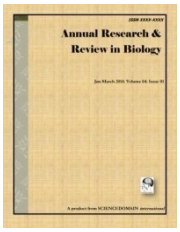

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Application of Pesticides in Rice-prawn (Crustaceans) Culture: Perception and Its Impacts

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Authors' contributions

This work was carried out in collaboration between all authors. Author MNH managed the literature searches, wrote the protocol and prepared the first draft of the manuscript. Authors HMR I and SS managed the analyses of the study. Author KKUA managed the literature searches and corrected the first draft. Author YM designed the overall study. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

The general purpose of this study was to evaluate farmers' awareness towards the pesticides used in rice-prawn integrated culture technique. Randomly selected survey technique was applied through direct observations and personal interviews for this study. : Data were collected from five different upazillas viz. Fultola and Dumuria of Khulna, Mollahat, Fokirhat and Chitolmari of Bagerhat district which were situated in the south-west region in Bangladesh from January to March 2011. Randomly selected survey technique was applied to collect information from sample farmers which were chosen by consultation with local Agriculture Extension Officer and Fisheries Officer. A total of 75 (45 from Bagerhat and 30 from Khulna) sample farmers were asked to mention various information. Eight active ingredients of pesticides within 28 trade names were used to kill pest such as the stem borers, green leafhoppers and some of grasshoppers and gall midges infesting the rice farms. Pesticide frequency was varied between 1 and 3 sprays per crop season. A total of 94% respondents applied pesticides for controlling pests, 5% respondents used biological control and 1% respondent did not use any technique for pest management. The

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pesticide groups Organophosphorus and carbamate were used by 40% and 38% of the respondents respectively and another 15% farmers used pyrethroid in their rice crop during the winter period. Various groups of pesticides were used in order of 36% for Carbofuran, 17% for Chloropyriphos, 12% for Malathion, 11% for Diazinon, 7% for Cyhalotrin, 3% for Carbosulfan, 1% for Thiomax and 7% for Cypermethrin, respectively of the respondent farmers. No banned pesticides were identified from the respondents during this survey. It is suggested that pesticides regulation and effective implementation, increasing farmer's awareness of effective pesticide use and expansion of IPM (Integrated Pest Management) practices can be helped towards sustainable integrated rice-prawn culture in the part of Bangladesh.

Keywords: Rice-Prawn; pesticides; bio-control; pest management.

1. INTRODUCTION

Pest control becomes social needed in countries where the food supply is shortened and urgently necessary to increase rice production. The third world's uses of pesticides are increased greatly during the Green Revolution in the 1960`s and beyond. As in many developing countries, Bangladesh had promoted the uses of pesticides to expand agricultural land and increased output per acre in 1957 distributed by the government to farmers free of cost until 1973. It is related the changed growing conditions which are buying about by the uses of green revolution varieties and technologies. Monocultures coupled with increases in irrigation and fertilization often improves conditions for pests, necessitating more control efforts [1]. Promotional activities are included extension services and significant subsidies [2]. As a consequence of this expansive policy, pesticide uses were increased since 2007, rising from 37712.08 metric tons to 45172.43 metric tons in 2010 whereas declined in 34011.26 metric tons in 2011 [3]. Insecticide chosen in the developing world is often older, broad-spectrum compounds belonging to the organophosphate and carbamate classes chemical families noted for their acute toxicity. Organochlorine insecticides such as DDT, lindane and toxaphene are still widely used in the developing world, although their danger to humans and animals are well known [4]. In fact, about 1/2 of the pesticides used in the lesser developed countries are persistent Organochlorine, such as DDT. Consumers are always used cheaper and consider safer to apply due to their relatively low short-term toxicity to mammals (including farmers). From an environmental perspective, chemically-polluted runoff from fields has contaminated surface and also ground waters, damaged fisheries, destroyed freshwater ecosystems and created growing "dead zones" in ocean areas proximate to the mouths of rivers that drain agricultural regions [5]. Many of these impacts are direct result of the overuse and misuse of pesticides, often wildly deviating from recommended application procedures. Several recent studies investigating this behavior found that inadequate product labeling and farmers are lack of information often lead to widespread overuse or misuse of dangerous pesticides in developing countries [6]. Population of native fishes species (*Channa* spp., *Heteropneustes clarias* and *Anabas testudineus*) are now endangered and the traditional rice-fish systems were disappeared [4]. However, a clear understanding of farmers' perception of risk and pesticide application behavior is necessary in the design of any policy intervention. Currently, systematic studies of the application of pesticides are scarce in developing countries. The present study was formulated to know the pesticides uses practice as well as to evaluate the farmer's knowledge, attitude and perception regarding the impact of pesticides on aquatic environment.

