

**FARMERS' AWARENESS REGARDING JUDICIOUS USE OF AVAILABLE
AGROCHEMICALS IN THE AGRICULTURAL FIELD**

A Thesis

By

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**Dedicated
To
My Beloved Parents**

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ABSTRACT

The non-judicial, unsafe and indiscriminate use of pesticides in agriculture represents a major hazard to the environment and human health. The aim of this study was to assess the levels of awareness of farmers regarding the judicial as well as the safe use of available agrochemicals at Dumuria upazila, Khulna. Data were collected from purposively selected 105 respondents using an interview schedule during 25 January to 7 February, 2022 through face to face interview. About one third (43.8%) of the respondent farmers were middle aged, and 40% had secondary level of education. About 40% of the farmers had small sized family and 56.2% had small sized farm, had medium farming experience 50.50%. Among all fungicide majority (76.19%) of the farmers used Kazim 80 WC usually, where 11.09% gave opinion of using Kazim 80 WC as insecticide, 72.38% used standard dosage and 15.23% sprayed more than standard dosage. Only 6.66% respondents knew about miticide as pesticide. A few (6.66%) of the farmer used Omite 57 EC among all listed miticide and they used standard dose of it. Among all chemicals, 100% respondents used finis as insecticide where as 79.04% of them used standard dosage and 20.95% used more than standard dosage considering in mind it can kill others organism existing in soil surface. Majority (69.85%) of the respondents used Manik 20 SP in standard dosage without 6.66% respondents. Farmer use super power, l-quat, Limset randomly for any weed species. Most of respondents (82.85%) used local rodenticide named poison bait along with zinc phosphite. Farmers were not aware of nematicide. Some respondents (17.14%) said they used unknown granular medicine as nematicide collected from local market. Farmers were aware about fertilizer more than others agrochemical. They try always to appropriate dosage of fertilizer in appropriate time. Ammonium phosphate, Monoammonium phosphate, Dai ammonium phosphate, triple super phosphate, Urea, Gypsum and MOP all of these were well known to farmers. Plant growth regulator were rarely used by farmers. More than half of respondents (63.80%) were aware to ethylene, 29.52 % used ethylene in standard dosage among 35.23% respondents. About whole respondents perceived agrochemical damaged soil fertility and its an excessive cost for them. They also agree about high exposure of agrochemical with its threat for ecology as well as for lives.

Key words: Available agrochemicals, farmers' awareness and judicial use.



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CHAPTER 1

INTRODUCTION

1.1 General background

Finding a way to feed an estimated 9.3 billion people expected to populate planet Earth by the year 2050 is considered a major challenge in terms of agricultural pest management (Godfray et al. 2010). On the other hand, crop productivity is at constant risk due to the continuous incidence of common pests, especially weeds, pathogens and arthropod pests (Oerke 2006). From the beginning of agriculture, pests have been a major problem for crop production and continue today. Despite substantial increase in pesticide use since the 1960s, global crop losses to pests have remained unsustainably high or even increasing in some cases (Oerke 2006).

Bangladesh is one of the most densely populated countries of the world. To meet the food grain requirement for the growing population with limited land resources, we are increasing pressure on land. The farmers use chemical fertilizers as a supplemental source of nutrients but they do not apply in balanced proportion (BRAC, 2005).

Agrochemicals include several pesticides (Insecticides, herbicides, etc.), Inorganic fertilizers, and disinfectant products (CFSPH, 2010).

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 agricultural input was introduced in Bangladesh in 1957 and mainly DDT and BHC (Islam, 2000).

Population growth has led to the need to increase global food production. Pesticides are an important tool used in efforts to control insect pests. About 20-30% of agricultural produce is lost annually due to insect pests, diseases, weeds and rodents. While pesticides are effective against pest populations, if used injudiciously. (Rahaman, et al, 2018)

In Ghana, they are predominantly applied on cash-crop plantations of cocoa, rubber, and oil palm to maximize yield as foreign exchange commodities. Likewise, there is substantial use on root and tubers, cereals and especially, vegetables. The role of inorganic fertilizers that either doubled or tripled crop yield in a short space of time is tremendous and could not be discounted. (Habib, 2020).

