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Advances in Pesticide Use in the Cocoa Belts and Perceptions of Vegetable Farmers

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Abstract

Chemical pesticides are commonly used in the management of pests and diseases in vegetable production in Ghana. However, there is increasing concern about the adverse effects this use has on public health and the environment. A study was conducted to assess how much farmers' know about the safe handling and use of pesticides, and what they perceive to be the hazards around their use. In-depth field surveys was undertaken with 437 sampled vegetable producers and complimented with focus group discussions and field observation. The results revealed that knapsack sprayers were the most widely used equipment for spraying pesticides (92.4%), followed by hand-held applicators (4.5%) whereas only 3.1% used motorised sprayers. Only 15.6% of the respondents fully protect themselves during spraying operations; others either wore partial protective clothing (38%) or did not wear any protective clothing at all (46.4%), thereby coming into direct contact with pesticides. Over 80% of the respondents re-entered their farms within 3 days of pesticide application; harvest their produce within 7 days, without observing safe harvest interval protocols. The study also revealed that the farmers were aware of and had experienced pesticide hazards such as headache, dizziness, body weakness, and itching. Three per cent of the farmers also mentioned burning sensation, catarrh, stomach pain, unconsciousness, itching of eyes and body pains as side effects from pesticides application. Females and illiterates were found to be more vulnerable to these hazards than their male and literate counterparts. The study findings show that most farmers dispose of empty pesticide containers (59.8%) and wash water from sprayers (79.2%) by throwing or disposing them on their farms. The study concludes that farmers are misapplying pesticides by disregarding the potential harmful effects of pesticides on human health and the environment.

Keywords: Pest management; Pest control; Crop protection practices; Agricultural knowledge and information systems; Farmers' perceptions; Hazard; Pesticide policy

Introduction

Vegetables are the most important ingredients of human diets for the maintenance of good health and prevention of diseases. Cultivation of vegetables is an excellent source of employment for both rural and urban dwellers as it takes place in many rural areas through truck farming and in the outskirts of towns and cities in the form of market and backyard gardening to supply fresh produce to urban markets [1]. It thus plays an important socio-economic role as well as in diversifying diets for improved nutrition [2]. Ghana benefits from considerable foreign exchange through the export of vegetables such as okra and chillies to European countries including Belgium, Britain, Germany, Italy, and Switzerland [3,4]. Chilli exports for instance have ranged between 26,000 and 41,000 MT per annum over the past 5 years with corresponding foreign exchange from US$18.2 to US$28.7 million [4].

As vegetables are generally susceptible to a wide range of pests and diseases, these are major constraints to vegetable production in Ghana and require intensive effort in their management [2,5]. The increased demand for food, particularly to feed the growing urban population in Ghana, has necessitated an expansion and intensification of agriculture and horticulture and a concomitant increase in the use of synthetic pesticides for food production [6], particularly for the production of high-value cash crops and vegetables [1,7]. However, these pesticides are often applied indiscriminately and inappropriately, resulting in adverse environmental and health effects, and negative effects on other economic activities such as fisheries and tourism [2,8,9].

In the cocoa belts of Ghana it is likely that pesticides approved for controlling diseases and pests on cocoa are used instead on vegetable crops or vegetables are contaminated with these pesticides when intercropped with cocoa.

The World Health Organization (WHO) reports that 20% of pesticide use in the world is concentrated in developing countries posing a danger to human health and the environment [10]. Families residing in agricultural areas were found to have elevated levels of pesticides in their bodies [11]. These were greater in homes located closer to fields [12]. Problems experienced by farmers during and after the application of pesticides have been well documented in Ghana [2,13]. A survey carried out by the Northern Presbyterian Agricultural Services (NPAS, 2012) on 183 farmers in 14 villages in the Upper East region of Ghana found that more than a quarter had recently suffered from directly inhaling chemicals and one fifth from spillage of chemicals on the body [14]. A study on the analysis of pesticide contamination on farmers in Ghana also found the presence of organochlorine pesticide residues, including dichlorodiphenyltrichloroethane (DDT), in the breast milk and blood of vegetable farmers [13].

The Ghanaian public and government are becoming aware of the increasing and excessive use of chemical pesticides by vegetable farmers and that if agricultural production is to be safe and sustainable then this trend should be reversed [15]. While the better educated or more informed populace in Ghana are increasingly concerned about the long-term adverse effects of pesticides on the environment and the health of the country's resources, little scientific research has been done to properly characterize, quantify or address the issue. This study was aimed at better understanding how vegetable farmers in the cocoa belts of Ashanti and Western Regions of Ghana use pesticides, and their knowledge and perceptions of appropriate pesticide use and the associated risks involved. These are important pre-requisites for the development of more appropriate and sustainable pest management options and tools, and better pesticide policies or guidelines.

