

Farm Level Pesticides Use in Patuakhali and Comilla Region of Bangladesh and Associated Health Risk

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Abstract: A survey study was conducted among two hundred farmers from Patuakhali and Comilla district, Bangladesh to determine the farmers' awareness about farm land pesticide application on major crops with beneficial and harmful effects, pesticide use trends in last five years (2011–2016), crop harvesting time after pesticide application, integrated pest management (IPM) with indigenous technology etc. determinants. Survey result showed that 82% of the farmers of Patuakhali cultivating local varieties of rice and used IPM with indigenous technology in addition with application of pesticides for pest management. Though these farmers did not use any pesticide in 2011 except carbofuran but in 2016, they are used various kinds of organocarbamate and organophosphate pesticides for controlling pest. On the other hand, farmers from Comilla regions increased their pesticide application three times during the last five years and used only piercing as an indigenous method for pest management. Pesticide application intensity (3/4/more times in a cropping season) higher in Comilla region compared to that of Patuakhali region. Vegetables harvesting time within 24 or 48 hrs after application of pesticides will be alarming for consumers due to toxicity development of pesticide residue. Application of pesticides more than the recommendation limits increasing the environmental, animal and human health risk at the studied area. It is concluded that effective implementation of government policy, continuous monitoring, increasing IPM practices, expansion of indigenous technologies and as a whole growing farmers' awareness about the pesticide use are suggested for sustainable and quality crop production and healthy consumption.

Keywords: Crops, Environment, Farmer, Health, Pesticide

1. Introduction

Agricultural is one of the important economic sectors in Bangladesh to nearly half of the country economic output. This sector facing many challenges due to severe agro-climatic conditions like annual flooding, cyclones, tidal storms and salinity etc. As a direct consequence of these

difficult conditions, agricultural production has been highly susceptible to attack pests and diseases. In their defense, farmers have begun to use more pesticides to prevent crop losses from pest attack. Pesticide use in Bangladesh negligible until the 1960, has recorded a dramatic increase over the past five decades. This is partly due to government's preference to adopt chemical control measure to increase

crop production as well as to prevent pre- and post-harvest crop losses [1, 2, 3]. Rahman [4] analyzed the trends of different determinants of pesticide used in Bangladesh of over a 33 year period (1977–2009) and found that pesticide use significantly ($p < 0.01$) grew at an alarming rate of 10% per year where corresponding major crops yield has been minimal ($< 1.0\%$ per year).

Bangladesh Rice Research Institute [5] conducted a survey about pesticide used in farmland during 1997–2008 and reported that the use of toxic pesticides by Bangladeshi farmers increased by 328 percent during the past 10 years posing a serious health hazards on human and environment due to long term residual effect. They also showed that in 1997 the use of pesticides in Bangladesh was more than 8000 tons; it doubled to 16000 tons in 2000, and it increased to nearly 20000 tons in 2005 and it rose up to 48690 tons in 2008.

Though pesticide use viewed as an economic, labor-saving and efficient tool for pest management and increase crop production [6], but emergence of pest resistance to pesticides is one of the major negative aspects and for this reasons widely use of pesticides employed harmful effects on environmental health. An estimated 1–5 millions farm workers suffer from pesticide poisoning every year and at least 20,000 die annually from exposure, mostly in developing countries compared to developed countries [7, 8].

However a rapid increase in pesticide consumption raises concern about its potential impact on farmers' health as well as on the environment. Studies on pesticide use in Bangladesh are relatively limited, although news and magazines often report about pesticide poisoning due to widespread use of banned pesticides [9]. So the current survey study has been conducted that deals with different determinants of pesticides use for major crop production at the farm-level during December, 2015 to July, 2016 with their associated human and environmental health risk.