2. MATERIALS AND METHODS

The study was conducted in two districts namely Khulna and Bagerhat of Bangladesh based on production and area coverage. Three upazilla from Bagrhat and two upazilla from Khulna which were located at the south-west part of Bangladesh were selected to collect primary data and information from sample farmers (Fig. 1). The study area was chosen in consultation with local Agriculture Extension Officer and Fisheries Officer. Farmers were chosen on the basis of their rice-prawn composite culture. A total of 75 sample farmers of which 45 farmers from Bagerhat and 30 Farmers from Khulna district were randomly selected for interview. Data were collected during the period from January to March 2011. The farmers were asked to mention the name (trade name), amount of pesticide used for unit area, attained of training etc. The common names were collected from the retail pesticide traders of the study areas. From the quantity of used per unit of area, the amount was calculated for hectare. The data was analyzed using tabular and descriptive statistical techniques. The summary tables were prepared in accordance to the objective of the study. The technique of analysis included the classification of tables into meaningful result by arithmetic mean, percentage and ratios.

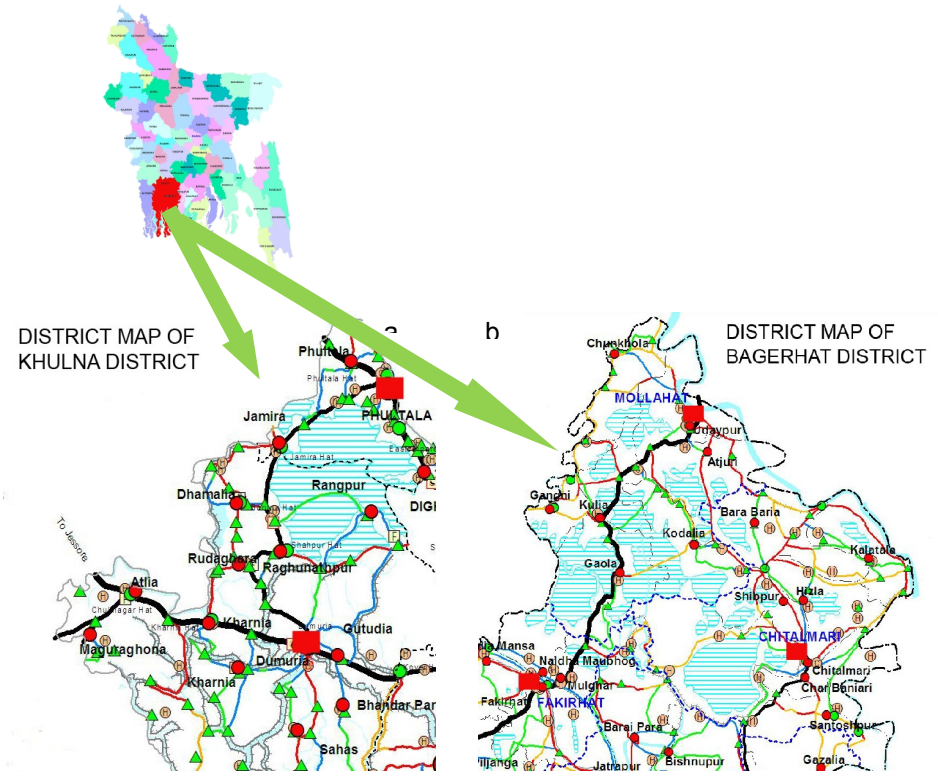

Fig. 1. Locations of experimental site (a) Khulna and (b) Bagerhat

3. RESULTS

3.1 Pesticide use Profile

A total of eight active ingredients of pesticides with 28 trade names were used by the respondents farmers among various upazilla of Bangladesh during winter rice crop of the year 2011 (Tables 1 & 2).

