides are chemical products that cover a wide spectrum of biologically active compounds, including herbicides, fungicides and insecticides applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport (Dugje, Ekeleme, Kamara, Tegbaru, Omoigui, Onyibe &. Teli. 2008; Boland, Koomen, Lidth de Jeude, & Oudejans, 2004). They help to prevent, destroy or control any animal pest or disease caused by microorganisms as well as unwanted weeds (Ming, 2005). Nevertheless, improper use of pesticides may cause a variety of potential hazards. Pesticides are often highly toxic and persistent, posing a threat to humans, the environment and crops (Pimentel, 2005). Further, pesticides are harmful to animals and microorganisms through direct contact, feeding or other kinds of effective exposure during their stages of growth (Alloway and Ayres, 1997). According to Biney (2005), the symptoms and signs of pesticide poisoning vary with the type of pesticide and the degree of contamination. In a broader sense, the symptoms of pesticide poisoning can be classified as mild, moderate symptoms and severe. Mild symptoms of pesticide poisoning include headaches, dizziness, tiredness, irritation of the eyes, skin, nose and throat and diarrhea, excessive perspiration, and loss of appetite while moderate symptoms are comprised of the inability to walk, general body weakness, chest discomfort, blurred vision, constricted pupils, stomach cramps, vomiting and profuse perspiration. Severe symptoms may include convulsions, loss of consciousness, muscle twitches, secretion from the mouth and the nose, breathing difficulty, and ultimately death.

2.2 Adverse Effects of Pesticide Use on Humans and the Environment

The World Health Organization and the UN Environmental Programme estimate that each year, three million agriculture workers in the developing world experience severe poisoning from pesticides out of which about eighteen thousand die (Miller, 2004). Exposure to high levels of many pesticides has both acute and long-term neurological consequences. They interact with the hormone, estrogen, linking them to increases in breast cancer among many women. The breast cancer rate has be found to raised from 1 in 20 in 1960 to 1 in 8 in 1995 (Colborn, Myers & Dumanoski, 1996), presumably because of pesticides. Pesticides that interfere with the body's endocrine hormonal system are known to cause deleterious reproductive, immunological and developmental effects (McCarthy, 1993). For example, some pesticides have been found to cause testicular dysfunction or sterility (Colborn et al., 1996). There is also evidence that pesticides can bring about sensory disturbances as well as cognitive defects, such as memory loss, language problems, and learning impairment (Hart and Pimentel, 2002). A study conducted by the Northern Presbyterian Agricultural Services (NPAS) (2012) found skin irritation, headaches, general body weakness, difficulty in breathing, and dizziness to be the most common problems experienced by farmers during and after the application of pesticides. The incidence and severity of ill health from pesticide use are far greater in developing countries than in those developed because of under reporting, lack of data and misdiagnosis (1993). The World Resources Institute (WRI) (1998) reported that farmers in the developing world are noted to employ insecticides that are more toxic than those used in developed countries. They also use hand sprayers, thus increasing the incidence of direct contact.

Miller (2004) pointed out that 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non-target species, air, water, and food. According to Jiries, Nasir and Beese (2002), the contamination of lagoons is a major source of concern as it is the natural habitat of fish and other aquatic organisms that are the major sources of protein for most people in Ghana. They also pointed out that uncontrolled chemical activity in water bodies implies a high rate of exposure to humans, who obtain much of their protein nutrition from these sources, and also to those who consume vegetable crops produced using such waters as a means of irrigation. In addition, pesticides end up in the tissue of aquatic organisms and bioaccumulate with time.

2.3 Factors Influencing Small-Scale Farmers' Pesticide Use Practices

Small-scale farmers constitute a significant proportion of the world's population, estimated to be 450–500 million farmers and representing 85% farmers across the globe (Nagayet, 2005). Small-scale farmers are mostly resource poor and lack access to available technology (Todaro, 1989). They also do not possess the appropriate skills and knowledge to properly use new technologies, as in the case of pesticides. Major factors that might be influencing small-scale farmers' pesticide use practices include their socio-demographic characteristics, equipment and technical issues, along with institutional and information problems (Nwangwuma & Okorongo, 2007; Dugje et al., 2008; Abdulsalam, Yaro & Alobo, 2010; Imonikhe, 2010).