Materials and Methods

Population and sampling approach

The study population was vegetable farmers in the cocoa belts of the Ashanti and Western regions of Ghana. Reconnaissance surveys in Ashanti and Western regions allowed familiarization with the study area after which multi-stage sampling was used for the in-depth one-on-one interviews. Through interaction with the Vegetable Growers' Association and the regional directorate of the Ministry of Food and Agriculture, information such as which were the most important vegetable growing areas in each region, was obtained to guide the sampling plan. Offinso North, Atwima Nwabiagya, and Amansie East districts in the Ashanti Region, and Sefwi Bekwai, Bibiani-Anwiaso-Bekwai, and Prestea-Huni Valley districts in the Western Region, were then selected for the survey. These districts were selected purposely from each region to reflect the importance and scale of vegetable production, diversity of vegetables grown, and technology levels in vegetable production in the study area. The sample size of respondent farmers was proportionate to the total number of vegetable farmers in each region and district. A total of 437 farmers were interviewed.

Up to five communities from each district were selected for the study based on criteria including poverty and population density thresholds, access to pesticides and produce markets and other institutions, natural resources integrity, and farming systems.

Instrumentation and data collection

The study used participatory tools and techniques for data collection, including in-depth interviews with vegetable producers, focus group discussion (FGD) with farmer groups, use of observational checklists on the selected communities and in farmers' fields, and key informant interviews with officials from the Plant Protection Regulatory Services Division of the Ministry of Food and Agriculture, including pesticide inspectors. Secondary data on the list of registered pesticides was obtained from the Environmental Protection Agency (EPA). Four survey instruments were developed, and their content validated for use with the specific respondent types. Ten enumerators from the area were trained in the administration of the data collection instruments. Structured interview schedule with both open ended- and closed ended- questions was prepared and pre-tested to determine the ability of enumerators to administer it. The questions were written in English and administered in the corresponding lingua franca (Akan) of each community. The one-on-one survey instrument comprised of two categories of questions based on (i) household socio-economic and farm characteristics of respondent farmers (i.e., age, sex, educational background work experience, size of farm under vegetable cultivation) and (ii) pesticide use practices and management (i.e., sources and types of pesticide acquisition, time and frequency of pesticide application, the use of protective clothing, knowledge of pesticide hazards, re-entry and pre-harvest intervals, disposal of pesticide containers etc.).

Information from the structured interviews were complemented with informal focus group discussions comprising of 6 to 12 respondents per group with the help of a facilitator. Two to three farmer groups were purposively selected from each of the four communities from each district with help of agricultural extension agents. At the group meetings information was gathered on vegetable cropping systems, type of vegetables grown, farmers' perception of pesticide use, constraints in the use of pesticides, and poverty indices among others.

Farmers' perceptions on pesticides and health risks were assessed with the farmer groups through a modified ranking game described by Warburton et al. [16] and modified by Ntow et al. [2]. All participants were individually shown empty containers and/or labels of pesticides commonly available in the study area. The containers and/or labels were shown one by one, and the names of the pesticides were read out to ensure that each participant knew what it was. They were asked which ones they recognised (but not necessarily used); the unfamiliar pesticides were removed and noted in the questionnaire. From the familiar containers and/or labels the respondents were asked which ones were thought to be generally effective in controlling popular identified pests (fungi, insects, weeds, and nematodes) hence dividing the containers and/or labels into two piles: 'effective' and 'ineffective'. The 'ineffective' pile was removed and the 'effective' pesticides were ranked according to degree of effectiveness in destroying/controlling specific identified pest and perceived hazardous side effect on humans resulting from application on crops. Once the pesticides were ranked as per the stated criteria, respondents were asked to describe how effective each pesticide was on a likert scale of 1-5 (Table 1). Respondents were finally asked their reasons for ranking a particular pesticide as the most effective. In situations where empty containers and/or labels of the target pesticides were not available for recall purposes, farmers were asked to list the pesticides they use and rank them accordingly. Ranking of pesticides in terms of their hazard levels followed a similar pattern. Farmers were asked to select and rank empty containers and/or labels of pesticides thought to be hazardous in terms of their combined perceived side effects (i.e., contact with undiluted concentrate, ingestion of undiluted concentrate, inhaling-in chemical during spraying) on human health through application. Responses were again ranked on a likert scale of 1-5 (Table 1) with reasons assigned for ranking a particular pesticide as most hazardous. The relationship between farmers' perception of pesticide hazard and pesticides' perceived effectiveness against pests was assessed by the $\chi 2$ test proposed by Ntow et al. [2].

Using a checklist, observations were made on the selected communities for socio-economic indices such as road access to the community, housing types, water delivery system, marketing facilities, and education infrastructure and facilities. Observations were also made on selected farmers' fields for vegetable cropping system, pests and disease incidence and severity, pesticide use and management, pesticide types, pesticide storage system, type of irrigation facilities, type of land preparation methods etc. Collected data was analysed using descriptive statistics (means, frequency distributions, and percentages), inferential statistics (chi-squared test), partial budgeting and cost analysis. Microsoft 'EXCEL' and IBM 'Statistical Package for the Social Sciences (SPSS)' Software Package Version 16 were used to process the elicited data.

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Effectiveness	
1	Very effective: 75-100% of identified pest killed
2	Effective: 50-75% of identified pest killed
3	Small effect only: < 50% of identified pest killed
4	No effect
5	Makes the effects of the identified pest problem worse
Hazard	
1	Extremely hazardous: likelihood of hospitalisation or long-term illness
2	Moderately hazardous: likelihood of more than 2 days sick and need to see a doctor
3	Slightly hazardous: likelihood of dizziness or vomiting or blurred vision or skin sores
4	Least hazardous: likelihood of some dizziness, tiredness, or headache
5	No effects

Table 1: Description of ranking levels used for pesticide ranking game.