Most of the pesticides were used to kill the stem borer, green leafhopper and some of grasshopper and gall midge. The frequency of pesticide uses were varied 1 to 3 sprays per crop season. The rate of application was not so high which varied from about 0.5 10 kg/L per hectare of land. Among the total respondent of 94% was applied pesticides for controlling pests and 5% respondent for biological control and pest management, whereas, 1% respondent did not use any technique for pest control as shown in Fig. 2.

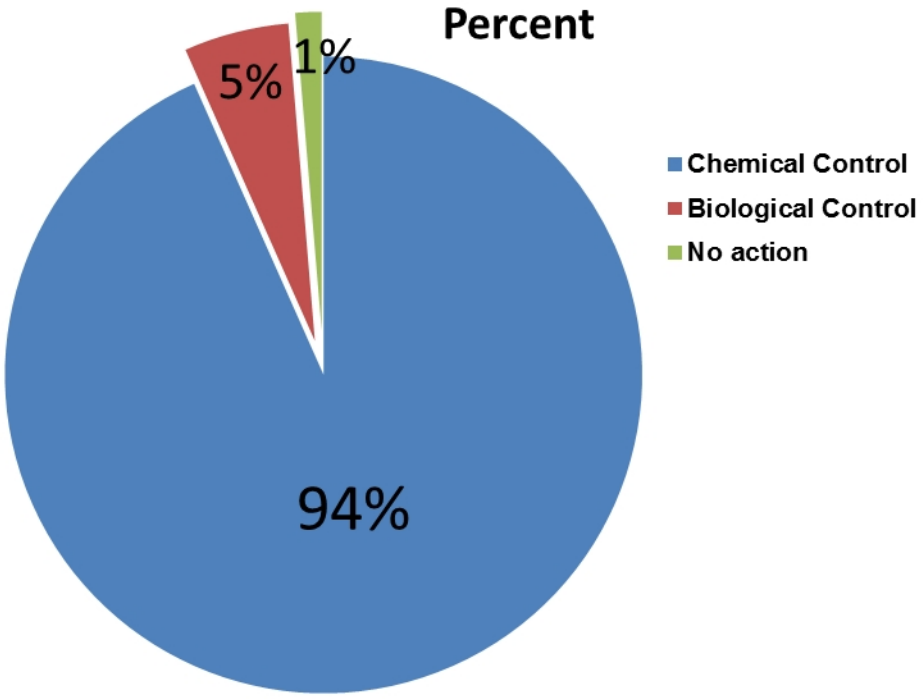

Fig. 2. Percent of farmers used pesticides

Table 1. Pesticides used in 2011 winter rice by the respondent's farmers in Khulna and Bagerhat