2.3. 1Equipment and Technical Issues

Pesticide use is very complex and it is rather difficult for an individual farmer to adopt safe and responsible practices without proper technical training. In Ghana, technical training of small-scale farmers on the application of pesticides and other agriculture inputs has been given little attention and is almost wholly neglected (Offei et al., 2009). As farmers do not have the technical abilities and the equipment they use is obsolete, superfluous amounts of pesticides are unnecessarily applied. Nwangwuma & Okorongo (2007) have documented specifically the misapplication of agricultural inputs by farmers. The authors attributed this to a lack of knowledge on pesticides usage. Generally, most small scale farmers utilize very little or completely lack personal protection during spraying. They sometimes use rubber boots, overalls with long sleeves, gloves and a piece of cloth to cover the mouth (Todaro, 1989; Nwangwuma & Okorongo, 2007). The majority wear trousers and a long-sleeved shirt. However, some wear a short-sleeved shirt and short trousers, with no gloves, and slippers, exposing a greater part of their feet. Moreover, some of these farmers are noted for using their bare hands to mix pesticides in a container. As a consequence, their legs, feet and hands come into contact with the chemicals. Empty pesticide containers are disposed off by throwing them on the field. Where farms are close to waterways, the disposal of unwanted pesticide solutions and empty containers in the field presents a problem for aquatic systems which support varied animal and plant life and serve as sources of livelihood for human communities (Ntow, Gijzen, Kelderman and Drechsel, 2006). Dugje et al. (2008) emphasize that farmers should also be trained in the selection and efficient handling of commonly operated pesticide equipment.

2.3. 2 Institutional and Information Problems

Education has both cognitive and non-cognitive outputs affecting a farmer's productivity. Cognitive outputs of education include the transmission of specific information as well as the development of general skills and proficiencies while non-cognitive outputs encompass changes in attitudes, beliefs and habits (Imonikhe, 2010; Ezeibe, 2011). Increasing literacy helps farmers acquire and understand information and to calculate appropriate input quantities in a modernizing or rapidly changing environment (Ezeibe, 2011). Abdulsalam, Yaro and Alobo (2010) have stated that the level of education of a farmer is an important factor determining their ability to understand policies or programs affecting farming. In a study conducted by Ballara (1991), it was reported that four years of primary education increased productivity by 7.4% with additional benefits in the form of increased modernization of agricultural production incentives, marketing facilities, distribution of seeds and fertilizers, and adequate access to extension programmes. In the analysis of Brood-and-Sell Broiler Enterprise in Enugu State, Nigeria, Ezeibe (2011) also observed that the level of formal education had positive and significant effects on farmers' output. Nwangwuma & Okorongo (2007) described misapplication of farm inputs by farmers based on a lack of knowledge on the correct use of the pesticides. Agricultural extension, a non-formal education, is aimed at improving the skills and knowledge of farmers on appropriate farm practices (Ogunlade et al., 2012; Nwangwuma & Okorongo, 2007). Unfortunately, the agricultural extension service of MoFA in Ghana could not reach every small scale farmer as the field extension staff to farmer ratio stands at 1:1500 or more (Alston & Reding 1998; Chambers 1983; Funk & Downey 1981; Wolf 1995; Ogunlade et al., 2012).

