Original Research Article

Using Behavior of Agrochemicals and Pesticides and Their Impacts on Human Health: A Perception based Rural Study in Bangladesh

ABSTRACT

The main theme of the present study has been taken to know the using behaviour of agrochemicals and pesticides and their impacts on human health at *Rangasree* union of Barisal district in Bangladesh. Both the primary and secondary sources of data are integrated to achieve the findings of the study. Primary data were collected through direct field observation survey, questionnaire survey, focus group discussion (FGD) and expert's opinion survey. There are 400 questionnaires were selected randomly and conducted during the months of April 2015 to December 2015. Secondary data were collected from various official records and related researchers' publications through their paper and articles and also internet sources. It is observed from the study that a significant number of farmers (31%) were used to apply white nitrogen fertilizer mainly Urea in their field. They used to familiar some other agrochemicals namely; triple super phosphate (TSP), murate of potash (MP), zinc and single super phosphate (SSP) by 26%, 21%, 8%, and 7% respectively found in the study area. It is known from the study that maximum (95%) farmers are habituated to use urea fertilizer. It is observed that (82.5%) farmers were used to apply Basudin ranging from 2.50 kg to 7.50 kg per acre on the cropping land. It is also observed from the study that only 21% users are used to apply spray machine and about 39% farmers are habituated to use free hand as a tools for pesticides use in their filed. It is identified from the present study that 75.75% farmers' healths are affected by the use of agrochemicals and pesticides. The findings of the study also suggested for building awareness about safe agrochemicals and pesticides use with management and undesirable practice in rural Bangladesh.

Keywords: Agrochemicals, Pesticides, Human, Health, Perception, Rural, Bangladesh.

1. INTRODUCTION

Bangladesh is an agriculture based developing country. Agriculture contributes almost 18.70% of total GDP of the country and provides employment 47.30% of total labor force in various types of economic activities [1]. Bangladesh comprises a limited small area with a

large population and the per capita arable land is only 0.21 acres [1]. To fulfill the demand of its huge population, we need to apply agro-chemicals and pesticides to increase produce more food [2]. The introduction of fertilizer responsive High Yield Varity (HYV) seeds in the country in mid-60's, coupled with the governmental favorable policy for fertilizer distribution and price controlling, resulted in a rise in fertilizer consumption from 313 thousand Metric Ton (MT) in 1970-75 to 3,223 thousand MT in 2000 -2004 [3]. The excessive use of these agrochemicals is creating detrimental effects on human health, plants, soil, water, and the overall environment. Soil organic matter is a key factor in maintaining long-term soil fertility since it is the reservoir of metabolic energy, which drives soil biological processes involved in nutrient availability. A good soil should have at least 2.5% organic matter, but in Bangladesh, most of the soils have less than 1.5%, and some soils even less than 1% organic matter [4,]. Organic matter content of top soils particularly under high land and medium high land situations has declined over time. Organic matter is known as 'storehouse of plant nutrients' and 'life force of a soil' [4, 5].

Agrochemical is a generic term for the various chemical products, such as fertilizer, hormone, fungicide, insecticide, or soil treatment that improves the production of crops. Pesticide as an agricultural input was first introduced in Bangladesh since 1957 and the common pest was available namely DDT [6]. The using behaviours of pesticides in Bangladesh are comparatively less in comparison to other nearest developing countries. It is mentionable that, pesticides use in Bangladesh usually 0.03 kg/hectare compared to 0.3 kg/hectare in India, 0.4 kg/hectare in Sri Lanka and 0.8 kg/hectare in Indonesia [7]. However, recently the uses of pesticides are gradually increasing day by day. Simultaneously, uses of agro-chemicals are rapidly increasing which is responsible to reduce the natural nutrients on the soil surface and contaminate the biotic and aquatic environment [8]. Moreover, chemical fertilizers are more harmful in the agro-environment than the natural fertilizer because it can be polluted the soil nutrients and responsible to decrease the activities of microorganisms into the soil [9]. On the other hand, chemical fertilizers are

needed to grow more agricultural production to ensure the food security. Completely agricultural system is widely depended on the environmental resources. Therefore direct impacts were felt by the local farmers because of the massive uses of fertilizers on their agriculture land and thus the environmental resources are seems to be lost their ecological system by the pollutants of agrochemicals [10]. Now a days, agricultural development, and production must be needed to increase for our own survival. It may be noted that agricultural development could not achieved without the proper implication of agricultural inputs like; HYV of seeds, fertilizers & pests, proper irrigation water either individually or in their suitable combination. The suitable combination of HYV seeds, fertilizers, pesticides, and irrigation into the cropping land may increase agricultural output economically. Bangladesh is an over populated and cultivable lands are decreasing day by day. Therefore, to fulfill the demand of this huge population we need to grow more production from our land. That is why; we are bound to use HYV of seeds, fertilizers, & pests and extract our ground water through irrigation by traditional techniques and newly partially added some mechanization. As a result, last few decades are recorded as witness for major revolution of agriculture through changing behaviour with its capital investment, technology, seed and resource variety, production process and governess system. The use of agrochemicals on domestic food crops in developing countries is a more recent occurrence beginning largely in the 1950's and 1960's [9]. The HYVs wheat and rice varieties described in a report then began to make their appearance in the Least Develop Country (LDC's) in the 1960s, which in turn helped stimulate fertilizer use. The use of both HYV's and agrochemicals was stimulated by a food crisis in South Asia in the mid-1960's [11].