Since the era of the Green Revolution, Agricultural production worldwide experienced much efficiency with a remarkable aim to eradicate threats of food insecurity. This breakthrough was anchored on science and technology. Among the interventions this era saw to date were the use of fertilizers and pesticides in our day-to-day farming activity to boost yield and control pests/diseases. (Habib, 2020)

Though the use of pesticides in Bangladesh is less in comparison to other developing countries which is 0.03 kg/ha compared to 0.3 kg/ha in India, 0.4 kg/ha in Sri Lanka and 0.8 kg/ha in Indonesia. (Sultana and Nobukazu, 2001).

Pesticides are substances or mixtures intended for controlling, preventing, destroying, repelling or mitigating any form of life declared to be a pest. Today pesticides (insecticides, fungicides, herbicides, rodenticides, nematicides etc.) are extensively used all over the world to save crops in the field and in the storage. If pesticides were not used in agriculture the crop loss in the world would have been around 40%. The ease with which these substances can be used, their initial low cost and the lack of knowledge on the part of grower has led to an overuse of pesticides, with danger our consequences. Evidence suggests that not only are chemical pesticides used in increasing quantities but they are sometimes used and handled in an irresponsible way. This has led to problems to the environment, human and other forms of life. (Sharma et al, 2014)

Profitability in smallholder farms is mostly contingent on the use of Agrochemicals with intensity variation depending on the production type (Nyambo et al., 2019).

Farmers cultivate different crops at various environmental and geographical location. Farmers use different agrochemicals such as chemical fertilizer, fungicide, insecticide when cultivation practices are conducted. Various agrochemicals are available in the market which are used for crop production. Farmers might not have any clear concept about the agrochemicals, including its judicious and timely use. Farmers might not have clear idea about judicious dose too, and also what is the time for using and how much they have to apply. If famers are adequately aware about all the matters of agrochemicals they can minimize the harmful effect of agrochemicals on crop, on environment as well as on human health. The exact knowledge may increase crop production without resulting any failure. If farmers use high amount of agrochemicals that will be hazardous for human health and if it is low in amount then farmer will face loss in crop production. So it is urgent to know and understand to what extent the farmers are aware about all these aspects of judicious use of agrochemicals

In Bangladesh a good number of crop grown throughout the year on different season through using different agrochemical to make high profit even they forget the adverse effect. They do all things in view of increase the income of population and nutritional considerations. Farmers used to grow cereal crop, pulse crop, oil seed and vegetables in and around the whole country with the help of pesticide, fertilizer, plant growth regulators by using the weather, climate and soil of Bangladesh. Overall environmental situation is very much suitable for growing crops round the year.

This study was done in selected villages of Dumuria to study the knowledge and practices regarding storage, handling and disposal of routinely used pesticides and fertilizers (agrochemicals). The farmers' perceptions of agrochemical use and health effects were also explored. This study also intended to determine whether the commonly used agrochemicals for agricultural purposes had reached the ground water. This information was thought to be useful to make informed policy decisions for bringing about changes in the agricultural practices to reduce the risk of exposure to harmful agrochemicals.



1.2 Statement of the problem

There are many problems faced by the farmers for producing crops. It is common that farmers get higher price of agricultural goods if it can succeed till harvesting time. Most of the farmers faced the problems reduce final income for pest and disease infestation and its management. One of the important problems of crop production loss due to epidemic infestation of pest and disease, at large farmer use agrochemical for control such devastating situation. Then agrochemical cost problems become important for the producer. The output of using agrochemical observed quickly but it damaged soil health as well as overall environment, and concern is farmers are not aware about adverse effect of agrochemical. Though farmers are suggest different solutions to overcome their problems. They need regular government extension service. Government must ensure proper step through training the farmer for manage the situation also give frequent knowledge agrochemical effect and about biological control of pest and disease which is economically cost effective and soil protective. Considering the nature of study the researcher sought information regarding following research questions.