Common name	Trade name	WHO category	Type	Recommended crops	Recommended pests	Recommended dose rate/ha	Dose applied Kg or Litre/ha	% of farmers use
Diazinon	Mapzinon 10 G	Class II	OP	Rice	Yellow Stem borer	16.80 kg	14.82 kg	2.67
	Razdhan 10 G			Rice	Yellow Stem borer	16.80 Kg	14.82 kg	6.65
Chlorpyrifos	Solar 55 EC			Bean	Aphid	1 ml/L	0.49 L	2.60
	Dursban 20 EC			Rice	BPH, Hispa	1.00 L	7.74 L	1.33
				Tea	Termite	10.00 L		
				Potato	Cutworm	700 ml		
				Cotton	Boll worm, Aphid, Jassid	11.25 L		
	Rain 48 EC			Nill	Nill	Nill	0.79 L	1.33
	Petrofos 20 EC	Class II	PY	Potato	Cutworm	7.50 L	7.47 L	1.33
				Rice	BPH	1.00 L		
	Gola 48 EC			Tea	Termite	4.00 L	0.49 L	1.33
				Rice	Hispa	500 ml		
				Potato	Cutworm	3ml/L water		
	Kirifos			Potato	Cutworm	7.5 L	1.48 L	5.33
				Rice	Hispa	1.00 L		
	Marine 20 EC			Rice	BPH	1.00 L	0.49 L	1.33
				Potato	Cutworm	7.50 L		
Carbofuran	Curaterr 5G	Class I-B	C	Rice	Stemborer, Hispa	10.00 kg	9.90 kg	1.33
				Sugarcane	White grub, Top shootborer	40.00 Kg		
				Tea	Nematode	165gm/M^3		
	Briker 5G			Rice	Ufra disease	15.00 Kg	10 kg	2.66
	Green furan 5G			Rice	BPH	16.80 Kg	10 kg	5.33
	Carbofuran			Rice	BPH	16.80 Kg	12.00kg	1.33
	Bifuran 5G			Tea	Nematode	165 gm/M^3	9.90 kg	1.33
				Rice	BPH	10.00 Kg		
				Sugarcane	White gurb, Top shootborer	40 kg		
	Furadan 5G			Rice	Stemborer & BPH	10.00 Kg	4.89 kg	2.67
				Sugarcane	White grub, Top &Early Shootborer	40.00 Kg		
				Potato	Cutworm	1.00 KG ai		
	Agrifuran 5G			Rice	Hispa & BPH	10.00 Kg	9.90 kg	2.67
				Surgarcane	White gurb & Early shootborer	40.00 Kg		
				Tea	Nematode	165 gm/M^3		

Table 2. Pesticides used in 2011 winter rice by the respondent's farmers in Khulna and Bagerhat (Please mention Table 2. Inside the Text after Table 1.)

Common Name	Trade Name	WHO category	Type	Recommended Crops	Recommended Pests	Recommended Dose rate/ha	Dose applied Kg or Litre/ha	% of farmers use
	Cartap 50 SP	Class II	C	Rice	Stemborer	1.40 kg	1.38 kg	9.33
					Hispa	800 gm		
Cartap	Cetap 50SP			Rice	Hispa	800 gm	1.58 kg	4
					BPH	1.20 Kg		
					YSB	1.40 Kg		
Thiamaxam	Actara 25WG	Class II	OP	Rice	BPH	60 gm	0.059 L	1.33
Malathion	Fayfanon 57EC			Rice	Leaf roller, GLH, Thrips, Hispa	1.12 L	1.5 L	6.67
	Ashathion 57 EC	Class III	OP	Vegetables	Aphids	1.12 L	2.0 L	5.33
Cyhalothrin	Jubas 2.5 EC	Class II		Jute	Hairy caterpillar	550 ml	0.74 L	1.30
				Potato	Cutworm	1.50 ml/ L water		
	Karate 2.5 EC			Jute	Hairy caterpillar	1 ml/ L water	0.74 L	5.30
				Mango	Hopper	1 ml/ L water		
			PY	Potato	Cutworm	0.75 L		
	Fighter 2.5 EC			Mango	Leafhopper	1 ml/ L water	0.5 L	1.33
				Tea	Helopentis	500 ml		
				Potato	Cutworm	1.5 ml/ L water		
Carbosulfan	Marshal 6G	Class II	C	Rice	Yellow Stemborer & BPH	10.00 Kg	10 kg	2.67
				Sugarcane	White grub, Top & Early Shootborer	33.00 Kg		
Cypermethrin	Shobicron 425 G	Class II	PY	Brinjal	Shoot & fruit borer	2 ml/ L water	0.198 L	4
				Mango	Hopper	1 ml/ L water		
	Agromethrin 10 EC			Mango	Hopper	1 ml/ L water	1.08 L	1.33
NO use	Nill							2.67
Biological control								8.00

Note: Ia = Extremely hazardous, Ib = Highly Hazardous, II = moderately hazardous; III = Slightly hazardous; U = Unlikely to present acute hazard in normal use; OP = Organophosphorus compound, C = Carbamate; PY = Pyrethroid ai=Active ingredients