Pesticides can enter the human body in three ways, flow directly by mouth, and infiltrate by skin, and breathing [12]. Moreover, pesticides also can bring a lot of issues to the people who are directly engaged with the chemical fertilizers. Currently, pesticides have become much more serious for long-term effects on human body as well as in foods such as meet, fruits, vegetables and other productions through pesticide residues [9]. Pesticides are often

considered a quick, easy, and inexpensive solution for controlling weeds and insect pests in agricultural landscapes. However, pesticide use comes at a significant cost. Pesticides have contaminated almost every part of the environment. Pesticide residues are found in soil and air and in surface and ground water across the nation. Pesticide contamination poses significant risks to the environment and non-target organisms ranging from beneficial microorganisms, to insects, plants, fish, and birds [13]. Although the rural farmers in Bangladesh to increase the production but some toxic substances of those chemical use chemical fertilizers and pesticides are slowly decreasing the soil fertility. Finally, they are responsible for creating hazardous effects to both human health and environment. The study area, *Rangasree* Union also seems to be potential threatened area for similar types of effects as the farmers are using these agrochemicals and pests vastly in order to increase agricultural crops. The present research project has been taken to find out the recent trends of using behaviours of agrochemicals and pesticides with their impacts on agricultural fields through micro level field study in rural Bangladesh. To assess the concept of agrochemical and their availability, uses and misuses of various chemical fertilizers and pesticides with impacts on soil, water and human health on field level users, the present research project is urgently needed for sustainable rural agricultural development to reduce food security and rural poverty in Bangladesh. The present study was taken to focus on availability, uses, and misuses of various agrochemicals and pesticides with their impacts on farmers as user health through field level perception study with attention to sustainable agrochemicals and pest use and management in the context of rural Bangladesh.

2. MATERIAL AND METHODS

2.1 Selection of the study area

The *Rangasree* Union of Bakergonj Upazila under Barisal District has been taken for the present study. The *Rangasree* Union is almost agrarian with plain land and rural area. There are no varieties of landforms and types. Maximum farmers are used to familiar with agrochemicals and pesticides. After consideration all these issues, this village level agrarian

area may be represented as an ideal to conduct a perception based study for rural Bangladesh. That's why; the *Rangasree* Union has been taken for the present research study. The study area is shown in the following Fig. 1.

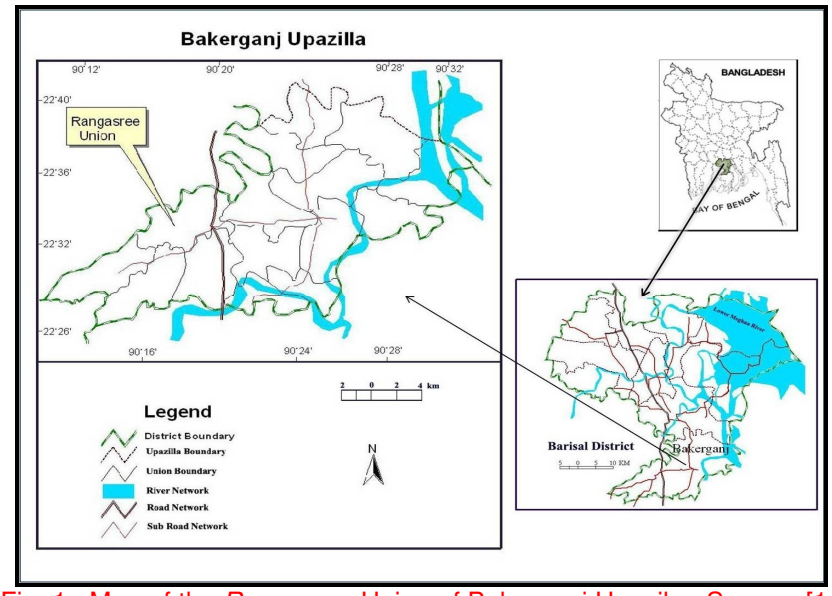

Fig. 1: Map of the *Rangasree* Union of Bakergonj Upazila; Source: [14]

2.2 Data collection and analysis

The present study was carried out based on the combination of primary and secondary data, which were collected from different sources. Primary data had been collected through direct field observation survey, questionnaire survey, focus group discussion (FGD) and expert's opinion survey. To conduct the questionnaire survey, around 400 respondents were selected randomly from the study area. The whole survey was conducted both in summer and winter seasons during the months of March 2015 to December 2015. Two FGD were conducted and three intensive interviews were taken from different professional as expert opinion survey within the study area. After completion of field survey, all the primary data with questionnaires and interview schedule were compiled. Secondary data had been comprised with literatures survey, related books, articles, seminer proceedings, edited books, local agricultural offices' records, related GOs/NGOs reports from print and online version also incorporated. Appropriate coding and scoring techniques were followed to convert the qualitative data into quantitative forms. The responses of the individual respondent

contained in the interview schedules were transferred to a master sheet for entering the date into the computer. The collected information from the questionnaire and FGD survey were finally tabulated and analyzed in accordance of serial number of question of the questionnaires and cited text as required to objectives.