3.0 Methodology

3.1 Design Research

This study employed a cross section survey design in the Nsawam Adoagyiri municipality in the Eastern region of Ghana. Nsawam Adoagyiri municipality is one of the 22 districts within the Eastern Region. It experiences a bimodal pattern of rainfall of 1700mm per annum with mean annual rainfall of 1250mm per annum (Nsawam Adoagyiri Municipal Assembly, 2010). The major rivers in the municipality are the Densu, Ponpon, Dobro, and Nsakyi. Soil types are generally sandy loam but clays are found in the valley bottoms. Major crops grown in the municipality include pineapple, pawpaw, maize, cassava, oil palm and plantain while the major vegetables grown are okro, pepper, garden eggs, onion, cabbage and tomatoes. The economic activities of the people in the area include farming, bread baking, agro-processing, and petty trade. Nsawam Adoagyiri has a total population

of 80,453 people with 4,861 households and a mean household size of 4.2 (Nsawam Adoagyiri Municipal Assembly, 2010).

The target population of the study was all vegetable farmers who had registered with the Extension Service of the MoFA in the Nsawam Adoagyiri municipality. There are 375 registered vegetable farmers. Each of the two (2) main vegetable growing communities in Nsawam Adoagyiri, including Sakyikrom and Pampanso, has 200 and 150 registered small-scale vegetable farmers, respectively**.** A purposive sampling technique was used to select the two (2) communities because almost all registered vegetable farmers are located in these two communities. Quota sampling was employed to select a total of 150 respondents with 85 respondents from Sakyikrom and 65 from Pampanso. A structured interview schedule was utilized to collect information from the 150 respondents as the majority of the farmers could not read or write in English. The interview schedule consisted of four main sections. The first section focused on demographic characteristics of the farmer while the second captured information on farmers' pesticide practices and knowledge. The third section focused on the various pesticides used by farmers. In the fourth section, questions on pesticide effects on humans and the environment were included.

3.2 Analytical Technique

Univariate analysis involving simple percentage, frequency and mean score were computed for respondent levels of health hazards and competency of pesticide usage. Spearman's rank correlation coefficient or Spearman's rho was then computed to discern the relationship between farmers' technical knowledge and pesticide health hazards. The Spearman's rho, a nonparametric statistic, specifically measures the relationship between two variables (Chen & Popovich, 2002).

Mean score

$(\overline{X}) = \sum fx / n$ or $(\sum \& f f^n$

Where X = mean score
$\sum$ = summation
f = frequency
x = Liker nominal score
n = number of respondents

Model Specification

$$\rho = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$$

where Spearman's coefficient is denoted by the Greek letter, ρ(rho), or as r_s.

A sample of size, *n*, and the *n* raw scores, X_i, Y_i, were converted to ranks, x_i, y_i, and ρ was computed from:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}.$$

where $d_i = x_i - y_i$, is the difference between ranks.

4.0 Results and Discussion

4.1 Socio-Demographic Characteristic of Respondents

The results in Table 1 indicated that 135 (90%) of the study participants were male while the remaining 15 (10%) were female. The median age of respondents was 38 years and the median period of cultivating vegetables with pesticides was 3.9 years. The median area of land cultivated by the small-scale commercial vegetable growers was1.5 acres. A little more than half (57.3%) of the respondents had no formal education. However, 101 (67.3%) of the respondents received training on pesticide usage from agricultural extension agents and friends. Study participants having formal education or non-formal education, such as training on pesticide usage, is a very important factor that could influence the proper utility of improved agro pesticides. Although 57% of the respondents did not obtain any formal education, many (67%) of received training on pesticide usage.

Table 1: Socio-Demographic Characteristic of Respondents

Characteristics	Frequency	Percentage
Sex		
Male	135	90
Female	15	10
Age (Yrs)		
20-40	92	61.3
41-60	58	38.7
Educational Level		
Non formal education	86	57.3
Formal education	64	42.7
Access to training on pesticides		
Yes	101	67.3
No	49	32.7
Duration of Cultivation		
1 year- 3years	11	7.3
>4 years	139	92.7
Area Cultivated (Acres)		
≤ 1	84	56.0
>1	65	54.0