Results and Discussion

Household and farm characteristics of respondent farmers

Most of the respondent household heads were male (75.9%), within 40-49 years age bracket (35.7%) as indicated in Figure 1 and had achieved a Middle School or Junior High School certificate (42.6%) (not reported). This is an interesting result since farmers within 40-49 years age bracket are a very component of the active labour force are mostly literate. Thus adoption of improved farming methods and/or technology for this age group can be better enhanced. This makes the prospects of an improved vegetable production very positive. However, 22.2% of the household heads are illiterates. This is of critical concern for the growth of the vegetable production industry since abuse of pesticide by vegetable farmers has been partly attributable to their high illiteracy levels [17]. The size of farms of the majority of the respondents ranged from less than (0.4 ha) up to 4 ha and is in conformity with the observation that, the majority of respondents in the study area are smallholder farmers. It is indeed reported that agriculture is predominantly on a smallholder basis in Ghana [18]. Vegetable farmers with less than 10 year's experience in farming constitute 40.3% but the number of farmers decreased with increased number of years in farming (Figure 1). This indicates that the number of people engaging in vegetable production is increasing, perhaps because of increasing demand for vegetables for the increasing urban population.

Pesticide acquisition and storage

Majority of the farmers (90.8%) obtain their pesticides from local agrochemical input dealers (Figure 2). This is not surprising as the majority of the respondent base are unable to distinguish between different pest and disease pathogens and control measures such as insecticides and fungicides and rely on information and advice provided by local agro-input dealers for the decision making. In the course of the focus group discussion however, farmers did classify and confirm that some pesticides were deemed effective on some vegetables and not on others Consequently, farmers perception of the effectiveness of chemical pesticides based on advice provided by agro-input dealers in managing pests and diseases in vegetables might be a major contributing factor to their excessive use and hence their abuse or misuse, as has already been earlier reported.

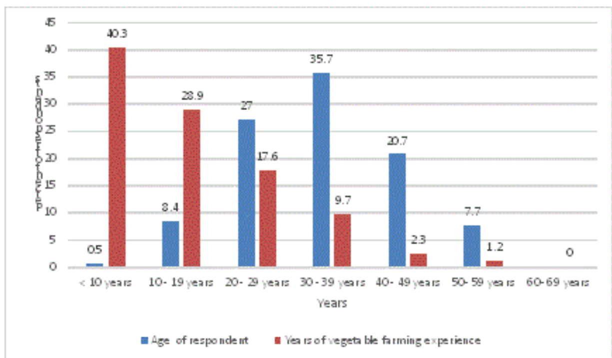

Figure 1: Household and farm characteristics of respondent farmers.

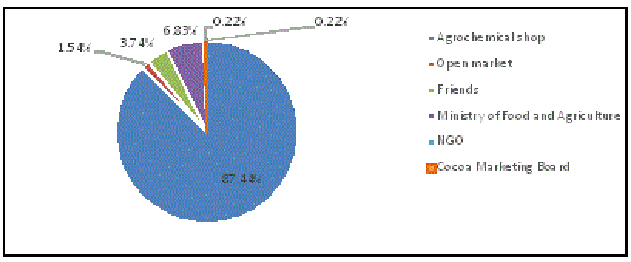

Figure 2: Source of agrochemicals by respondents.

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Continuous use of the same pesticide against a particular pest can lead to the development of resistance by the pest against the pesticide, thereby rendering the pesticide ineffective [19]. Unfortunately, this is the currently being practised by most of the vegetable farmers (77.4%) in the surveyed communities and perhaps several other parts of Ghana. Field observations showed for example that, in Sefwi Bekwai, a large cultivated cabbage farm had been abandoned by a respondent prior to crop maturity. This observation is partly attributed to ineffectiveness of various pesticides applied on the field to control the diamond back moth that is the major pest of crucifers. The concerned respondent confirmed that he applied four different types of insecticides on the cabbage plants with the perception that diverse combination of chemicals might be more effective than a single type. After probing further, it was later discovered, that the 4 different insecticides that were applied had the same active ingredient and similar concentrations, albeit with different trade names, a fact that is hardly understood by the farmer.

Results from Figure 3 show that, even though majority of the respondents (81.6%) appear to store pesticides at a safe place that is under lock and key after procurement, a large number of them (17.6%) store them in their bedrooms, thereby exposing them to toxicity through direct inhalation of the pesticides. Ntow [2] for example confirms that storing pesticides in open accessible places such as bedrooms may lead to acute and/or chronic exposures, with adverse health consequences [2]. It has also been reported that in late 2010, 15 farmers died from suspected pesticide poisoning in Upper East region of Ghana and most of these deaths resulted from poor storage of pesticides, which seeped into food stocks [14].