3. RESULTS AND DISCUSSION

3.1 Concept of agrochemicals and pesticides

Agrochemicals are generally prepared with the combinations of essential nutrients for plants to grow properly. The primary nutrients in fertilizers are three essential elements: nitrogen (N), phosphorus (P) and potassium (K), which are often combined into an NPK blend. Secondary nutrients (sulfur, calcium, and magnesium) are needed in smaller amounts for normal plant growth. Micronutrients are also needed but in even smaller quantities. Micronutrients include boron, chlorine, copper, iron, manganese, molybdenum, nickel and zinc. [15]. Nutrition is the supply and absorption of those nutrient chemical elements required by an organism. Crop nutrients are the elements indispensable for the growth of crops and not synthesized by the plant during the normal metabolic process [16]. Pesticides are generally familiar as insecticide, herbicide, fungicides etc. They are mainly classified into organochlorines, organophosphates and carbonates based on their chemical nature. These chemicals are present in the components of environment through human activities and food chain in living organisms to harmful levels [17]. The environmental impact of pesticides consists of the effects of pesticides on non-target species. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, because they are sprayed or spread across entire agricultural fields [18]. The term pesticide encompasses a large number of chemical compounds over 900 [19]. Pesticides are materials used to prevent, destroy, repel or otherwise control objectionable insects, rodents, plants, weeds or other undesirable forum of life [20].

3.2 Types of agrochemicals and pesticides in the context of Bangladesh

Agrochemicals are mainly two types; namely complex fertilizers & Straight fertilizers [21]. Two or more nutrients in one compound are known as complex or compound fertilizers. These fertilizers are granular and easy to apply such as; Di-ammonium Phosphate, Ammonium Phosphate, Ammonium Sulphate. When a chemical fertilizer contains only a single nutrient is called a straight fertilizer such as nitrogenous, phosphate. Common pesticides can be categorized chemically into three general groups such as- inorganic pesticides, natural organic pesticides and synthetic organic. Their biological usefulness viz. insecticides, herbicides, algaecides, fungicides, and rodenticides [20] may also classify them. All halogenated pesticides (Dieldrin, Chlordane, Toxaphene, Heptachlor, Methyoxychlor, DDD, EDB, DBCP and 1,2-dichloropropane) are considered to be significant concern because of their persistence and high potential for creating harm to human and the environment [20]. Pesticides are commonly classified according to the target group of pest organisms namely; Insecticides, Herbicides, and Fungicides [22]. The classifications of pesticides with example are shown in the following Table 1.

Table 1. Types of pesticides with example in the context of Bangladesh

Type	Chemical group	Examples with name
Insecticides	Chlorinated Hydrocarbons / Organochlorine	Heptachlor, Aldrin, Dieldrin, BHC, DDT, Endrin, Chlordane, Toxaphene.
	Organophosphates	Diazinon, Parathion, Dursban, Malathion, Phosphomidan, Schradan, Disulfoton, Phorate, Fenitrothion, Dimethoate, Dichlorvos
	Carbonates	Carbonyl, Carbofuran, Methomyl, Aminocarb
	Pyrethroids	Cypermethrin, Fenvalerate
Herbicides	Phenoxyalkyl acids	2, 4-D, 2, 4, 5,-T, MCPA.
	Triazineas	Atrizine, Simazine, Propazine
	Phenylureas	Diuron, linuron, Fluometuron
	Aliphatic acids	Dalapon.
	Carbonates	Butylate, Vernolate.
	Di-nitro anilines	Trifluralin, Benefin.
	Di-pyridyl	Paraquat, Diquat.
	Amides	Alachlor, Propachlor, Propanil, Alanap.
	Benzoies	Amiben, Dicambra
Fungicides	Thio-carbamates	Ferbam, Maneb
	Mercurial	Ceresin
	Others	Copper sulphate, Chlorothalonial

Source: [22,23]

3.3 Consumption outlook of agrochemicals in Bangladesh

It is recorded from the secondary sources that total urea fertilizer production was 15 million Metric Ton (MT) in Bangladesh and total demand was 28.50 million MT in the Financial Year (FY) 2008-09 [24]. Domestic production of urea may be covered more than 50% of its total demand of urea. Similarly, domestic production of TSP was 0.50 million MT, which covered 10% and domestic production of Gypsum 0.60 million MT and covered 40% of the total demand [25]. Moreover, the demand of 4 million MT of MP completely imported from foreign countries [25]. The year wise consumption outlook of chemical fertilizers during the period from FY 2007-08 to 2013-14 in Bangladesh are shown in the following Table 2.