2. Methodology

Data was collected from the selected farmers of two district of Bangladesh namely Patuakhali and Comilla. Three upazila (sub-district) were selected from each district and three unions (sub-upazila) were selected from each upazila for data collection. The total number of farmers was two hundreds. A multistage sampling technique with mixture of purposive and stratified random sampling methods was employed [10]. The farmers were selected using stratified random sampling methods from the villages of the selected unions with four standard based on crop cultivation experiences and farm size. These are: Low experiences (1–5 years), medium experiences (5–10 years), high experiences (10–15 years) and very high experiences (> 15 years). A questionnaire was prepared for collecting data by using face to face interview system about major crop cultivation, experiences about crop production, major diseases and pest infestation with their management practices, pesticide application intensity and doses, crop harvesting time after

last pesticide application, pesticide use trends in last five years (2011 and 2016), farmer's perception for pesticide application with their associated human and environmental health risk etc. determinants. The qualitative data then converted to quantitative with percentage.

3. Results and Discussion

3.1. Major Diseases and Pest Infestation with Their Management in Patuakhali and Comilla Regions of Bangladesh

3.1.1. Diseases and Pest Infestation in Patuakhali and Comilla in Kharif and Rabi Season

A number of diseases and pests occurred by various pathogen causes significant crop losses in Bangladesh and estimates of the scale of these losses vary by context and scope. From table 1 and 2, it is observed that, in kharif season, the rice farmers of Patuakhali and Comilla districts of Bangladesh mainly had to strive against brown spot and sheath blight diseases. Brown spot occurred in an epidemic form in Comilla region and affected 96% rice fields (Table 2). On the other hand, in Patuakhali region, 70% rice field was infected by brown spot (Table 1). Though rice blast was the second most important disease for Comilla region (infected 80% of rice field), this disease could not spread over the fields in Patuakhali region might be due to cultivation of local rice varieties. Sheath blight occupied 46% rice fields in Patuakhali and 50% fields in Comilla region. Sheath rot and tungro virus were found prominent only in Patuakhali. Only three species of rice pests namely yellow rice stem borer (YRSB), leaf roller and pumri were eminently seen in both the investigated areas. YRSB seized highest area in both Patuakhali (74%) and Comilla (98%) region (Table 1 and 2). Leaf roller infested 84% rice fields in Comilla, but it was less injurious than pumri (invaded 72% fields) in case of Patuakhali region. Rahman [3] found that the principal pests of rice plants are the stem borers and plant hoppers and the most serious pests of rice and wheat in storage are the weevils, moths and beetles.

Considerable number of pest insurgence occurred in rabi season in both experimental areas. Table 1 and 2 showed that, fruit borer, pod borer and aphid were the main problem for rabi crop production. Pod borer and aphid attacked 86 and 52%, respectively of mungbean field in Patuakhali. Fruit borer of chili was found less injurious than cutworm which infested both chili (26% fields) and ladies finger (34% fields) of that area. On the other side, about one-third of the brinjal and tomato fields in Comilla were infested by respective fruit borer pests. According to Das [11], there are about 209 species of pests/mites of different crops and stored products. The farmers in Patuakhali and Comilla region face a formidable challenge to bring in their harvest without losing some or all the potential yield to pests and mites. Rice is the most important crop in Bangladesh occupying 78.35 of the gross cropped area in 2009 and is prone to pest attacks almost every year [12].

Table 1 presents that most of the farmer (84%) produced mungbean, half of them (50%) produced chilli and about one-third (36%) of them produced ladies finger as rabi crop in patuakhali region. But about one-third of the farmers (32%) cultivated brinjal, about one-fourth (28%) cultivated tomato and about one-fifth (18%) cultivated potato as major rabi crops in Comilla (Table 2). Yellow mosaic virus (YMV) and vein clearing of okra were two main diseases of

mungbean and ladies finger, respectively. Mungbean fields were severely infected (92%) by YMV in Patuakhali. Information shows that, 16% potato field was affected by late blight while some other were caught by scab of potato in Comilla. Leaf roll virus invaded 22% tomato fields of that region. Das [11] and Matin [2] also listed similar pest and diseases during rice, pulses and vegetable production in Bangladesh.

Table 1. Major crop production, diseases and pest infestation with their management using pesticides and IPM or indigenous technology in Patuakhali district (%farmers').