Pesticide use by vegetable farmers

Over half of the farmers (56.8%) had received training on safe handling and application of pesticides, while 43.2% had received no training (Table 2A). The observed results are consistent with the findings of Fianko et al. [20] for the Densu River basin of Ghana. The relatively large cohort of respondents with no technical knowledge in pesticide use can be a major source of worry given the absence of farmer training has been found to further increase the heightened danger of pesticide misuse and abuse in vegetable production [21]. The misuse of pesticide by the farmers can also endanger their health and that of consumers as well as the environment [8]. It appears that even those who claim to have received some form of official training seemed to be still misusing and abusing pesticides in their vegetable fields. For instance, results from Table 2C indicate that most farmers apply the pesticide either at the sight of a pest and/or disease (52.2%) or according to crop calendar (45%), corroborating the report of Amoako et al. [22].

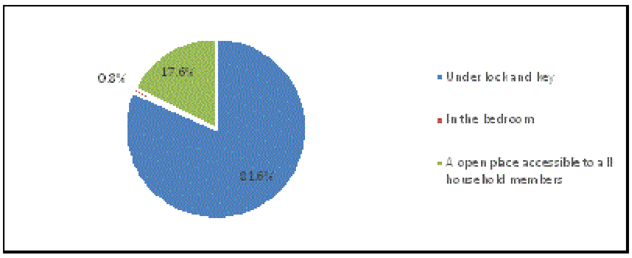

Figure 3: Mode of pesticide storage after harvest.

As noted in Table 2E, pesticide mixture preparation for spraying were done mainly by shaking knapsack sprayers as represented by 47.8% of respondents or using a stick (43.8%). Some respondents (6.2%) however confirmed mixing pesticides with their bare hands. This is obviously unacceptable and disturbing since the farmers concerned will be directly exposed to the hazardous of the pesticides. As reported by Amoako et al. [22], most farmers mix two or more pesticides together without considering their compatibility or active ingredients but rather rely on the perceived efficacy based on their trade names. Mixing of pesticides was encouraged by the farmers' desire to have rapid knockdown of pests or the economics of managing both pests and diseases at a single spraying operation. This idea is however, questionable, at least as practised [2], because the combinations used could be indiscriminate and incompatible resulting in ineffectiveness of the pesticides to manage the pests and diseases [2,23]. This findings are also consistent with that of Biney [24] who attributed the increase in incidences of insect pest infestation of tomato in Ghana to the practice of using indiscriminate combinations of pesticides, particularly of insecticides.

With respect to pesticide application procedures, the knapsack was the most popular spraying equipment used (88%), though a few farmers did use motorised sprayers/mist blowers (3%) and hand held applicators (4.3%) as confirmed in Table 3B. Lack of capital was the main reason for farmers' inability to buy required equipments such as motorised sprayer, hence their intended use of knapsack sprayers. Over 17% of respondents were found not to own a sprayer at all.

Variable	**Total respondents**	
	N	%
Have you ever received training on safe handling and application of pesticides?		
Yes	248	56.8
No	187	43.2
Total	435	100
Source of farmers' knowledge on pesticide application rates		
Pesticide dealer	54	20.1
Fellow farmer	48	17.8
Agricultural extension agents	149	55.4
Media (Radio, TV, Newspaper)	22	8.2
Pesticide label	6	2.2
COCOBOD	5	1.9
NGOs	6	2.2
School	2	0.7
Government	1	0.4
Total	269	100
Timing of pesticide application		
When first symptoms of pests /diseases are observed	229	52.2

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Based on severity of pest infestation / disease infection	30	6.9
Based on crop calendar / date of transplanting	197	45
Based on advice from Agricultural Extension Agents	1	0.2
Do you mix different kinds of pesticides?		
Yes	186	42.6
No	251	57.4
Total	437	100
How do you mix pesticides?		
With bare hands	25	6.2
With stick	178	43.8
Shaking the sprayer	194	47.8
Wear hand gloves and protective eye goggles	9	2.2
Total	406	100
What direction do you spray?		
With the wind	283	76.1
Against the wind	6	1.6
Perpendicular to the wind	33	8.9
Don't consider the wind	50	13.4
Total	372	100
Do you eat or smoke while spraying?		
Yes	8	1.8
No	429	98.2
Sign to indicate to people field has being sprayed with pesticide		
Sign board	27	6.6
Red flag	24	5.9
Empty pesticides bottle	31	7.6
None	327	80
Total	409	100
Farmer re-entry interval (days)		
Same day	23	5.7
1-3	321	79.65
4-7	56	13.9
8-14	3	0.7
> 14	0	0
Total	403	100
Pre-harvest interval (in days)		
Same day	6	1.4
1-3	38	9.1
4-7	319	76.3
8-14	48	11.5
> 14	7	1.7
Total	418	100.0

Table 2: Pesticide application by vegetable farmers.

In the course of the focus group discussions, some farmers without access to a knapsack sprayer reported using a brush, broom or leaves tied together to splash pesticides from a bucket as their means of spraying. Consequently, such practices expose users to the harmful effects of pesticides, especially as most of the farmers do not wear protective clothing when spraying.

Most farmers own and utilize a knapsack sprayer, yet the use of this type of sprayer in itself presents some danger to the user. According to Ntow et al. [2], it is prone to leakage, especially as the spray equipment ages. Matthews have identified causes of leakage from the knapsack and have emphasised the need to provide better-quality equipment at an affordable cost that will be more durable in a hot and humid tropical environment such as sub-Saharan Africa.