Table 2.Consumption outlook of agrochemicals in Bangladesh (in '000' MT) Source:[24]

FY	Name of Fertilizers*										Total
	Urea	TSP	DAP	SSP	NPKS	MOP	S	Gypsum	Zinc	Others	
2007-08	2762.00	392.00	129.00	118	120.00	262.00	7.00	75.00	20.00	0	3885.00
2008-09	2532.96	156.00	18.23	20	40.00	75.00	3.00	15.00	5.00	0	2865.19
2009-10	2409.00	420.00	136.00	0	50.00	263.00	5.00	20.00	10.00	0	3313
2010-11	2652.00	564.00	305.00	0	40.00	482.00	6.00	25.00	7.00	0	4081
2011-12	2296.00	678.00	409.00	0	20.00	613.00	6.00	15.00	12.00	0	4049
2012-13	2247.00	654.00	434.00	0	18.00	571.00	8.50	20.00	18.00	0	3970.5
2013-14	2462.00	685.00	543.00	0	27.00	577.00	2.70	173.00	4.29	1.79	4475.78

* **Notes:** FY: Financial Year; TSP: Triple Super Phosphate; DAP: Di-Amonium Phosphate; SSP: Single Super Phosphate; NPKS: Nitrogen, Phosphorous, Potasium and Sulpher; MOP: Murate of Potash; S: Sulpher

3.4 Practices and consumption outlook of pesticide in Bangladesh

The farmers of Bangladesh had been begun to use more toxic chemicals to control pests since 1972 that have reputations of speed and effectiveness [26]. The Government of Bangladesh also promotes the use of pesticides to expand its agricultural frontiers and increase output per acre of land [12]. As a result, pesticide use in general is increasing. According to statistics from the Government of Bangladesh, consumption of pesticides increased from 7,350 MT in 1992 to 16,200 MT in 2001, more than doubling in the past decade [27]. Farmers of Bangladesh mostly use insecticides of organophosphate chemical group rather than other types of pesticides. Generally, they were not much aware of pesticide toxicity and protective measures, which must be taken at the time of and after handling, carrying, mixing, storing, or any other type of contact with and disposal of pesticides. Moreover, pesticides user are smoking, drinking, and consuming something

during application resulting suffering from pesticide related both acute and chronic health hazards. It is mentionable that among the pesticides users who are under age group from 15-30 years are suffering vastly [26]. The consumption levels of pesticides use in Bangladesh are shown in the following Fig. 2.

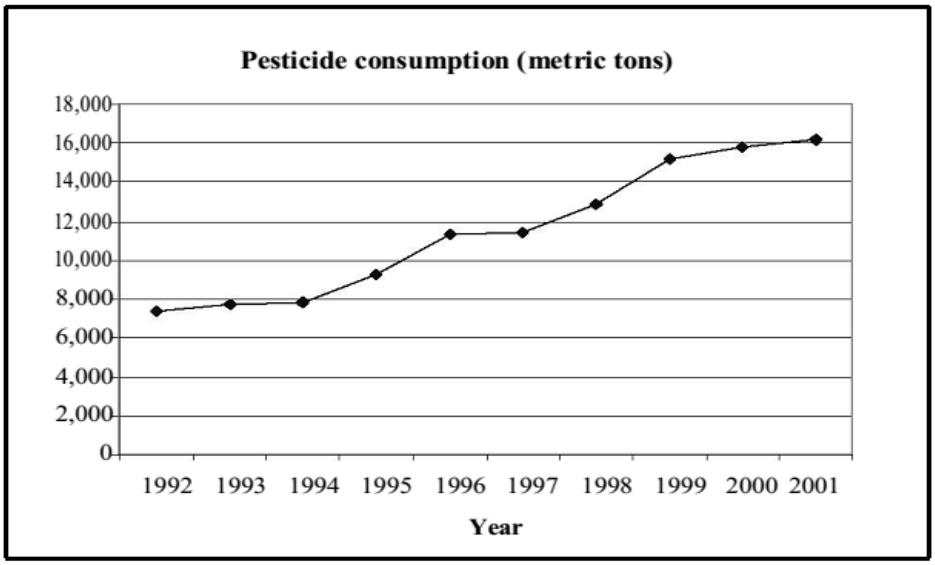

Fig. 2. Consumption outlook of pesticides in Bangladesh; Source: [1]

It is observed from the above Fig. 2 that pesticides consumption capacity is gradually to be increased day by day from two decades. If the consumption for the last several years, it is established that pesticides consumption is increasing in relation to acreage of irrigated agriculture [28]. The major pesticides used by the farmers are Cypermethrin, Dichlorvos, Malathion, Carbofuran, Mancozeb and Diazinon depending upon the invading pests in different districts of Bangladesh [29]. In Bangladesh, average pesticides use rate is 3.4 kg per acre during the cropping season [30].

3.5 Types and using behavior of agrochemicals in the study area

The present study identified various types of agrochemicals, which are frequently used by the farmers in the study area. They are used to familiar with the Urea, TSP, and MP as common fertilizers in their fields. The various types of agrochemicals that are frequently used by the farmer in the study area are shown in the following Fig.3.

