

Changing Pattern of Pesticide usage in Ghana and the hidden Risks of herbicide handling: A Review

K. Frimpong-Anin*, P. Mintah**, B. Annor***, G. Ohene-Mensah****, S. Arthur*****, J. A. Opoku*****

Abstract

Pesticides have been adopted by both small and large scale farmers in the management of pests, to boost agricultural production. This review discusses the increasing usage of herbicides compared to fungicide and insecticides, which used to be the predominantly used pesticides in Ghana. Risks associated with herbicide handling practices are also discussed. Majority of reports for the review were sourced from post graduate theses, but also from journals, technical reports and newsletters. Wide acceptance of herbicides in Ghana's agriculture is more recent relative to insecticides, which have been used on cocoa for over six decades. Herbicide consumption in Ghana is increasing rapidly with annual importation rising from 2,186t in 2002 to 1,005,815t in 2012 compared to 4,130t to 4,749.39t of insecticides and 1,079t to 3,611.28t of fungicides over the same period. Herbicide misapplications, mixing different types to form cocktails and non-usage of protective gear are common practices. Unlike insecticides, the notion that herbicides, are generally not poisonous to humans, since they are applied to kill plants and not animals heightens poisoning risks. Contrarily, toxicity of some herbicides are however comparative to insecticides. Herbicide poisoning levels through spraying among farmers and residues in foodstuffs are rarely studied in Ghana. Where available, the studies mostly looked at pesticides in general but results and discussions tend to skew focus on insecticides. It is therefore imperative to conduct herbicide target specific poisoning levels among farmers and also residues in foodstuffs, water and soil.

Keywords

Herbicide, insecticide, fungicide, farmers, poisoning

*CSIR-Crops Research Institute, P. O. Box 3785, Kumasi, Ghana. Email: nanakofy@yahoo.com/k.frimpong-anin@croprosearch.org

*Corresponding author: K. Frimpong-Anin Email: k.frimpong-anin@croprosearch.org

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1. Introduction

Pests are major constraints to crop production and chemical pesticides, particularly insecticides, fungicides and herbicides are widely used in various agrosystems worldwide to manage them. The use of these pesticides in agriculture has reduced production cost and crop losses have been curtailed to appreciable extent, in the quest to produce more food for the growing world human population (Gianessi and Reigner, 2007; Thompson et al., 2015). In Ghana, cost of manual weed control in peanuts was estimated to be up to GHC1,668.00 depending on farmer practice (Arthur et al., 2016). Sole use of herbicides reduced weed control cost by 94% whilst integrated herbicide and manual weeding regime resulted in 53 – 60%

reduction in weed control cost relative to sole manual weeding. While an average of 66.6 man-days/hectare was required to control weeds in peanut for a season in Ghana, herbicides and/or its combination with manual weeding required 1.3 man-days/ha and 36 – 41 man-days/ha respectively (Arthur et al., 2016). Other observations from farmer surveys in different parts of Ghana under different agrosystems suggest that cost in using herbicides in other agrosystems is significantly lower (Frimpong, 2009; Lugushie and Atabila, 2012). Traditionally, the focus on safe pesticide usage in Ghana has been on insecticides due to the long history associated with insecticide usage in the cocoa sector (Buffen et al., 2004). This is particularly so with the use of persistent organochlorine insecticides such as Dichlorodiphenyltrichloroethane (DDT), Lindane, Aldrin and Endosulfan. Herbicide usage has however increased rapidly in recent years, and like insecticides, their misuse is also widespread (Fianko et al. 2011a; Miensah, 2015). This poses both environmental and health challenge which needs to be addressed. This review paper assesses the changing pattern of pesticide consumption in Ghana, with emphasis on herbicides and associated risks. The proportional consumption rate of herbicides compared to the other pesticides, research focus, usage practices and potential risks associated with its abuse in various agrosystems are discussed.