Most farmers are adopting safer pesticide application practices such as spraying against the d wind irection, not eating or smoking during spraying so as to prevent respective potential dermal and oral contamination with pesticides. However, majority of the respondents do not display warning signs after spraying so as to prevent public or any member of the household from entering a sprayed field. This is not surprising because majority of the farmers even re-enter a sprayed field within 24 hours. This could be a major reason why pesticide poison is common among most smallholder farmers in Ghana.

The study further revealed that most vegetable farmers harvest their produce within 7 days after spraying pesticides with some harvesting their produce on the same day after spraying, thereby endangering the lives of consumers. Amoako et al. [22] also reported that majority of cabbage farmers in the Ejisu-Juaben Municipality of the Ashanti Region of Ghana continue spraying pesticides during produce harvesting, hence no waiting period is observed, thereby exposing consumers to high pesticide residue levels. Residues of Chlopyrifos (Dursban), lindane, endosulfan, Karate and DDT have been detected beyond maximum permitted residue levels in samples of lettuce from major markets from Kumasi, Accra and Tamale [6]. Darko and Akoto [25] also assessed contamination levels and health risk hazards of organophosphorus pesticides residues in tomatoes and eggplant and showed that health risks are associated with levels of pesticides exceeding the recommended doses for these vegetables. Death cases resulting from consumption of pesticide contaminated vegetables have already been reported in some parts of the country. In early December 2010, the then Upper East Regional Minister, Mark Woyongo, announced that 12 farmers had died after eating food contaminated with pesticides, and that a further 63 had been treated and discharged from hospital [26]. Personal communication with some consumers indicates that they are very wary of consuming vegetables such as cabbage and okra which they believe are contaminated with pesticides.

Disposal of pesticides containers and waste water by the vegetable farmers

The commonest way of disposing of empty pesticide containers (59.8%) and waste water from the sprayer (79.2%) among the respondent farmers was by throwing or discharging them on the field (Tables 3A and 3E), as also confirmed by Ntow et al. [2]. During field observation, empty pesticide containers were found loitered in some farms (Plate 1 and Plate 2), and in some farms the containers were found close to water bodies. This can potentially pollute the water bodies which are sources of livelihood for human communities and support varied animal and plant life as also reported by Ntow et al. [2]. The authors further asserts that accumulation of such agrochemical pollutants in the tissues of non-target fauna and flora, which ultimately accumulate in the food chain, may restrict the consumption of valuable food resources such as fish. It is therefore not surprising that organochlorine pesticide residues (DDE) was detected in tilapia fish and water samples from Lake Bosumtwi and in fish samples in four Lagoons in Ghana [27-29]. The health risk associated with pesticide contamination of fish from the Densu River Basin in Ghana have also been reported by Fianko et al. [20].

It was also revealed during the group discussion that some farmers use the empty pesticide containers for storing food items such as salt and palm oil, and as containers for kerosene. This practice appears to be common among farming communities in Ghana. NPAS [14] has also reported a widespread re-use of containers for storing food or water for humans or livestock.

Variable	Total respondents	
	Frequency	Percentage
Disposal of empty pesticide containers		
Incineration	52	13.1
Burying	100	25.3
Throw away on farm	237	59.8
Throw away in town or village	7	1.8
Total	396	100.0
B. Type of sprayer used		
Knapsack sprayer	388	92.4
Motorized sprayer/Mist blower	13	3.1
Hand held applicator	19	4.5
Total	420	100.0
Own a sprayer		
Yes	350	82.7
No	73	17.3
Total	423	100.0
Do you wash sprayer after use?		
Yes	335	76.7
No	102	23.3
Total	437	100
Disposal of waste water		
On the field	346	79.2
In nearby stream	7	1.6
On floor within premises of own household	14	3.2
In a septic tank within compound	2	0.4
At nearby bush	24	5.4
Bury waste in a hole	1	0.2
Spray over the waste (garbage heap)	1	0.2
In a dug pit	1	0.2
Total	396	100.0

Table 3. Disposal of pesticides containers and waste water from sprayers.

Plate 1: Insecticide containers found in a cabbage farm at Sefwi Bekwai in the Western Region of Ghana

Farmers' knowledge of pesticides hazards

Results from Table 4E show that, the most common pesticide poisoning side effects mentioned by the farmers based on multiple responses were itching (64.3%), headache (26.1%), weakness (24.3%) and dizziness (11.7%). Some farmers also mentioned burning sensation, catarrh, stomach pain, unconsciousness, itching of eyes and body pains as hazards associated with use of pesticides. The findings of this study therefore corroborates that of Ntow et al. [2] and NPAS [14] who concluded that the most common symptoms of pesticide poisoning among Ghanaian farmers include skin irritations, headaches, general body weakness, difficulty in breathing and dizziness.

Only 15.6% of the respondents protect themselves fully during their spraying operations; others either wear partial protective clothing (38%) or do not wear any protective clothing at all (46.4%) and come into direct contact with the pesticides (Table 4B). This may partly explain why majority of the respondents said that the pesticide solutions come into contact mainly with their hands (53.8%), back (48.1%), feet (33.2%), and face (3.1%) resulting in poisoning.