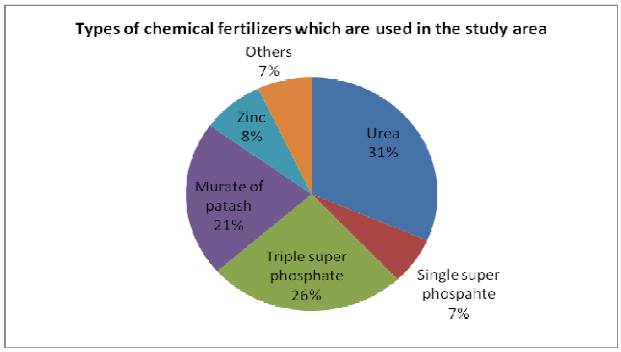

Fig. 3: Various types of agrochemicals, which are frequently used in the study area
Source: Questionnaire Survey, (2015)

It is observed from the above Figure 3 that a significant number of farmers (31%) are frequently used to apply white nitrogen fertilizer mainly Urea in their agricultural land. Simultaneously, they used to some other chemical fertilizers such as; triple super phosphate (TSP), murate of potash (MP), zinc and single super phosphate (SSP) by 26%, 21%, 8% and 7% respondents respectively (Fig. 3).

3.6 Consumption level of agrochemicals in the study area

Inorganic fertilizers have been widely adopted by farmers in the study area because of its wide range of benefits, their cheapness, their cleanliness, and ease of handling, their ease of storage and transport. In addition, the guaranteed composition of inorganic fertilizers makes it easier for users to determine the rate of application and to predict the effect upon yield. Plants can only absorb their required nutrients if they are present in easily dissolved chemical compounds. The item wise using levels of chemical fertilizers in the study area are shown in the following Table 3.

Table 3. Consumption level of agrochemicals in the study area

Item wise using level and % (*f**)			Frequency (*f**) for volume wise use in the land (kg/acre)				
Name of the agrochemicals	*f**	%	Below 20 kg/acre	20-40 kg/acre	41-60 kg/acre	61-80 kg/acre	Above 80 kg/acre
Urea	380	95.00	0	8	105	110	48
Di-ammonium phosphate	210	52.50	20	160	15	0	0
Triple super phosphate (TSP)	280	70.00	0	84	80	36	140
Hyper phosphate (HP)	12	3.00	0	16	2	0	0
Single super phosphate (SSP)	80	20.00	0	30	26	0	0
Murate of potash (MP)	110	2.50	16	66	10	2	4
Zipsam	30	7.50	10	20	0	0	0
Zinc	48	12.00	28	20	0	0	0
Note: Total number of respondent (*f*) = 400; *f** Multiple answers are considered							

Source: Questionnaire Survey, (2015)

It is observed from the above table 3 that about 95% farmers are habituated to use urea while di-ammonium phosphate (52.5%), triple super phosphate (70%) and single super phosphate (20.0%) and rest of uses Murate of potash, hyper phosphate, zinc and others types of fertilizers used agricultural fields in the study area. It may be pointed the use of agrochemicals are rapidly increased from the last 40 years and this seem to be the common phenomenon for the whole south Asia. Liquid fertilizers became more popular because of its effect on high crop production without taking consideration of the possible dangers to the environment. It is also observed from the study that respectively 160 and 105 farmer in the study area (Table 3) frequently uses TSP and di-ammonium phosphate in different levels. For example, Di-ammonium phosphate is used as the level of maximum 41-60 kg/acre, TSP as also 41-60 kg/acre (Table 3). The using level of SSP, MP, Zipsam, and Zinc are also mentionable. On the other hand, agrochemical dealers said that they sold 5-25 MT Urea, 1-10 MT TSP, 500kg to 5 MT MoP and 100kg DAP in every three months during the cropping season in the study area (Table 3).

3.7 Types and using behavior of pesticides in the study area

The present study also identified various types of pesticides, which are frequently used by the farmers in the study area. They are used to familiar with the basodin, furadin, sobicron, carote and thiodin in their field. The various types of pesticides that are frequently used by the farmer in the study area are shown in the following fig. 4.

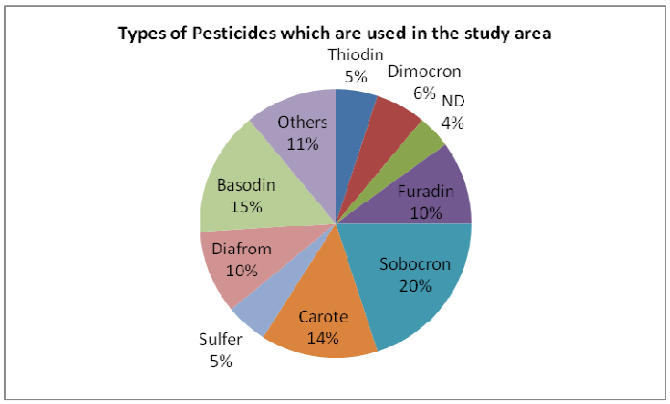

Fig. 4: Various types of pesticides which are frequently used in the study area
Source: Questionnaire Survey, (2015)