3.2 Different Type of Pesticide Used

The farmers were used three Organophosphates which including 5 trade name. They were used three Organocarbamate which including 10 trade names and three Pyrethyroids of 12 trades name locally available pesticides. The respondent farmers were used mostly categories Ia, Ib and II pesticides that the WHO classified, extremely highly and moderately hazardous. Carbamate and pyrithroids groups of pesticides which were used extremely hazardous categories having wide spectrum toxicity to the environment. The pesticide groups of Organophosporus and carbamate were used by 40% and 38% of the respondent farmers (Fig. 3). Total 15% farmers were used pyrethroid in their rice crop during the winter period. The various group of pesticides were used in ordered of 36% of Carbofuran, 17% of Chloropyriphos, 12% of Malathion, 11% of Diazinon, 7% of Cyhalotrin, 7% of Cypermethrin, 3% of Carbosyphan and 1% of Thiomax, respectively for the respondent farmers (Fig. 3). Luckily no Organochlorine pesticide had been found while taking interviews from the respondents' farmers.

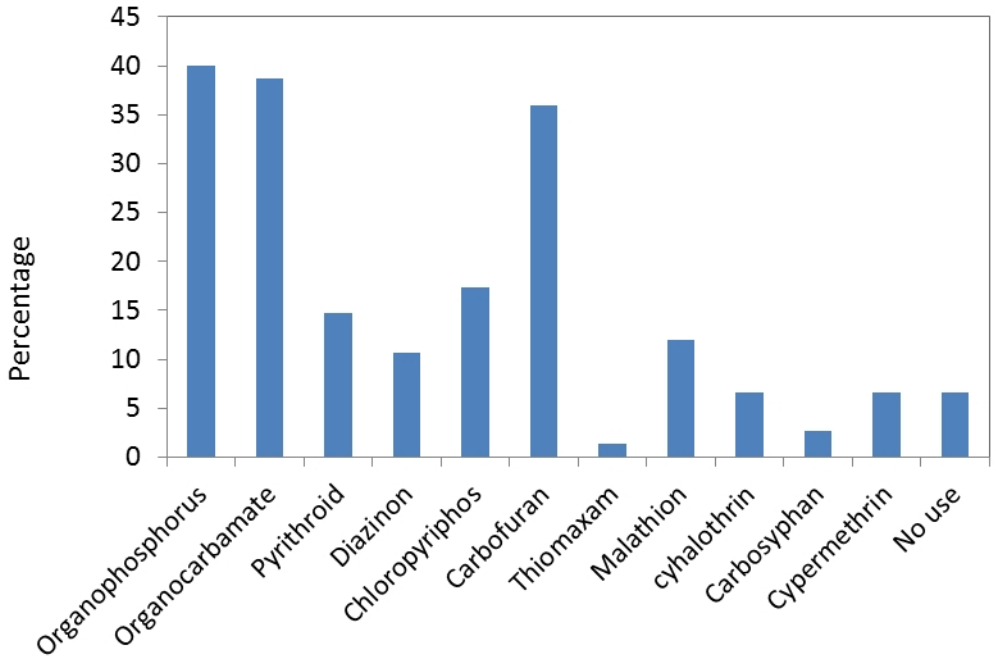

Fig. 3. Group of pesticides reported by farmers

3.3 Basis of Application

Almost equal proportions of farmers were used pesticides on the basis of presence of pest and after consultation (Fig. 4). Thirty eight percent of farmers were used pesticide after consultation with the personnel of the Department of Agricultural Extension and the pesticide buyers. About 14% of farmers were used calendar spray for preventive measure. As reported by the Pesticide Association of Bangladesh many farmers were applied pesticide mixed with basal dose of fertilizer as preventive measure, without any basis.