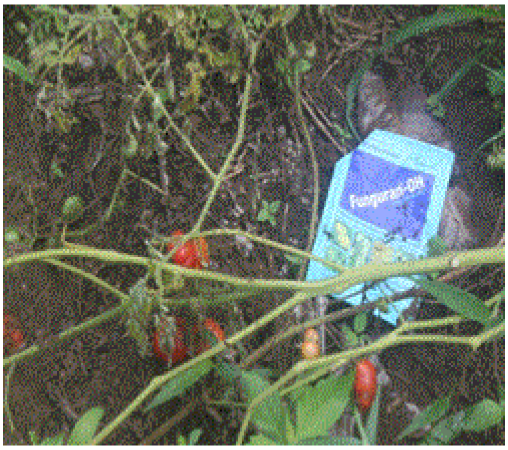

Plate 2: Fungicide container f ound in tomato field at Akumadan in the Ashanti Region of Ghana

A survey of pesticides use among farmers in the 3 Northern regions of Ghana also revealed that most farmers fail to use any protective equipment while virtually no farmers use all the recommended equipment [14]. It is reported that Ghanaian farmers who use chemical pesticides to control insects and diseases on their crops are potentially exposed to pesticides through the skin, on the eyes or through inhalation or ingestion, with key risks being death, cancer, birth defects and damage to the nervous system [14]. Apart from not wearing protective clothing, about 25% of the vegetable farmers do not change their clothing immediately after spraying operation, leading to their long exposure to the pesticides, with consequent poisoning.

Variable	**Total respondents**	
	Frequency	Percentage
Likert scale ranking of pesticide hazards on a scale 1-10 (1 is lowest risk and 10 is highest risk)		
1	19	5
2	35	9.3
3	29	7.7
4	65	17.2
5	47	12.4
6	56	14.8
7	20	5.3
8	70	18.5
9	4	1.1
10	33	8.7
Total	378	100
Type of protective cover used		
No protective cover	193	46.4
Partial protective cover	158	38.0
Full protective cover	65	15.6
Total	416	100
Part of human body where does pesticide solution comes into contact?		
Hand	235	53.8
Feet	145	33.2
Back	210	48.1
Face	14	3.1
Lower abdomen, waist and thighs	4	0.8
Any part	1	0.2
Do you change clothes right after spraying?		
Yes	310	74.9
No	104	25.1
Total	414	100
Common symptoms associated with frequent pesticide poisoning among farmers		
Headache	114	26.1
Dizziness	51	11.7
Vomiting	6	1.4
Weakness	106	24.3
Itching	281	64.3
Stomach pain	7	1.6
Unconsciousness	7	1.6
Burning sensation	14	3.1
Catarrh	11	2.5
Itching of eyes	4	0.8
Body pains	1	0.8
Nausea	1	0.2

Table 4: Farmers' knowledge of pesticide application side effects.

Relationships between pesticide side effects and gender, education and age of the farmers

The susceptibility of male and female farmers to the hazards of pesticides differed among the farmers interviewed (Table 5). For common symptoms of pesticide poisoning such as headache, dizziness, vomiting and stomach pains, females were found to be more vulnerable than males. However, male farmers were equally as susceptible as their female counterparts with respect to itching which is the most common symptom reported by both genders. This perhaps explains why pesticide application is usually carried out by males.

Generally, farmers with no formal or non-formal education were more likely to be affected by the pesticides as they complained of more poisoning symptoms than those who have received formal education (Table 6). This findings partially agrees with Asante and Ntow [17] who reported that workers exposed to pesticides are often illiterates, and lack training, equipment, and the necessary safety information. There appears to be no clear association between pesticide poisoning symptoms and the farmers of the various age groups. However, only young farmers within the age group of 10-19 years did experience body pains (Table 7). This indicates the vulnerability of young farmers to pesticide poisoning. This agrees with Ntow et al. [2] who reported that generally, possible poisoning cases are reported more among the young than the aged farmers. Caution should however be exercised not to overemphasize our present study findings, as only few farmers (2%) were within this age category. Ntow et al. [2] however, observed that the percentage of farmers reporting about body weakness and itching/ irritation increased from a younger group to a relatively much older aged group whereas headache/dizziness were reported more among the younger group. It was also observed that farmers with all age distribution reported more of itching than the other symptoms.

Symptoms of pesticide poisoning	Female (n=105)		Male (n=330)	
	F	%	F	%
Headache	35	33.3	79	23.9
Dizziness	25	23.8	26	7.9
Vomiting	3	2.9	3	0.9
Weakness	34	32.4	72	21.8
Itching	65	61.9	215	65.2
Stomach pain	1	1.00	6	1.8
Unconsciousness	3	2.9	4	1.2
Burns	0	0.0	14	4.2
Body pains	2	1.9	2	0.6
Catarrh	2	1.9	8	2.4
Eye irritation	0	0.0	4	1.2
Nausea	0	0.0	1	0.3
Sneezing	0	0.0	1	0.3

Table 5: Relationship between pesticide poisoning and gender.