Source: Field Survey, 2015

4.2 Distribution of Farmers' Use of Personal Protective Clothing and Precautionary Measures

The majority of respondents reported a lack of and no usage of personal protective clothing, including hand gloves (95.3%), face masks (98%), and overalls (96%), as shown in Table 2. Not having personal protective clothing could expose these farmers to pesticide poisoning. In most developing countries, many small-scale farmers are often exposed to pesticides and they suffer many health hazards (Magauzi et al.; United States Environmental Protection Agency, 2000). Small-scale farmers often do not have the money to purchase protective clothing in combination with not having knowledge of proper pesticide use. However, a number of study participants reported wearing long sleeves and using pieces of cloth to cover their face during the application of pesticides. Although vegetable growers lacked essential protective clothing, they nevertheless took precautionary measures to reduce the negative health effects of pesticides. Table 2 also suggests that 92 (61.3%) of study respondents claimed they changed their clothes immediately after spraying. Almost all (98.7%) of respondents, except one, stated that they washed their hands after spraying pesticides.

Table 2: Respondents' Use of Protective Clothing and Precautionary Measures

Precautionary measures	Frequency	Percentage
Able to read expiry date		
Yes	74	49.3
No	76	50.7
Change clothes after spraying		
Yes	92	61.3
No	58	38.7
Wash hands after spraying		
Yes	148	98.7
No	1	0.7
Hand gloves		
Yes	7	4.7
No	143	95.3
Mask		
Yes	3	2.0
No	147	98.0
Overall		
Yes	6	4.0
No	144	96.0

Source: Field Survey, 2015

4.3 Respondents Technical Knowledge and Practices Pesticides of Use

To measure how knowledgeable respondents were about the proper application of pesticides, they were asked to respond to questions that focused on how well they use and maintain spraying equipment. They were also asked how well they could determine pesticide application rates and methods. The response options ranged from strongly disagree (1), disagree (2), cannot tell (3), agree (4) to strongly agree (5). As shown in Table 3, the mean score of the survey respondents' technical knowledge can be considered high. Table 3 also shows that the respondents' use of pesticide equipment had a technical score of 4.52 and ranked the highest. As well, the maintenance of equipment had a mean score of 4.29 followed by the ability to determine pesticide method of application, having a mean score of 4.00. The mean score for all the various technical competencies of vegetable farmers was 4.10. This implies that technology knowledge of the vegetable growers on the Likert scale of 1 to 5 is high. This could be attributed to training they received on pesticide use from extension agents.

Table 3: Respondents' Technical Knowledge and Practices of Pesticides Use

Capability	**Strongly disagree**	**Disagree**	**Cannot tell**	**Agree**	**Strongly agree**	**Total**	**Mean Score**	**Rank**
Use equipment well	2	3	0	55	90			
	(2)	(6)	(0)	(220)	(450)	678	4.52	**1 st**
Maintain equipment well	2	13	0	59	76			
	(2)	(26)	(0)	(236)	(380)	644	4.29	**2nd**
Determine application rate	13	34	0	61	42			
	(13)	(68)	(0)	(244)	(210)	535	3.57	**4th**
Application method	6	15	0	81	48			
	(6)	(30)	(0)	(324)	(240)	600	4.00	**3rd**

Source: Field Survey, 2015

4.4 Symptoms Associated with Pesticide Usage

The respondents were also asked to indicate their feelings regarding specific health hazards during pesticide application, with response options ranging from nil (1), very low (2), high (5) to very high (6). As seen in Table 4, the mean score for eye irritation is 2.65 (low) and it was ranked the highest. The mean score for skin irritation was 2.61 (low) and is ranked after eye irritation. These two symptoms were commonly reported by the respondents because they did not use hand gloves, masks, or overalls during spraying. The rest of the health symptoms reported by the respondents were rated with low mean scores, including headaches (1.5), excessive sweating (1.37), dizziness (1.22), diarrhea (1.06), and vomiting (1.04). Generally, the respondents experienced few symptoms of the health hazards associated with pesticide use. This observation could be attributed to the farmers' use of other protective clothing and taking precautionary measures during and after spraying, including changing of clothes and washing of hands. Farmers' high technical knowledge also most likely fostered their taking precautionary measures.