2. Materials and Methods

Majority of materials for analysis of this review were sourced from post graduate theses retrieved from repositories of the various Ghanaian universities. They are all from public universities running agricultural related programmes. They are University of Ghana (UG), University of Cape Coast (UCC) and Kwame Nkrumah University of Science and Technology (KNUST). University for Development Studies (UDS), University of Energy and Natural Resources (UENR) and the private universities did not have their post graduate thesis online at the time of this review. A total of 78 theses with pesticide related studies were retrieved of which 16 were relevant to the subject matter under review. The rest of materials used include articles from refereed journals, technical reports and newsletters retrieved through google scholar search engine with the necessary filters. This was informed by a preliminary assessment of pesticide researches which indicated majority of the investigations on pesticides were carried out through post graduate studies. Exceptions were those pertaining to the cocoa sector, which was mostly carried out by the Cocoa Research Institute of Ghana (CRIG). Little emphasis is put on pesticide usage in the cocoa sector, because the focus of most the work in that sector is primarily on insecticides and fungicides, and therefore reference materials did not cover those from CRIG.

3. Results

3.1 Pesticides in Ghana's agriculture

Chemical insecticides usage in Ghana's agriculture date back to the 1950s, when the threat of insect pests to the production of the country's major crop, cocoa, became pronounced. Cocoa has been the backbone of Ghana's agriculture for over six decades, and the identification of mirids and mealy bugs became motivational factors for mass application of the insecticides (Acquaah, 1999; Buffinet al., 2004). Hailed efficacy of DDT, probably influenced its introduction to other crop production, and this explains why pesticide approved for use on cocoa find their way to other agrosystems. Thus the national promotion of pesticides and the loose pesticide management mechanisms at their inception in the cocoa industry and subsequently other crops has culminated in the poorly regulated use of any pesticide on any crop. Pesticides are currently popular among farmers both at the peasant and commercial levels with a greater proportion of insecticides and fungicides imported being used in the cocoa sector (Buffin et al. 2004; Fianko et al. 2011a). Although herbicides were introduced in the 1940s, it assumed worldwide popularity in the 1960s (Gianessi and Reigner, 2007) and wide acceptance in Ghana seems to have commenced in the late 1990s and early 2000s. This was after the promotion of no-tillage practices introduced jointly by Crops

Research Institute, Sasakawa Global 2000 and Monsanto Company. Through this project estimated 100,000 small holder farmers had adopted the practice by the year 2000 (Ekboir, 2002). In assessing the impact of the no-tillage practice, Ekboir (2002), found out that 61% of agrochemical dealers started selling herbicides in 1996. A survey in 1992-1994 in four regions (Eastern, Ashanti, Brong Ahafo and Western) in Ghana revealed that 67% and 30% of farmers use insecticides and fungicides respectively. The combined proportion of farmers who used herbicides and others (e.g. nematocides, molluscides and growth hormones) constituted only 3% (Acquaah and Frempong, 1995). Currently high proportion of growers under varied farming systems across the country use herbicides rather than the traditional manual slashing and hoeing e.g. 98% of pineapple farmers (Aboagye, 2002), 76% okro farmers in Accra (Abla, 2015). Furthermore, Opoku-Asiamah (2008) and Ofosu (2013), respectively reported that about 64% and 89% of farmers growing variety of crops across the country use herbicides whilst proportions ranging between 33% and 91% vegetable growers apply herbicides (Ntow et al., 2006; Sowley and Aforo, 2014; Wandaat and Kugbe, 2015).

Majority of farmer surveys designed to illicit information on usage practices, contamination, residue and poisoning cases of all the major pesticides (insecticides, herbicides and fungicides) simultaneously end up focusing on insecticides, and to some extent fungicides (see Biney, 2001; Ntow et al., 2006; Ofosu, 2013; Sowley and Aforo, 2014; Asare-Bediako and Micah, 2014; Abla, 2015; Ansa, 2012; Dey, 2012; Dankwa, 2014;). As a result reviewed papers are also skewed to align with the farmer surveys (see Thompson et al., 2015; Donkor et al., 2016). Similarly, researches on pesticide residues in water bodies, soil and food are also mostly limited to insecticides (see Botwe et al., 2011; Fianko et al., 2011a,b; Bempah et al., 2012; Harisu, 2012; Asiedu, 2013; Kodua, 2014; Otoo-Oppong, 2014 Donkor et al., 2015; Okoffo et al., 2015; Tiako, 2015). For these reasons the actual risks associated with herbicide usage in Ghana are masked. About 70% of imported pesticides in the 1990s were insecticides, with herbicides constituting less than 3% (Fianko et al 2011a). There is however a rapid increase in the usage and demand for herbicides (Table 1). According to MOFA (2011) and Asare-Bediako and Micah (2014), the quantity of herbicides imported into Ghana has increased from 2,186t in 2002 to 1,005,815t in 2012, constituting 29.56% and 99.18% respectively. Within same period the insecticide increased from 4,130t to 837,579.50t making up 55.85% to 36.13% of total pesticides imported. This means the insecticide which has been regarded as predominant pesticide has been overtaken, in terms of quantity, by herbicides. This shift does not mean the quantity of insecticide used is decreasing, because the import data rather shows yearly increase in quantities imported, only