3.8 Consumption level of pesticides in the study area

Pests may damage an estimated 30% of crops produced on the farm every year in Bangladesh [31]. Pests are natural enemies affecting crops and may include weeds, insects, slugs, snails, rats, and mice. Pesticides are chemicals, which are used to kill or control these pests. Farmers of Bangladesh mostly used to apply insecticide and little amount of fungicide in the agricultural field. The consumption of pesticides throughout the world has increased rapidly over the past fifty years. Starting from 1950s, the consumption increased 10% every year up to 1980s [32]. In 1983 the pesticide consumption was around 20 billion US $ which went up to 27 billion in 1993 averaging 3% growth rate [31]. There is every reason to expect that the growth rate of pesticide consumption is likely to increase by the year 2020, especially in the developing countries [32]. Most of the farmers depend on local traders/dealers in selecting the brand or type of pesticide to be used to save their crops from pest infestation. They have little idea about types and dosages of pesticides. The using levels of various pesticides in the study area are shown in the following Table 4.

Table 4. Consumption level of pesticides in the study area

Types of pesticides	Consumption rate (%)			Consumption or use level by the farmers (*f*) [Note: kg/L per acre; g=gram; ml= milliliter]				
Structure	Name	*f**	%	Below 2.5kg	2.50-5kg	5.1-7.5kg	7.51-10kg	Above 10kg
Granular	Basudin	330	82.5	*f*=192 (48%)	*f*=106 (26.5%)	*f*=32 (08%)	0	0
Powder	Furadin	90	22.5	*f*=32 (08%)	*f*=14 (3.5%)	*f*=32 (08%)	8	0
				Below 100g	100-200g	201-300g	301-400g	Above 400g
	Thiodin	28	7	8	0	16	0	4
	Others	60	15	12	4	30	10	4
				Below 100ml	100-50ml	151-00ml	200-50ml	Above 250ml
Liquid	Mortar	126	31.5	0	0	16	54	56
	Regent	144	58.5	0	16	0	84	54
	Virtako	72	18	4	0	0	40	28
	Nativo	90	22.5	4	16	0	50	20
Note: Total number of respondent *(f)* = 400; *f** Multiple answers are considered								

Source: Questionnaire survey, (2015); * Multiple answers are considered

It may be pointed from the above table 4 that the popular and common pesticide is identified is frequently used by the 82.5% farmers in the study area from granular types of pesticides namely, Basudin. It is also observed form the study that 48%, 26.5% and 8% basudin users are habituated to apply below 2.5kg, 2.50-5kg and 5.1-7.5kg per acre respectively in the study area during cropping season (Table 4).

3.9 Tools and techniques for using agrochemicals and pesticides

Today's pest management practices require modern equipment to apply a variety of pesticides. In an addition, the equipment must be properly selected, operated, calibrated, and maintained. The pesticide application methods depend on the nature the target pest, the suitability of the application equipment and the cost and efficiency of alternative methods and equipments. The observed methods and techniques for using agrochemicals and pesticides in the study area are shown in the following fig. 5, 6.1, 6.2, 7.1 and 7.2 .

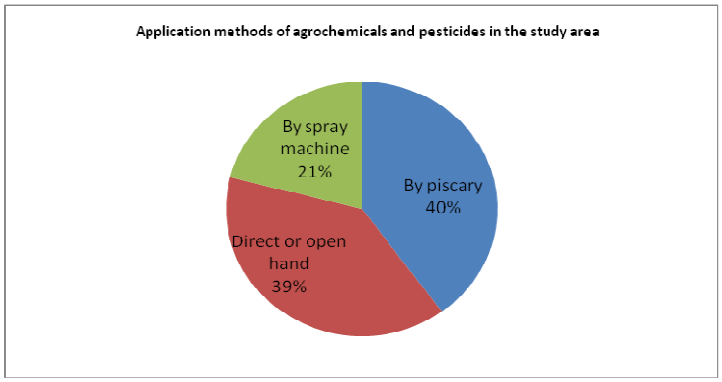

Fig.5: Application methods of using agrochemicals and pesticides by the farmers.
Source: Questionnaire survey, (2015)

Fig. 6.1 and 6.2: Using techniques of agrochemicals through free hand by the farmers in the study area

Fig. 7.1 and 7.2: Using techniques of pesticides through spray machine (without gloves) in the study area

It is observed from the above fig. 5 that 39% and 40% farmers are habituated with open hand and piscary (traditional throwing tools) for using various types of agrochemicals in their field. On the other hand, only 21% farmers are found familiar with spray machine (Fig.5). The above figures 6.1, 6.2, 7.1 and 7.2 are also indicated the frequent scenerios of unsafe using techniques of agrochemicals and pesticides by the farmers in the study area.