- I. What are the socioeconomic characteristics of crop growers?
- II. Does the farmer have any idea about available agrochemical and their use?
- III. Does the farmer know about proper dose of agrochemical?
- IV. Is farmer aware about harmful environmental effect of agrochemical?
- V. Does the farmer know about harmful effect of agrochemical to human health?

1.3 Objectives of the study

The research was designed to obtain these following objectives:

1. To describe the personal characteristics of farmers.
2. To identify the specific use of agrochemicals as perceived by farmers.
3. To find out judicious dose and application of the agrochemicals.
4. To assess awareness of farmer about effect of agrochemical on environment, on human health and on crop production.

1.4 Justification of the study

Dumuria is one of the most important Upazila for vegetable production. A large portion of supplied vegetable to the market of Khulna city is produced in this area. In spite of having saline affected land farmers cultivate vegetables, they also cultivate some cereals such as rice and so little amount of wheat, oil crops such as mustard, sesame and pulse crop such as mungbean by intensive care. There are several researches related to soil salinity, effect of shrimp production on vegetable, cost benefit of production in this area are available. But no survey on farmers awareness about available agrochemical such as pesticides (insecticides, fungicides, herbicides, rodenticides, nematicides etc.) regarding judicious use in this area and its effect on crop production, even there is so much rare work and survey on this in whole country. This survey aimed at investigate the mostly the occurrence of non-judicial use and result in crop production and available control what is the perception picture in farmer level.

1.5 Scope of the study

The present study was designed to understanding farmer awareness about the available agrochemical and their judicious use and also trying to understand farmer perception about the effect of all these agrochemicals on their life as well as on environment at Dumuria. Here the finding of adverse effect agrochemical on soil, water and crop production, also their management procedure may applicable for future study. So on the findings may also be applicable to others areas of Bangladesh where socioeconomic situation do not differ much than those study area. The findings may also helpful to works of agricultural extension service provides to improve strategies of control the use of agrochemical in judicious way in cultivation field for high production. Lastly, it assumed that the recommendation of this study will be helpful in formulating extension program for reducing the health risk and preserve ecology from the effect of toxic chemical infestation in field and increasing total food production of the country.

1.6 Limitation of the study

Considering the time, money and other necessary resources available to make the study manageable and meaningful, it was necessary to consider the following limitations:

- I. The study was confined only certain number villages under Dumuria upazila in Khulna district so the whole figure of crop cultivation and its dependency on agrochemical in these area could not be demonstrated.
- II. Sample size of the study was limited.
- III. The investigators were dependent on the data furnished by the selected respondents during their interview.
- IV. Major information, facts, and figures supplied by the respondents were applicable to the situations prevailing in the locality during the year 2022.
- V. The characteristics of the respondents were many in number but only few personal and socio-economic characteristics were selected for investigation in this study.
- VI. The study was limited to only one season cultivation whereas farmers also involve in cultivation throughout the year.

- VII. Sometimes farmers failed to give accurate information of the major problem they face during cultivation, cause they are not enough aware about harmful effect of agrochemical.

1.7 Definition of terms

The term which have been frequently used throughout thesis are defined and interpreted below:

Age

Age of a respondent is defined as the span of his/her life and is operationally measured by the number of years from his/her birth to the time of interview.

Educational qualification

Education referred to the development of desirable knowledge, skill, attitudes etc. of an individual through the experience of reading, writing, observation and related matters respondents during data collection.

Family size

It referred to actual number of permanent members in a subject's family who lived in a fixed dwelling unit and ate from the same cooking arrangement.

Farming experience

It referred to the actual number of days that an individual are involved with agricultural work or agricultural related profession, which measured by the number of years from his/her involvement with agricultural work to the time of interview.

Knowledge on agriculture

Knowledge on agriculture is the sum of the OLs and farmer body of information regarding agriculture which reflects their understanding, applying, analyzing, cultivation and creating in regards to agricultural works.