Types of pesticides applied in vegetable production

A total of 43 pesticides were found in use for vegetable farming in the Ashanti and Western regions of Ghana. The pesticides consisted of 7 fungicides, 9 herbicides and 30 insecticides (Appendix 1). It is important to note that one systemic insecticide, Carbofuran is used by most farmers both as an insecticide and nematicide as they perceive and have also found it effective in the short-run. The class of pesticides commonly used by vegetable farmers in the surveyed area was insecticide (61.7%), followed by fungicide (32.7) and herbicides (5.5%). On the contrary, in a similar work conducted in Ghana by Ntow et al. [2] herbicide was found to be the most commonly used pesticide (44%), followed by insecticide (33%) and fungicide (23%).

Type of poisoning effect	Educational background of farmer					
	No Formal Education (f=109)	Non- Formal (f=8)	Primary School (f=67)	Middle or Junior Secondary High School (f=184)	Junior Secondary High School (f=77)	Tertiary Education (f=7)
Headache	25.7	50.0	19.4	29.3	16.9	28.6
Dizziness	9.2	50.0	9.0	12.5	10.4	57.1
Vomiting	1.8	25.0	3.0	0.5	1.3	28.6
Weakness	24.8	12.5	26.9	26.6	10.4	28.6
Itching	71.6	50.0	67.2	66.8	36.4	57.1
Stomach pain	1.8	25	3.0	1.1	1.3	100.0
Unconsciousness	2.8	12.5	0.0	1.6	0.0	0.0
Burns	5.5	0.0	0.0	2.3	2.6	0.0
Body pains	0.0	50.0	3.0	1.1	0.0	0.0
Catarrh	0.0	12.5	0.0	4.3	0.0	0.0
Eye irritation	0.0	0.0	0.0	1.1	2.6	0.0
Nausea	0.0	0.0	0.0	0.5	0.0	0.0
Sneezing	0.9	0.0	0.0	0.0	0.0	0.0

Table 6: Relationship between pesticide poisoning and educational background of the Farmers.

Hazard	Age distribution of farmer						
	10-19 (f=2)	20-29 (f=36)	30-39 (f=116)	40-49 (f=153)	50-59 (f=89)	60-69 (f=33)	Total (n=429)
headache	0.0	19.4	25.9	27.5	30.3	15.2	25.9
dizziness	0.0	16.7	11.2	9.2	14.6	12.1	11.7
vomiting	0.0	0.0	0.9	1.3	2.2	3.0	1.4
weakness	0.0	30.6	23.3	22.2	29.2	18.2	24.2
itching	50.0	77.8	59.5	66.0	65.2	60.6	64.6
stomach pain	0.0	0.0	2.5	2.6	0.0	0.0	1.6
unconsciousne ss	0.0	5.6	0.9	0.0	2.2	6.1	1.6
Burns	0.0	2.8	2.5	3.3	3.4	3.0	3.0
Body pains	100.0	0.0	0.9	1.3		3.0	1.4
Catarrh	0.0	0.0	32.5	3.3	1.1	0.0	2.1
Eye irritation	0.0	2.8	0.0	1.3	1.1	0.0	0.9
Nausea	0.0	0.0	0.0	0.0	0.0	3.0	0.2
Sneezing	0.0	0.0	0.0	0.0	0.0	3.0	0.2

Table 7: Relationship between pesticide poisoning and age of the farmers.

This supports the respondents' general perception that pesticides were chosen mainly for the control of pest organisms and hardly for disease pathogens. In addition, farmers desire to satisfy consumers taste (preference for unblemished, cosmetically perfect produce with extended shelf and storage life) and to produce high yields could account for the high proportions of fungicides and insecticides used, as reported by Thomas [30]. The classification of these pesticides by the category of pests they control, active ingredient, chemical group and the World Health Organization (WHO) Hazard category is presented in Table 8 as well. Three out of 7 fungicides used by the farmers are not registered by the Ghana Environmental Protection Agency. Even those that were registered are strictly meant for cocoa and /or coffee, and belong to WHO Hazard Category III, designated as highly hazardous. This is quite serious and requires immediate action to prevent harmful toxic public health hazards and environment pollution. Generally, most farmers use insecticides, fungicides and herbicides which are not cleared for use on target vegetable crops or they are applying pesticides which are not registered for vegetable production. The findings of the presents study thus supports the report of Amoako et al. [22] who confirmed that certain banned chemicals (i.e., Lindane, Endosulfans and DDT) and those not recommended for vegetables (i.e., Akatemaster which contains bifenthrin, Confidor which contains Imidacloprid and thiamethoxam and Cocostar (contains bifenthrin and pirimiphosmethyl) are being used for cabbage production by farmers in the Ejisu-Juaben Municipality of the Ashanti Region of Ghana. This suggests that such farmers are misusing such pesticides thereby affecting the quality and safety of vegetables for consumption. It is suggested that vegetable farmers should sensitized and be trained in integrated crop and pest management practices so as to minimize use of pesticide and also desist from using unregistered and unapproved pesticides. One official from Plant Protection and Regulatory Services Division of the Ministry of Agriculture however claims that there is more to this as "the farmers have been adequately informed about the consequences of pesticide abuse but they are just refusing to heed to the advice". During the farmers' interview and the focus group discussion, this assertion was partially confirmed was clear that most of them know that some pesticides are not meant for application on vegetables yet they applied them because they claimed they were effective, disregarding their potential risk to themselves and the environment. For instance Akatemaster (Bifenthrin) which is fully registered for cocoa pests only are commonly used by vegetable farmers because they claimed it was very effective.