Crops	Patuakhali				
	Diseases	Management	Pests	Pesticide	IPM / Indigenous technology
Rice (Local variety like Lal mota, sada mota, mou lata, Dud kolam, Deshari, Bouri, mota moda, Chini kura, Dhan shai, Deshari etc.) (82)	Tungro Virus (30)	No	Yellow rice stem borer (74)	Carbofuran (70)	Piercing
	Sheath rot (44)	No	Leaf roller (68)	Cypermethrin (40)	Gul, Inverse U, Mahagony and neem seed extract, Making smoking by burning tyre.
	Sheath blight (46)	No	Pumri (72)	Cypermethrin (28)	No
	Brown spot (70)	No	-	Carbendazim (8)	No
Mung bean (84)	yellow mosaic virus (92)	no	pod borer (86), Aphid (52)	Thiamethoxam + chlorantraniliprole (30) Cypermethrin (18)	Piercing
Chilli (50)	No	no	Fruit borer (10)	Thiamethoxam + chlorantraniliprole (16)	Piercing
Ladies finger (36)	vein clearing of okra (30)	Cyperme-thrin (18)	Cut worm (26)	Cypermethrin (14)	Piercing
			cut worm(34) Aphid (13)	Cypermethrin (14) Cypermethrin (20)	Ashing

3.1.2. Management Practices Against Major Pests and Diseases in Kharif and Rabi Seasons in Patuakhali and Comilla

Disease and pest control becomes a social need in countries where the food supply is short and there is an urgent necessity to increase food production. Management practices for crop protection depend upon pest infestations and the types of crop grown. Pesticides have long been used to control pests and diseases in agriculture [13, 14, 15 and 16]. To lessen the outbreak of above mentioned diseases, farmers use a variety of chemicals on their crop. Current study results denote that, the farmers showed favorable attitude towards the pesticide application other than considering IPM or indigenous technology as a control measure. This might be due to the influence of socio-economic characteristic such as, age and education and occupation [17]. In Comilla region, 38% farmers used carbendazim while 18% applied mencozeb and metalaxyl to control sheath blight of rice (Table 2). 76% farmers applied mencozeb and metalaxyl to reduce the insurgence of rice blast. Though Brown spot infected almost all rice fields (96%) of Comilla, farmers did not undertake any management practice to overcome it. On the other hand, farmers in Patuakhali were found to use no control measure against any of the diseases of rice (Table 1).

Farmers of both regions undertook no management

practice during rabi season. But, 18% farmers of Patuakhali applied cypermethrin against vein clearing of okra and the same number of Comilla farmers applied diazinon in case of potato scab. Few (10%) farmers used mancozeb and metalaxyl to control late blight as well as potato scab (Table 1 and 2).

In Comilla region, almost all the farmers (90%) applied thiamethoxam + chlorantraniliprole to control YRSB and more than half of the farmers (54%) used the same chemicals to control leaf roller. On the contrary, 70% farmers in Patuakhali informed that they used carbofuran effectively against YRSB. Most of them preferred cypermethrin in case of pumri and leaf roller attack.

Farmers in Patuakhali preferred cypermethrin pesticide against cutworm and aphids of different vegetables but in Comilla, potato farmer's utilized ash in case of aphid attack. 16% chili farmers in Patuakhali informed that, they used thiamethoxam and chlorantranilipole pesticides to control fruit borer and some used the same chemicals effectively against mungbean pod borer also. Farmers of Comilla told that, they applied lamda cyhalothrin in brinjal and tomato to get rid of fruit borer. Similar findings with pesticide use were found in the experiment done by Parveen and Nakagoshi [18] where they analyzed the use of pesticide for rice pest management in Bangladesh. They also mentioned cypermethrin and cyhalothrin as two of the most common pesticides used by Bangladeshi farmers.

Table 2. Major diseases and pest infestation with their management using pesticides and IPM or indigenous technology in Comilla district (%farmers').