Farm size

Farm size referred to the total area on which a respondent's family carries on farming operations, the area being estimated in terms of full benefit to the farmer's family.

Monthly family income

Family income referred to the total earnings of all the family members of a respondent from agriculture/job, business, service and other accessible sources.

Training received

It referred to the total number of training and total days that a respondent received in his entire life from different organizations under different training programs.

Organizational participation

Organizational participation of an individual referred to his/her participation in various organizations as ordinary member, executive committee member and executive committee officer.

Cosmopolitanism

It referred to an individual's exposure outside his own social environment, his exposure to the nearest village, own union, own upazila, other upazilas, districts or places of social and agricultural important.

Extension media contact

It referred to an individual's exposure to or contact with different communication media and sources and personalities being used for discrimination of new technologies among the OLs and farmers related to agricultural extension.

Agrochemical

Agrochemicals are chemical products comprised of fertilizers, plant-protection chemicals or pesticides, and plant-growth hormones used in agriculture. An agrochemical is a chemical substance like fertilizer, hormone, fungicide, insecticide or soil treatment that helps improve the production of the crop. It refers to inorganic fertilizers and pesticides that provide benefits and manage agricultural eco system and is used in the farming fields.

Judicious use

Judicious implies the possession and use of discerning and discriminating judgment: a judicious use of one's time. Judicial has connotations of judgments made in a courtroom and refers to a fair and impartial kind of judgment: cool and judicial in examining the facts.

Judicious pesticide use: Judicious use of pesticides can be made by considering the following:

- Waiting periods of chemicals,
- Economic threshold levels,
- Compatibility of chemicals with natural enemies,
- Nature of chemicals,
- The recommended doses,
- Time of application, and
- Application technology etc



CHAPTER 2

REVIEW OF LITERATURE

The purpose of this study is to review the past studies conducted by different researchers related to the present study. The researcher tried to review the available literature from different countries related to knowledge of agrochemicals judicial use and impact on environment. Unfortunately, none of the studies were directly related to the present study.

2.1 Initiation of agrochemical utilization

Since the era of the Green Revolution, Agricultural production worldwide experienced much efficiency with a remarkable aim to eradicate threats of food insecurity. This breakthrough was anchored on science and technology. Among the interventions this era saw to date were the use of fertilizers and pesticides in our day-to-day farming activity to boost yield and control pests/diseases. The study assessed farmers' knowledge in the use of Agrochemicals given their environmental effects such as on water bodies, occupational hazard and safety, disposal, and storage regarding product use. Questionnaires were administered to farmers cultivating vegetables, food, and cash crops under Open-field and Greenhouse managements in respective Production Specification; Organic and Inorganic productions. (Habib, Y. 2020)

It is estimated that pests, i.e. insects, plant pathogens and weeds, destroy about 40 % of all major crops every year (Pimentel 2005). Among crops, the total global potential loss due to pests varied from about 50 % in wheat to more than 80 % in cotton (Oerke 2006). Absolute crop losses and loss rates vary largely among crops due to differences in their reaction to the competition of weeds and to the attack of other pest groups (Oerke 2006). The overall loss potential is especially high in crops grown under high productivity conditions as well as in the tropics and subtropics, where climatic conditions favour the damaging function of pests.

WHO (2008) reported that when pesticides are applied directly to targeted pests (plant or insect), the whole site is affected, including crops and humans in the immediate area. The process of controlling the pest and disease menace invariably leads to overuse for the most part when the users are not well informed in contrast to the prescribed quantities for application.

Nnamonu and Ali (2013) was, for an average farmer, the higher the Agrochemical applied, the higher the yield. Overapplication of Agrochemicals has a great impact on water quality through field runoff (Habib et al., 2017; Zhou et al., 2010).

The improper management practices create many problems such as negative externality and deleterious effects on the environment as well as to the human health (both users and bystanders) (Prasannath and Prasannath, 2013; Persuap, 2013).