	Common Name	Active Ingredient	Registration status	Crops	Hazard Class
Fungicide (32.7%)	Champion	Copper Hydroxide	FRE	Cocoa and Coffee	III
	Funguran-OH	Copper Hydroxide	FRE	Cocoa	III
	Cobox	Copper Oxychloride	UNREG		
	Kocide	Cupric Hydroxide	FRE	Cocoa	III
	Dithane	Mancozeb	UNREG		
	Ridomil Gold	Metalaxyl-M + Cuprous oxide	FRE	Cocoa	III
	Topsin	Thiophanate methyl	UNREG		
Herbicide (5.5%)	Condemn		UNREG		
	Agrazine	Atrazine	PCL	Various Crops	II
	Adwumapa	Glyphosate	FRE	Vegetables and cereals	III
	Adwumawura	Glyphosate	FRE	Vegetables and cereals	III
	Roundup	Glyphosate	FRE	Various Crops	III

	Sunphosate	Glyphosate	PCL	Various Crops	III
	Weed-out	Glyphosate	FRE	Various Crops	III
	Gramoquat	Paraquat dichloride	FRE	Various Crops	II
	Gramozone	Paraquat dichloride	UNREG		
Insecticide (61.7%)	Poison		UNREG		
	Buffalo	Acetamiprid	FRE	Vegetable and Fruits	III
	cocoprid	Acetamiprid	FRE	Cocoa	II
	Golan	Acetamiprid	FRE	Vegetables and Fruits	III
	Phostoxin	Aluminium Phosphide	FRE	stored grains	Ib
	Akate Master	Bifenthrin	FRE	Cocoa	II
	Multifos	Chlorpyrifos	UNREG		
	Conpyrifos	Chlorpyrifos ethyl	FRE	Vegetables and cereals	II
	dursban	Chlorpyrifos ethyl	FRE	Various Crops	II
	Sunpyriphos	Chlorpyrifos ethyl	UNREG		
	Termicot	Chlorpyrifos ethyl	PCL	Various Crops	II
	Polythrine C	Cypermethrin	FRE	Vegetables	II
	DDT	DDT	BANNED		
	Akatesuro	Diazinon	PCL	Cocoa	II
	Attack	Emamectin benzoate	UNREG		
	Control	Emamectin benzoate	FRE	Vegetables	II
	Confidor	Imidacloprid	FRE	Cocoa	II
	Consider	Imidacloprid	FRE	Vegetables	II
	bossmate	Lambda Cyhalothrin	UNREG		
	Clear	Lambda Cyhalothrin	FRE	Vegetables	III
	Kombat	Lambda Cyhalothrin	UNREG		
	Karate	Lambda Cyhalothrin	FRE	Vegetables	II
	Lambda	Lambda Cyhalothrin	FRE	Vegetables	II
	K-optimal	Lambda Cyhalothrin	FRE	Vegetables	II
		+ Acetamiprid			
	Bypel	Perisrapae Granulosis Virus	PCL	Cabbage	IV
		+ *Bacillus thuringiensis*			
	Actellic	Pirimiphos-methyl	FRE	Various Crops	III
	Super Agro Blaster	Pyrethrum	FRE	Stored produce	II
	Actara	Thiamethoxam	FRE	Banana	III
Insecticide/ Nematicide	Furadan	Carbofuran	FRE	Various Crops	II

(0.1%)					

Table 8: Types of pesticides and active ingredients used by respondents. NOTE: PCL= Provisional Registered List; FRE= Fully Registered List; UNREG = Unregistered.

Conclusions

It is clear from the results of the study that the majority of the vegetable farmers obtain pesticides from agrochemical shops mainly for pest agent control, mix different chemicals together and apply the pesticides without wearing protective clothing. Knapsack was the most popular spraying equipment used though a few farmers did use motorised sprayers/mist blowers and hand held applicators. However most farmers enter fields treated with pesticides within 7 days without observing re-entry waiting period and also harvest produce within 7 days after spraying pesticide without observing the recommended waiting period. It was further shown that most farmers dispose of empty pesticides containers by throwing them on the field. The study also revealed that farmers were mostly aware of the hazardous risks which they are exposed to from pesticide application but show a negative attitude to taking the necessary precautionary measures. The most common consequences of pesticide exposure mentioned by the farmers were itching, headache, weakness, and dizziness. Some farmers also mentioned burning sensation, catarrh, stomach pain, unconsciousness, itching of eyes and body pains. Females and illiterates were found to be more likely to be affected than their males and literate counterparts. It can therefore be concluded that the farmers are misapplying the pesticides by disregarding the dangers they cause to human health and the environment as a result of which re-enforcement awareness creation and behavioural change communication are required to change their attitudes in addition to the need for training in integrated crop and pest management practices to minimize pesticide application for safer vegetable production.

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