Crops	Comilla				
	Diseases	Management	Pests	Pesticide	IPM / Indigenous technology
Rice (HYV like BR 11, 15, 22, 27, 28, BRRI Dhan 29, 31, 32, 41, 40) (98)	Tungro Virus (66)	No	Yellow rice stem borer (98)	Thiamethoxam + Chlorantraniliprole (90)	Pierching
	Rice Blust (80)	Mencozeb + Metalaxyl (76)	Leaf roller (84)	Thiamethoxam + chlorantraniliprole (54)	Pierching
	Sheath blight (50)	Mencozeb + Metalaxyl (18), Carbendazim (38)	Pumri (20)	Lamda cyhalothrin (16)	No
	Brown spot (96)	No	-	-	-
Brinjal (32)	No	No	Shoot and Fruit borer (32)	Lamda cyhalothrin (15)	Piercing
Tomato (28)	Leaf roll virus(22)	No	Fruit borer (30)	Cypermethrin (6) and Lamda cyhalothrin (18)	Piercing
Potato (18)	Late blight (16)	Mancozeb + metalaxyl (10)	Apid (16)	No	Piercing, Ashing
	Scab of potato (22)	Diazinon (18)			

3.1.3. Installment of IPM as a Control Measure Against Pest and Diseases in Patuakhali and Comilla

IPM is a leading complement and alternative to synthetic pesticides and hence results in lower pesticide use that will benefit not only farmers but also wider environments and human health. But the unconscious farmers of Bangladesh are not eager to utilize IPM or indigenous technology to reduce cost, health and ecological hazards of pesticide use [19]. As shown in table 2, farmers of Patuakhali used *gul* (kind of tobacco powder), inverse U, seed extract of mahogany (*Swietenia macrophylla*) and neem (*Azadirachta indica*), applying ash, smoking by burning tyre for leaf roller and piercing for YRSB as a part of pest management practice. Piercing was the only method practiced in Comilla for YRSB infested fields (Table 2). During rabi season, all the farmers of both regions adopted piercing as an old indigenous technology alongside pesticides to reduce crop loss as well as expensive chemical use on their crops.

It is clear enough from the study that, most of the farmers of Bangladesh are still dependent on hazardous chemicals for keeping up their crop production other than resorting IPM for sustainable farming system. Rahman [4] found that only 7.4% of the total farmers are used IPM technology during 1977–2009.

3.2. Pesticide Used Trends in Comilla and Patuakhali

Table 3. Pesticides used trends in Comilla.

Crops	Pesticides	2016			2011		
	Name of group	Rate / acre	Max.	Min	Rate / acre	Max	Min
Rice (HYV)	Thiamethoxam + Chlorantraniliprol	33 g	42.5gm	21gm	Absent	Absent	Absent
	Lamda cyhalothrin	400ml	490ml	350ml	110ml	125ml	80ml
	Carbofuran	4.5kg	5.2kg	2.5kg	1.7kg	2.5kg	1.2kg
	Diazinon	5kg	5.8kg	3.5kg	2.5kg	3.00kg	2.3kg
	Carbendazim	202.4g	245gm	140.2gm	130g	140gm	124gm
Brinjal	Lamda cyhalothrin	330g	390gm	305gm	140g	170gm	115gm
Tomato	Lamda cyhalothrin	300ml	320ml	270ml	165ml	190ml	120ml
	cypermethrin	160g	210ml	110ml	Absent	Absent	Absent
Potato	Mancozeb + metalaxyl	200g	300gm	160gm	80g	110gm	50gm
	Diazinon	6kg	9kg	4kg	4.5kg	6kg	3.3kg

Table 4. Pesticides used trends in Patuakhali.

Crops	Pesticides	2016			2011		
	Name of group	Rate / acre	Max	Min	Rate /acre	Max	Min
Rice (Local variety)	carbofuran	5kg	6kg	3.5kg	3.5kg	4kg	3.2kg
	cypermethrin	150ml	210ml	130ml	Absent	Absent	Absent
	Thiamethoxam + chlorantraniliprole,	150ml	170ml	130ml	Absent	Absent	Absent
Mung bean	cypermethrin	120ml	160ml	90ml	Absent	Absent	Absent
Chilli	Thiamethoxam + chlorantraniliprole	110ml	125ml	100ml	Absent	Absent	Absent
	cypermethrin	80ml	85ml	70ml	Absent	Absent	Absent
Ladies fingers	cypermethrin	100ml	105ml	90ml	Absent	Absent	Absent