3.10 Impacts of agrochemicals and pesticides on users' health

It is observed from the present study that about 75.75% farmers as users had been suffering different types of health problems due to excessive and unsafe use of agrochemicals and pesticides. They freely expressed with their long time experiences that they were suffering eye, respiratory, skin, acidity, headache, breathing problems due to unsafe use of agrochemicals and pesticides through inhalation, and mixing with food and expose parts of body. The local doctor also recognized that various skins related and other diseases may be generated by the excessive unsafe use of some toxic agrochemicals and pesticides. According findings of the questionnaire survey, various skins and other health related problems, which are related to excessive unsafe use of agrochemicals and pesticides among the users within the study area, are shown in the following fig 8.

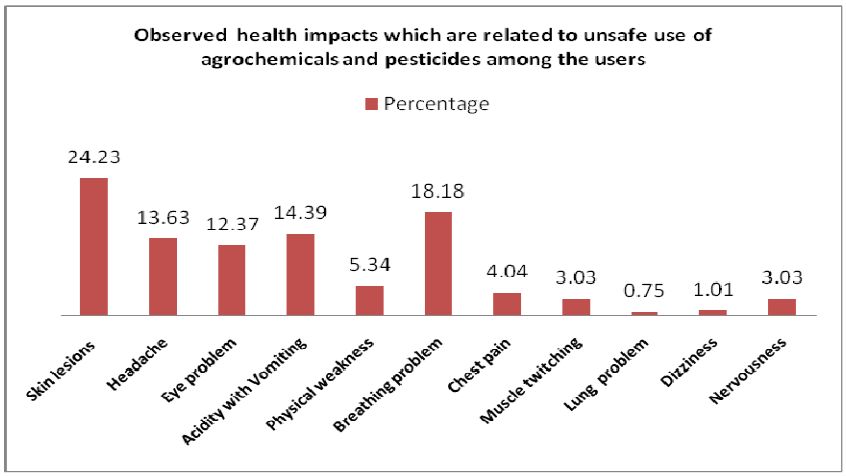

Fig. 8: Observed health impacts which are related to unsafe use of agrochemicals and pesticides among the users in the study area; *Multiple answers are considered; Source: Questionnaire survey, (2015)

It is observed from the above figure 8 that maximum users' healths are more or less affected by the unsafe use of agrochemicals and pesticides in the study area. Therefore, the observed various health impacts types which are suffered by the users are counted as skin lesions, breathing problem, acidity with vomiting, headache, eye problem, nervousness and muscle twitching etc. After the use of agrochemicals and pesticides, they also suffered physical weakness, chest pain headache, breathing problem and acidity problems found frequently among the users in the study area.

3.10.1 Skin lesions

Usually, farmers of Bangladesh are not concerned with toxic effects of agrochemicals and pesticides. They often expose it without wearing proper cloths, gloves etc. A large number of users are more or less affected by the skin lesions in the study area. It is observed from the present study that 24.23% farmers as users are more or less affected by the skin lesions (Fig. 8). They suffered various types of skin problems like irritation, itching etc. Muhibbullah, Mamataz, and Chowdhury (2005) also found that various skin-oriented problems are associated with the arbitrary use of agrochemicals and pesticides.

3.10.2 Breathing problem

Respiratory system is the main sucking organ in human body. It may be affected through spry system of liquid pesticides in agricultural field by handy pump machine. It is observed from the present study that 18.18% farmers were suffering by the breathing problems in study area (Fig. 8). It is also found from the experts' opinion that long time use of toxic chemicals and pesticides are the major reasons for users' breathing problem disease.

3.10.3 Headache

The excessive use of chemicals can damage the neuron system of human body [26]. The toxicity and dust particles as residues of agrochemicals and pesticides may create headache

among the users' through inhaling system. It is observed from the present study that about 13.63% farmers were suffering from severe headache particularly, after using the agrochemicals and pesticides into their fields in the study area (Fig. 8).

3.10.4 Eye problem

Eye is one of the main vision sensors in human body. These two sensors may be directly affected when liquid chemicals and pesticides are mixed with water. As a result, after a long time farmers or users may be suffered from eye irritation, eye burn, petrygium, encroached membrane of pupil, poor vision and others problems etc. [2]. It is observed from the present study that about 12.37% farmers as users is suffering from eye problems particularly who were cultivating rice and cereal crops as well as using pesticides for a long term (Fig. 8).

3.10.5 Acidity with Vomiting

Acidity and vomiting is an instant health problem through an adverse effect of toxicity of agrochemicals and pesticides among the male and female users in the rural area of Bangladesh. It is observed from the present study that about 14.39% farmers as users have been suffering by the massive acidity and vomiting health problem during and after using through direct or spray of agrochemicals and pesticides in to their fields (Fig. 8).

3.10.6 Others health problems

Agrochemicals and pesticides can enter into human body during application or after application through different parts of human body. It is also observed respectively from the present study that about 5.34%, 4.04%, 3.03%, 3.03%, 1.01% and 0.75% farmers as users have been suffering from physical weakness, chest pain, muscle twitching, nervousness, dizziness and lung problems through the adverse effects of solid and liquid agrochemicals and pesticides (Fig.8). Some pesticides are toxic for all and sometimes fatal for its applicator. Increasing use of pesticides in agriculture has lead to widespread concern about

their potential ill effects on human health. The World Health Organization (WHO) and the United Nations (UN) Environment Program estimate pesticide poisoning rates of 2-3 per minute, with approximately 20,000 workers dying from exposure every year, the majority in developing countries [27].