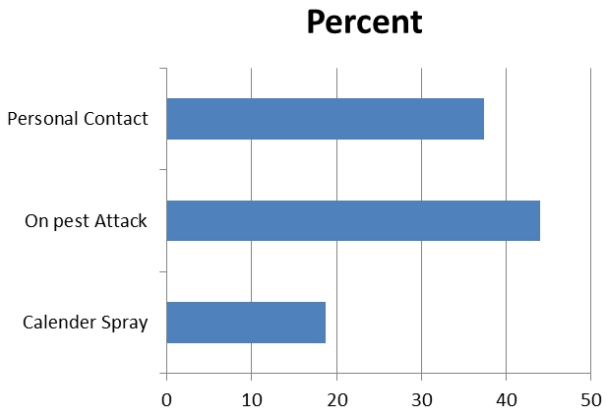

Fig. 4. Percentages of farmers on basis of pesticides application

3.4 Training and Averting Behavior

Farmers were naturally exposed to the mixing sprayed pesticides and their toxicity. Exposures to pesticides were leaded to an array of health effects, depending on the pesticide's toxicity and the dose absorbed by the body. The health effects of pesticide use can often be reduced significantly by averting behavior - wearing protective clothing [7] and exercising precaution. The extent of averting behavior of a farmer, in turn, depends on the perception of risk and training received on safe handling of pesticides. In our survey, only 12% farmers were reported receiving basic training on the use of pesticides and safe handling, while 88% openly did not take any protective measures during the handling of pesticides.

3.5 Monthly Pesticide Used Data

Major numbers of farmers were used pesticide in the early stage of paddy ripping. Vegetative growth stage was the most susceptible to the pest attack. For that reason farmers were applied mostly in the early and late tilling stages than booting, flowering and milky stages. Major insect pests such as stem borer, leaf hopper and plant hopper attacks were prevalent in these stages. Rice hispa is one of the major insect pests of rice attacks in the mature stage like soft dough [8]. In our survey area 36% rice farmers were used pesticides for controlling pest in the month of January. On the other hand, 32% of respondent farmers were applied in February and March (Fig. 5).