Use of pesticides for controlling pests is the common practices in the different regions of Bangladesh. Introduction of HYV and Hybrid varieties of crop and their susceptibility to pests, the trend of pesticides use are usually increased. But, due to the varieties of crops and farmers attitude in 2011 there was a distinct difference in using pesticide between the farmers of Comilla and Patuakhali region. As shown in table 3 and 4, five years from 2016 except carbofuran none of the pesticides was used by the farmers of Patuakhali and at that time they used comparatively lower dose (3.5 kg carbofuran/acre). Over 5 years of time, all the farmers of Patuakhali used pesticides for the controlling of pest of their mungbean, chilli, ladies finger, even local varieties of rice (Table 4). Data represented in table 3 indicated that the farmers of Comilla region used pesticide comparatively earlier than the farmers of Patuakhali region and the rate of

application was also higher in some instances. The increasing trend of pesticide used by the farmers of Comilla was supported by the findings of Rahman [20]. In his results he explained that due to rice monoculture farmers are needed to apply more amount of pesticide. In addition to that, recently the cultivating of some vegetables like brinjal, tomato and potato also promote the use of pesticide in this region. Not only the two specific region of Bangladesh, pesticides use trend is increased in other countries of the world. Ramulu [21] reported that the use of plant protection chemicals has increased tenfold within the past 15 years. Rahman [4] also mentioned that pesticides use significantly ($p < 0.01$) grew at an alarming rate of 10% per year.

3.3. Farmers' Experiences in Crop Production and Pesticide Used Intensity in a Cropping Season

Table 5. Farmers' (%) experiences in crop production and pesticide used intensity in a crop season.

Determinants		Patuakhali	Comilla
Farmers' experiences in crop production (year)	<1	0	0
	1-5	16	8
	5-10	12	8
	10-15	4	8
	>15	68	76
	Total	100	100
Farmers' applying pesticides	One time	12	10
	Two times	62	30
	Three times	18	40
	Four times	6	12
	More than four times	2	8
	Total	100	100

Since Bangladesh is an agricultural dependent country, therefore crop production is the most primitive practice. Though some new entrepreneurs are involved in crop cultivation, data presented in table 6 showed that in both region the number of 1-5 years crop production experienced farmers are minimum (4% in Patuakhali), (8% in Comilla). Most of the farmers (Patuakhali 68%, Comilla 76%) in both the region have more than 15 years of crop production experience. Farmers of these regions used pesticide for controlling pest of their crops. The intensity of pesticide use in a region depends on a good number of factors like nature of crop, nature and incidence of pest, technical knowledge and financial status of farmers. From data it is clear that in Patuakhali and Comilla region the number of one time and more than four time pesticide applying farmers are very minimum. In both the region's most of the farmers applied pesticide twice or thrice in a crop season. The present situation was completely different before an era, at that time the most of the farmers (97%) of Comilla used pesticide once in a crop season, as reported by Rahman [20].

3.4. Farmers' Opinion About Pesticide Application and Time Interval Between Vegetable Harvesting and Pesticide Application

Table 6. Farmers' (%) concept about pesticide applications and time interval between pesticides applications and vegetable consumptions.

Farmers' concept about pesticide applications	Patuakhali (% Farmers)	Comilla (% Farmers)	Time intervals (Hrs)	Patuakhali (% Farmers)	Comilla (% Farmers)
Increase crop production	2	2	<24 Hrs	14	34
Destroy pest	48	46	24-48	24	18
Both of above	50	52	48-72	26	26
No benefits	0	0	>72	36	22
Total	100	100	Total	100	100

Pesticides are applied to control the pests of agricultural importance. It helps to increase crop production by controlling pests. Sometimes it helps to improve physical quality of certain crops by developing texture and structure [22]. But, farmer's concept may be similar or different. In the present study, in both Comilla and Patuakhali, about 50% of the farmers informed that they apply pesticide for the destruction of pest and increment of crop production (Table 6). None of the farmers were found, who believe that pesticide have no effect on crop and pest. This information assured that farmers were conscious about beneficial impact of pesticide in crop cultivation system. Rahman [20] also found that 39.2% farmers gave opinions about pesticides application for destruction of pest.