Farmers would resort to applying quantities of Agrochemicals to lessen the insurgence of the pests and diseases on crops, especially as the Ghana horticultural industry was estimated to record about \$30 million deficits (Kwofi, 2017) in a chain reaction as far as pesticides are concerned.

However, the adoption and continued use are due to exacerbated and unfavorable site conditions on farmlands earmarked with reduced soil fertility, resurgence of pests, and weeds (Nonga et al., 2011). Recently, the strive for epitome related to pests and diseases free fresh Ghanaian Horticultural crops for export resulted in a temporal ban into the European market (Joyce, 2014) due to traces of chemical residues.

According to Danielou (2014), half the food we eat today is produced thanks to fertilizers. Agriculture is the core livelihoods of most rural households with increasing availability of inputs such as inorganic fertilizer and manure (Bayite-Kasule, 2009; FAO, 2011; Tittonell et al., 2008) in their rural communities. In crop protection, pesticides enviably provide numerous benefits in weed and insect control.

Pesticide use in Nepal started in the early 1950s with DDT for malaria eradication. This was subsequently followed by other organochlorines (such as BHC, dieldrin, chlordane), organophosphates (like, ethyl parathion, methyl parathion, malathion, and oxydemeton methyl), carbamates and finally synthetic pyrethroids. Some years before use of Chlordane, DDT, Dieldrin, Endrin, Aldrin, Heptachlor, Toxafen, Mirex, BHC, Lindane, Phosphamidon, Orano mercury fungicides, Methyl parathion and Monocrotophos are banned in Nepal. A steadily increasing trend in pesticide use has been observed. A total of 178 tons of pesticides were used in 2003, of which insecticides (58%) and fungicides (31%) made up the bulk consumed. The number of households using pesticides varies considerably across the country, with the Terai (plains) region having the highest users (25.04% of land holdings) and the Mountains region having the least at about 7.14% of land holdings [Central Bureau of Statistics (CBS). 2003]. The Mid-hills region has an average of 8.38% of land holdings using pesticides;

Farmers' Awareness of Agrochemicals Residues Farmers serve as the main unit of pesticide application. Hence, their degree of awareness of pesticide residues inherently affects their methods of pesticide application. Whether they apply pesticides in a standardized method affects the generated amount of pesticide residues, thereby ultimately influencing the safe production of agricultural products (Bo Hou, Linhai Wu. 2010). 171 household representatives were interviewed during the survey, making the response rate about 100% from the estimated households. The majority of the respondents had ample awareness about agricultural fertilizers and pesticides, in view of the fact that Rupandehi is one of the major and well-known districts for the cultivation of agricultural crops in Nepal. As much as 170 (99.41%) of the farmers had ample awareness regarding agrochemicals. (Bhandari, G. 2014)

Awareness of How Agrochemicals Residues Affect the Quality of Agricultural Products. Farmers in Sichuan Province of China lack knowledge on pesticide toxicity and do not follow specific guidelines. Rather, they utilize a random method when applying different kinds of pesticides on different kinds of agricultural products. However, this study in Rupandehi district confirmed that 170 (99.41%) individuals fully understand the basic method of agrochemicals application, 168 (98.24%) still lack the concept of bioaccumulation and bio magnification, which lead to the accumulation of chemical residues in agricultural products in a greater amount. (Bhandari, G. 2014).

2.3 Factors that influence farmers' awareness of agrochemicals residues

Many factors influence farmers' awareness of pesticides and pesticide residues. For example, (Nicol A. 2003) utilized a multi-variable model and concluded that the significant factors that influence farmers' awareness of pesticides include race, awareness of agricultural damage and awareness of health problems caused by pesticides, as well as whether they or their relatives have experienced damages caused by pesticides.