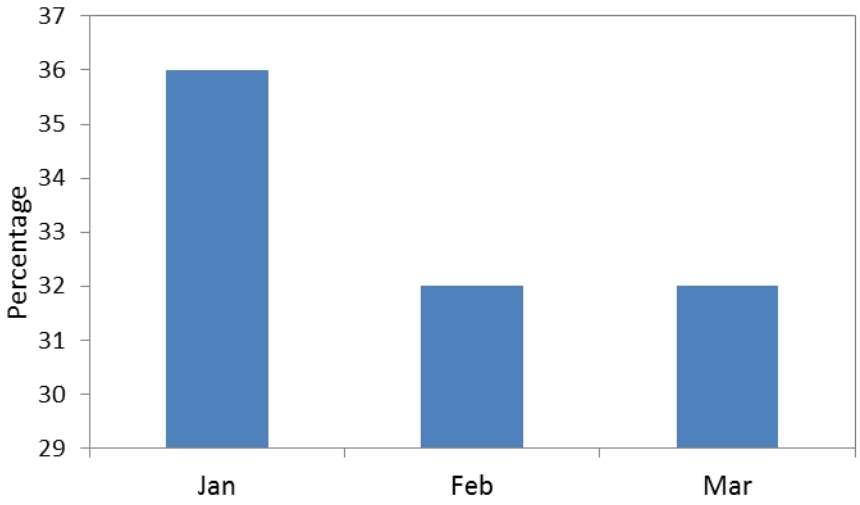

Fig. 5. Pesticides used in various months

4. DISCUSSION

Inappropriately for rice farmers in Asia, there is no shortage of rice pests, with major crop losses occurring from several classes of pests and number of pest types within each class. Rice producers have become more users of all types of pesticides. The case of Bangladesh is no exception in this situation. The respondent farmers are used mostly insecticides, because, in Bangladesh insect infestation is more serious than diseases in rice production. The rate of application of insecticides is found 0.5 to 10 kg/L per hectare of land with less frequency 1 to 3 sprays per crops. The rate of application and frequency is less for the small to medium farmers than large farmers. Although the large farmers are used more frequent and high doses, however, nobody has ever exceeded the recommended level. It is showed that formal schooling, training on pest management, information from media such as television, radio, contact with extension personnel and awareness of farmers on IPM are the critical factors in order to improve rice farmers' understanding about ecological hazards due to overuse of pesticides. Almost all of the carbamates pesticides are classified as highly hazardous and pyrethroids as moderate hazardous. The farmers used the spray methods which are associated with high risk of exposure and contamination [9]. Farmers used pesticides in rice field without any protective measures. Nobody has been reported to use any protective measure before and after the pesticide application. Our analysis further indicated that there is lacked on formal training and information on use and safe handling in research area. Only 12% of farmers in our surveyed area reported receiving basic training, on the use of pesticides and safe handling. This lack of training is reflected in the misperception of pesticide risk. About 37% farmers are used pesticide by consulting other farmers or department of agriculture extension personnel or pesticide dealers. The pesticide association of Bangladesh reported that many farmers are applied the mixed pesticide with basal dose of fertilizer as preventive measure, without any basis by the encouragement of traders. Farmers perceived that the pesticides are used very effectively (100% pests controlled) or effective (≤75% pest controlled), which encouraged them to use more chemical pesticides. However, over doses of pesticides use causes serious mortalities to fishes. The abnormal behavioral responses (loss of equilibrium, hanging vertically in water,

rapid gill movement, erratic swimming at water surface and staying motionless on aquarium bottom) in fingerling European catfish, *Silurus glanis* was observed at diazinon concentrations higher than 2 mg/L [10]. Some pesticides such as organophosporus exposure at low concentration result in significant hematological alteration. Effective substance of organophosporus pesticides also induce change which give evidence for decreased hematopoiesis followed by anemia induction in fish. It regards, e.g., changes in erythrocyte profile induced by acute effect of dichlorovos in *Clarias batrachus* [11], formothion in *Heteropneustes fossilis* [12]. Due to lack of knowledge, the farmers are using toxic pesticides and responsible for making the environment and the ecosystem vulnerable. Taking the opportunity of illiteracy, the pesticide trader and dealers are pushing the farmers using the dangerous pesticide in their rice and prawn composite culture field. In this regards, it may be mentioned that the pesticide distribution in Bangladesh is fully under private sector. The respective company has their own field representative, those who are responsible for sales of pesticide in a specific area directly to the farmers. Therefore, they are always trying to convince the farmers to use their products keeping their monetary gain the main target. In general the farmers are showed favorable attitude towards the pesticide application. As the farmers perceived that the pesticide is effective way to pest control without any detrimental effect; formed the favorable attitude towards the pesticide use. The farmer's perception about the impact of pesticide on the environment is not good or slightly little. Due to the lack of education and mass media campaign most of the farmers are not able to perceive the possible negative impacts of the pesticide on soil, water and aquatic animals. Moreover, due to over publicity of the pesticide trader's farmers only know the so called benefit; the traders never explained the negative impact of pesticide to the farmers. In most of the cases the pesticide traders push the farmers to buy and use when it is not necessary.

5. CONCLUSION

Bangladesh is increasing the uses of pesticides by farmers, unaware of the negative effects pose a big challenge to health, environment and declining the economy of the country. Fish behavior and physiological change is greatly influenced by accumulation of pesticides which sometimes becomes severe enough to disrupt the overall survivability of the animals in their natural environment. The occurrence of fish epidemics in different parts of the country is apprehended by the scientist and local people that fish mortalities in the open water of Bangladesh have occurred in order to uncontrolled the uses of pesticides in rice field. Some extremely and highly hazardous pesticides are used in our research area as these are banned in the country. Moreover, in Bangladesh the existing pesticides laws and regulations are not strictly enforced in relation to import, formulation, repacking, distribution and the uses of pesticides. Environmental degradation linked the agriculture is the impact of toxicity from improper pesticide uses and the damage is less on agricultural productivity than the people who are inadequately protected from the chemicals. Our findings suggested that overuse pesticides have measurable effects on aquatic environment as well as fishes. Steps should be taken including stricter enforcement of existing regulations and promoting of integrated pest management programs and further find out the alternative pest control methods which will be helpful for both rice and prawn production in integrated system.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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