that the quantities of herbicides are relatively higher. Unlike insecticides and fungicides where greater proportions are used on cocoa, majority of the herbicides are used in other agrosystems such as cereals, vegetables, tubers and other tree crops including mango, citrus and cashew. Frimpong-Anin et al. (2013) reported that herbicide use on cocoa is limited because some farmers are skeptical about the long term effect on the cocoa trees. This is because cocoa is considered a lifetime investment and that risk must be reduced to the barest minimum.

Table 1. Quantities of pesticides imported into Ghana between 2002 and 2012

Year	Insecticides		Herbicides		Fungicides	
	t	%	t	%	t	%
2002	4130	55.85	2186	29.56	1079	14.59
2003	5974	58.79	2939	28.92	1249	12.29
2004	8418	54.67	4578	29.73	2402	15.603
2005	10,006	48.16	8566	41.23	2205	10.61
2006	12,728	47.78	10718	40.23	3195	11.99
2007	975.84	10.95	6980	78.34	953.66	10.7
2008	3542	27.64	7,531	58.78	1740	13.58
2009	3448.71	23.46	9979.25	67.88	1273.59	8.66
2010	43694.7	7	336742	53.96	243624	39.04
2011	837580	36.13	884610	38.16	595930	25.71
2012	4749.39	0.47	1005815	99.18	3611.28	0.36

Adapted from MOFA (2011), Asare-Bediako and Micah (2014).

The observed increasing herbicide usage is attributed to the following reasons as outlined by Aboagye (2002), Ekboir et al., (2002), Frimpong (2009); and Abila (2015):

1. Unavailability of labour force for the traditional manual weeding and where available, are unreliable.
2. Cost of herbicide application is relatively cheaper and the chemicals are readily available.
3. Time lapse for weed regeneration is longer when herbicide is used, since efficiency of manual weeding depends on individuals involved.
4. Simplification of weed control.
5. Increased yield of crops upon using herbicide

3.2 Herbicide abuse and potential risk

Observations by Aboagye (2002), and Miensah (2015) among pineapple and maize growers respectively suggest misapplication of herbicides. All pineapple (Aboagye, 2002) and 71% maize (Miensah, 2015) farmers surveyed use cocktail of two herbicides (36 – 55% mix three depending on farm size) and in most cases herbicides with same mode of action were mixed together. According to Tadeo et al. (2004) global analysis of herbicide residues in food is generally low probably because most samples with detectable levels were found to be below the maximum residue limits (MRLs). This is because most herbicides are applied at the vegetative stage of the crop leading to

longer application to harvest time interval, compared to insecticides and fungicides. Nevertheless, herbicides may be applied during harvesting period if the field becomes weedy, without recourse to any waiting period. In such instances, there is the potential of having high herbicide residue in the harvested produce. Shin et al. (2011) for instance detected residue in samples of soyabean from some Chinese markets to be equivalent to the MRL. Majority of assessment of pesticide residues in foodstuff has concentrated on insecticides and fungicides. Afful (2002) and Miensah (2015) are among the few studies in Ghana that looked at herbicide residues in soil and food respectively. Results from Miensah’s (2015) work showed herbicide residues in maize sampled from all the regions were below the MRL whilst that of Afful (2002) did not detect residues in soils within parts of farming areas along the coastal regions. It must however be noted that herbicide usage at the time of Afful’s (2002) was not wide spread, compared to current trend and there is therefore the need to conduct more studies in areas with intensive cropping.

Generally, insecticides are more toxic than herbicides but the question is “is exposure to herbicides through mishandling and residues in food potentially harmful?” The answer is in the affirmative because toxicity analyses suggest certain herbicides are highly toxic depending on contamination route (Table 2). Paraquat is more toxic both orally and dermally compared to lindane and DDT. Toxicity is however influenced by type of formulation and application dose, and in most herbicides ready to use preparations make them less toxic compared to insecticides.