Table 4: Symptoms Associated With Pesticide Usage

Symptoms	**Nil**	**Very low**	**Low**	**Moderate**	**High**	**Very high**	**Total**	**Mean Score**	**Rank**
Headache	124	0	5	18	0	3			
	(124)	(0)	(15)	(72)	(0)	(18)	229	1.53	3rd
Dizziness	139	0	2	5	0	4			
	(139)	(0)	(6)	(20)	(0)	(24)	183	1.22	5th
Sweating	132	0	4	8	0	5			
	(132)	(0)	(12)	(32)	(0)	(30)	206	1.37	4th
Skin irritation	81	0	5	44	0	20			
	(81)	(0)	(15)	(176)	(0)	(120)	392	2.61	2nd
Eye irritation	82	0	5	39	0	24			
	(82)	(0)	(15)	(156)	(0)	(144)	397	2.65	1st
Diarrhea	147	0	0	3	0	0			
	(147)	(0)	(0)	(12)	(0)	(0)	159	1.06	6th
Vomiting	148	0	0	2	0	0			
	(148)	(0)	(0)	(8)	(0)	(0)	156	1.04	7th

Source: Field Survey, 2015

4.5 Relationship Between Farmers' Technical Knowledge and Pesticide Health Hazards

The literature reveals that small-scale farmers' access to training would increase their knowledge and skills to properly apply pesticides and take the necessary measures to reduce pesticide poisoning (Imonikhe, 2010; Ezeibe, 2011). In Table 3, the results of the study revealed that the vegetable farmers had high technical skills and knowledge of pesticide usage. The results in Table 4 also indicate that vegetable farmers reported experiencing low levels of symptoms related to pesticide use. It is therefore anticipated that the high level of farmers' technical competency could be associated with the low level of health symptoms during and after pesticide use. In order to investigate this, a Spearman rank correlation was conducted to examine if any relationship exists between farmers' technical knowledge and their experience of symptoms from pesticide hazards. In general, the results in Table 5 portray a negative relationship between the various symptoms of pesticide health hazards and famers' technical competency. Although most of the Spearman rank correlation values are not significant, the negative relationship implies that enhanced training of the farmers, proper use of spraying equipment, as well as employment of precautionary measures are associated with decreases in health symptoms among farmers during pesticide use.

Table 5: Relationship Between Farmers' Technical Knowledge And Pesticide Health Hazards**.**

Symptoms	Training on use of pesticides	Use equipment well	Change clothes after spraying	Use of hand gloves	Use of Mask
Dizziness	.011	-.032	-.094	.062	.040
Sweating	-.134	-.001	.005	-.227**	-.111
Skin irritation	-.244**	.092	-.085	-.101	-.116
Eye irritation	-.166*	-.018	-.092	.061	.006
Diarrhoea	.160	-.094	.016	.026	.017
Vomiting	.160	-.094	-.027	.026	.017
Headache	-.071	.116	.071	-.236**	.065

Note. Correlation is significant for coefficients: p*<.05; p**< .01.

5.0 Conclusion

The main aim of this study is to examine pesticides use and related health hazards among small-scale commercial vegetable growers in the Nsawam Adoagyiri Municipality in the Eastern Region of Ghana. The results of the study show that, in generally, the respondents experienced few symptoms of the health hazards associated with pesticide use. The vegetable growers demonstrated high level of technical knowledge and took the necessary precautionary measures during and after spraying, including changing of clothes and washing of hands to reduce the incidence of chemical poisoning. Nevertheless, eye and skin irritations were the two common health hazards that affected many of respondents due to their failure of not using personal protective clothing, including hand gloves, face masks, or overalls. It is recommended that the small-scale commercial vegetable growers be empowered to access and use personal protective clothing to reduce skin and eye irritation.

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