Farmers' opinions were elicited by asking open question about time interval between pesticides application and harvesting of major vegetables. Data presented in table 6

showed that higher numbers of farmers (34%) from Comilla region harvesting vegetables (like brinjal, tomato, potato etc.) within 24 hrs after application of pesticides whereas 36% farmers perform this activity after 72 hrs in Patuakhali. The harvesting time of vegetable within 24 or 48 hrs after pesticides application increases the contamination of pesticides through residual effects. Alamgir Zaman Chowdhury [23] detected that 51.3% samples (out of the 210 vegetable samples) from vegetable growing regions in Bangladesh contained pesticide residue in which 38.89% samples contained pesticide level above the maximum residue level. So continuous monitoring and public awareness should be needed for pesticide application and harvesting time for vegetable consumption.

3.5. Farmers' Perception About Environmental Health Risk and Protective Measure Taken During Pesticide Application

Table 7. Farmers (%) perception about environmental health risk and protective measure taken during pesticide application.

Determinants		Patuakhali	Comilla
Farmers (%) perception about environmental health risk	Farmers health risk		
	Vomiting	16	8
	headache	18	14
	Both	38	36
	No problem	28	42
Animal health risk	Total	100	100
	Aquatic organisms	62	46
	cattle's	14	14
	Goat	14	8
	Duck	38	40
Protective measure taken by farmers (%)		76	58
No protective measure taken by farmers (%)		24	42
Total		100	100

Chemicals are now widely used as pesticides in agriculture for the protection of plants against the ravages of pests including pathogen, insects, nematodes, rodents, mollusks, weeds etc. But many chemicals used in the control of pests are highly toxic and hazardous to the environment, health of man and animals, if proper care is not taken [24]. Since most of the farmers are not very educated and insufficient technical knowledge, therefore they considered some common general symptoms and had low to medium level of perception about adverse effect of pesticide on environment [25]. Present study indicated that 16-18% farmers of the Patuakhali region thought that sometimes vomiting and headache are found due to the mild poisoning of pesticide during application and 38% correspondent assumed that both symptoms are appeared (Table 7). Adhikary [26] studied on farmers' awareness on the impact of pesticides on environmental pollution and survey results showed different health problems such as difficulty in breathing, fever, headache, and nausea during application reported by farmers' as a result of pesticide application.

In case of aquatic life 62% informer of Patuakhali and 46% of the Comilla believe that good number of the aquatic organisms like fish, frogs etc. is endangered due to the adverse effect of pesticide. About 14% of the farmers of Patuakhali and Comilla considered that cattle's and goats are

affected by the harmful effect pesticides. On the other hand, 38% farmers of Patuakhali and 40% of Comilla perceive that ducks are highly affected from the field application of pesticide (Table 7). Rahman [20] also found that in Comilla region, pesticides application affects human health, causes fish destruction and death of livestock/poultry, destroy soil fertility and pollutes water body.

Because of the harmful effects of pesticide drifts, precautionary measures should be taken during pesticide application. Pesticidal accidents can be avoided, if safety measures are taken carefully. Farmer's level practical situations are completely different; some are used only a piece of cloth as a mask while others is not taken any protective measure. By this survey study, it was known that 76% farmers of Patuakhali and 58% of the Comilla farmers used only a piece of cloth (*Gamcha*) on their mouth while applying pesticide. 24% farmers of Patuakhali and 42% farmers of Comilla did not take any protective measure during pesticide application and hence susceptible for different hazardous symptoms in their body (Table 7).

4. Conclusion

Pesticide used increased twice or thrice time in the last five

years which are much higher than the recommended limits indicated that environmental and human health are at risk. There are many newly developed pesticides used by farmers in 2016 at high doses might be due to resistance grown in pest at lower doses. Intensive monitoring and training program for farmers' should be taken by government and NGOs stakeholders for pesticide application doses, precautionary measures taken during pesticide application, harvesting after pesticide application, and expansion of IPM technology for quality food consumption for healthy nation.

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