Table 2. Toxicity values for selected herbicides and insecticides

Pesticide type	Toxicity* (mg/kg)	
	Oral	Dermal
Herbicide		
Paraquat	100	80- >480
2,4-D	400-500	1,500
Atrazine	3,000	7,000
Glyphosate	5,000-10,000	>2,000
Insecticide		
Lindane	200	500-1,000
DDT	300	2 500
Chlorpyrifos	32-1 000	1,000 - >2,000

*Toxicity is the dose required to kill 50

WHO classify two common herbicides used in Ghana, atrazine (Frimpong et al., 2013; Sowley and Aforo, 2014; Miensah, 2015) and paraquat (Ntow et al., 2006; Wandaat and Kugbe, 2015), as slightly and moderately hazardous respectively. Pesticide Action Network (PAN) however classifies them as highly hazardous, just as chlor-

pyrifos insecticide. Atrazine in particular is one of the contentious pesticides internationally and its use has been restricted to plant growing in the European Union (PAN, 2008). Knapsack spraying of paraquat is prohibited in the EU but in Ghana that is the commonest mode of applying all herbicides. Moreover, in the EU where users are well educated and also equipped with adequate personal protective equipment (PPE), several poisonings from paraquat have been reported. Exposure to a number of herbicides have also been shown to exert chronic effects to humans endocrine disruption in humans e.g. 2,4-Dichlorophenoxyacetic acid (2,4-D) may disrupt the endocrine and damage internal organs like liver and kidneys (McKinlay et al., 2008) whilst atrazine is capable of affecting menstruation and causing birth defects (Ackeman, 2007).

Agrochemical sellers and farmers do not however consider herbicides as poisonous and hardly use PPE when packing or applying them (personal communication, K. Frimpong-Anin). Unlike insecticides, which they loosely call poison, herbicides are seen as relatively non-poisonous agrochemical, due to the fact that they are used to kill plants and not animals. It is therefore not surprising that the Upper East Regional Health Director has bemoaned the increasing poisoning cases from glyphosate (NPAS, 2012), the commonest herbicide used by farmers in Ghana. Der et al. (2013) also reported the death of seven persons in the Northern Region after consuming beans contaminated with atrazine. At the research level, pesticide poisoning studies usually focus on insecticide associated poisoning and generalize it as pesticide poisoning. This makes it difficult to appreciate poisoning associated with herbicides among applicators, who are mostly farmers. It is generally assumed that spraying herbicides does not require any technical training or skill but all that one need is just a knapsack sprayer, herbicide and water. There are therefore several herbicide handling practices with potential poisoning risks, and key amongst them are:

1. Unselective on type of nozzle and poor spraying techniques leading to non-uniform spraying, leaving patches untreated (Abla, 2015)
2. Applicators commonly eat and drink while spraying (Wandaat and Kugbe, 2015).
3. Wind direction is not considered a priority during spraying (Ofosu, 2013; Wandaat and Kugbe, 2015).
4. Farmers unaware of any restricted entry interval after spraying (Ofosu, 2013).
5. Use empty herbicide containers for drinking (Ofosu, 2013).

6. Majority of farmers use adopted 'standardized' measure of milk tin 180ml per knapsack tank full, irrespective of the type of herbicide or weed, instead of the manufacturers' instruction (Ekboir et al., 2002). Meanwhile knapsack sprayers come in capacities of 10L, 12L and 15L, although 15L ones are the commonest.

These observations suggest the need for researchers to conscientiously evaluate occupational poisoning levels among herbicides handlers. Another area where herbicide residue is crucial but again has not attracted attention is pollution of water bodies. Herbicides are easily washed away by rain runoff or through irrigation waters or drift into water bodies, especially when time lapse between spraying and rainfall is short. It may also leach into underground water (Ruiz-Toledo, 2014). All these are exacerbated by excessive dose, short post application to rainfall interval (usually less than 2/4hrs), improper disposal of empty containers and washing of equipment (Fianko et al., 2011a,b).

4. Conclusions and Recommendations

Herbicides currently constitute the largest pesticides consumed in Ghana compared to insecticides and fungicides, in terms of quantity. Agrochemical vendors and farmers generally regard herbicides as relatively non-poisonous to humans and thus do not normally put on protective gear when handling or using it. Limited research has assessed herbicide poisoning among farmers and also residue in foodstuff. More research and education on dangers associated with herbicide abuse is required.

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