3.11 Recommendations to proper use of agrochemicals and pesticides

The use of agrochemicals in Bangladesh will be increased in future, because of production oriented economic advantages. It is also necessary to get more agricultural product by using these types of agrochemicals and pesticides in rural Bangladesh. Simultaneously, the hazards, which are associated with the unsafe use of agrochemicals and pesticides particularly, farmers' health problems will be accelerated in future. Therefore, some steps should be taken for sustainable safe use of agrochemicals and to control pests in the context of rural Bangladesh, which are given bellow.

i. **It should be reduced impact of agrochemicals on farmers' health:** Farmers' health problems can be reduced by taking the following precautions when they use agrochemicals and pesticides in their field.
   - Farmers must be used to protective cloth and equipments like; gloves, musk etc.
   - Keep the pesticides in cold and dry places.
   - Do not apply pesticides in favor of wind current.
   - Do not throw them into empty containers and other residues in here and there.
   - Try to dump them into the peat.
   - Wash the expose part of the body with soap after using the agrochemicals and pesticides.

ii. **It should be reduced the impact of agrochemicals on agro-Environment:** Environmental pollution (soil and water) can be reduced by taking the following measures should be taken;
   - Should be preferred cow dung

- Use of Zipsham before cultivate the seeds
- Use of Lime and potash
- Use of compact of leaves, dead organisms and wastage
- Destroy pests in natural way

iii. **Proper Management should be ensured:** To ensure the proper management of agricultural system, the following steps should be taken as necessary.

a. Government should develop good mechanism for enforcing the regulations for the overall management and use of agrochemicals and pesticides, adopting FAO and Bangladesh Agriculture Research Council (BARC) guidelines with adequate educational and training interventions.

b. Raising the awareness of the grass roots and designing ways of solving existing problems that resulted from improper utilization of agrochemicals. Research and development on the use of bio pesticides and eco-friendly measures are highly recommended to minimize the use of hazardous pesticides.

c. There should be taken an approach to pesticide management and close collaboration of health, agriculture, and environment sectors.

d. Prevention and management of pesticide poisoning, and for enhanced surveillance, training is extremely important and must be carried out by the concerned authorities. For this issue, a central authority for chemical safety needs to be formed to work effectively on chemical safety and risk management.

4. CONCLUSION

Agrochemicals are considered as a powerful weapon or magic bullets in the developing countries in order to enhance the agriculture productivity. It is found from the study that farmers were habituated to use excessive amount of agrochemicals and pesticides on their cropping fields. Agrochemicals' and pesticides' contamination can poses with health risks to the users because farmers are directly associated and suffered with various types of chronic

419 diseases namely; eye problems, respiratory problems, skin diseases, gastrointestinal tract
420 problems, dental problems and other health problems. However, it was observed from the
421 present study that unsafe use of agrochemicals and pesticides are responsible for health
422 hazards. The present study is also suggested that the farmers' awareness should be
423 developed on safe pesticide management and undesirable practice. Promotion of alternative
424 pest control strategies such as application of bio-pesticides and integrated pest management
425 (IPM) is apparently inevitable. Use of bio pesticides, bioremediation of pesticide-
426 contaminated soils, utilization of plant-associated microbes, and effect of transgenic crop
427 cultivation are some of the successful alternative strategies to pesticide use and application.
428 Occupational exposure to pesticides in agriculture concerns product distributors, mixers and
429 loaders, applicators, bystanders, and rural workers re-entering the fields shortly after
430 treatment [33]. In spite of the economic and social importance of agriculture, the health
431 protection of agricultural workforce has been overlooked for too many years, causing an
432 heavy tribute paid in terms of avoidable diseases, human sufferance, and economic losses;
433 Particularly in the developing countries, where agricultural work is one of the predominant
434 job, a sustainable model of development calls for more attention to occupational risks in
435 agriculture [33]. The guidance values used to control their human health risks are important
436 now and will remain important for many years even if use shifts to other formulations [34].
437 Shoshani, Brenner and Sheindorf [35] showed a process that can function as an efficient
438 treatment system for the complex wastewater typically produced in the herbicide industry. It
439 is also recommended that complementary physico-chemical treatment steps be added to the
440 treatment process for nitro- organic wastes[35]. Li [36] found the acceptable daily intake
441 values which are the maximum amount of pesticide that can enter the human body by
442 ingestion food and water on a daily base without any adverse health impact. Li [37]
443 also suggest that this health risk characterization method applies to other regulatory
444 processes, including occupational, industrial, and agricultural applications. The impact of
445 pesticides on the human immune system has also attracted attention from scholars.

Scholars and experts are agreed with that certain pesticides may affect to the human endocrine and immune systems. Therefore, long-term environmental and health impacts of agrochemicals and pesticides research should be continued in future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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