A. Geographical Factors

Due to different plantation structures and habits in different regions, levels of pest diseases, pesticide production and sales, as well as economic levels, are all different. Hence, the levels of pesticide awareness among farmers also differ. (Yang T. 2006) believed that, among others, differences in annual income and geographical location can partly explain why farmers apply pesticides excessively. The amount of pesticides, especially highly toxic pesticides, applied in

developing countries are considerably higher than in developed countries (Tariq MI et al, 2003).

B. Gender and Age

Gender tends to influence awareness of the dangers of having pesticide residues [Bo Hou, Linhai Wu. 2010]. In Nepal, women do not have a strong notion of the dangers caused by pesticides because they have relatively lower education levels (Atreya K. 2007)

C. Education

If a farmer is relatively less educated, his/her ability to absorb professional knowledge is weaker. Furthermore, his/her capability to recognize pest diseases is also weaker. Hence, the less-educated farmer tends to lack awareness of both pesticide residues and the importance of applying pesticide in standardized ways. Consequently, with less education, there is a higher chance that the farmer will apply prohibited pesticide excessively, leading to highly concentrated pesticide residues (Xu Y. 2004)

D. Agricultural Use

(Zhao J, Zhang Z. 2007) found that farmers who plant rice to feed their own households tend to pay more attention to pesticide residue problems, while farmers who plant rice for commercial purposes pay more attention to the quantity of production.

E. Other Factors

(Dongmei Z. 2006) found that the education and training provided by agricultural technology personnel affect farmers' awareness of pesticide residues. Rupandehi district where this study had been carried out lies near the border between Nepal and India. Farmers can have the availability of large quantity of agrochemicals promptly in comparison to other places. Also many private shops near Bhairahawa sell agrochemicals by which the farmers have easy access. This has encouraged the individuals to depend on chemicals instead of organic manure.

2.4 Agrochemical exposers and poisoning:

No segment of the population of the developing countries like Bangladesh is completely protected against exposure to agrochemicals (pesticides) and the potentially serious health effects. Despite their popularity and extensive use, there is serious concern about health risks

arising from the exposure of farmers when mixing and applying pesticides or working in treated fields. From residues of pesticides on food and in drinking water the health risk for the general population have been raised (Pimentel, 2005; Maroniet.al.,2006; Soares and Porto, 2009).

In Bangladesh like other developing countries, farmers face great risks of exposure due to the use of toxic chemicals that are banned or restricted in other countries, incorrect application techniques, poorly maintained or totally inappropriate spraying equipment, inadequate storage practices (Asogwa and Dongo, 2009).

In addition, several studies have shown that inadequate product labeling and users' lack of information have led to the widespread overuse and misuse of dangerous pesticides. Although monitored health data on the effects of pesticides is not available in Bangladesh, projections suggest an annual incidence of organophosphate (OP) poisoning alone is as high as 900/100,000 population (Dasgupta and Meisner, 2005).

In Bangladesh, farmers still apply highly toxic pesticides with leaking equipment, often against wind drift, wearing cotton shirts and waistcloths ('lungi'). Educated farmers alone did not succeed in adoption of safety measures by them. A survey of 110 Bangladeshi pesticide traders (shops) show that, 90% of the traders indicated the need for further instructions on pesticide use and handling and over 92% indicated no protection measures were taken during the handling of pesticides (Dasgupta and Meisner, 2005). Also, accidental poisoning with agrochemicals in home is a possibility from the use of chemicals around the house or garden.

Vegetable growers used pesticides that may be highly hazardous and which were not registered in most cases. These situations could have unexpected consequences including the exposure of consumers to health hazards (Claude et.al., 2012).

In Bangladesh, vector control has consequently been intensified in all over the country with Indoor Residual Spray as a method of choice. The adverse health effects of such indoor insecticide sprays that still include DDT. Television advertisements of ant, mosquito and cockroach control products have become more available and colorful, probably reflecting their rising demand in the market. The links between pesticides and human health were suspected as early as the 1960s and 1970s., US epidemiologists observed an unusual rise in Non-Hodgkin's Lymphoma in areas of high pesticide use (Gupta, 2012). A number of more recent studies and reviews bring to light some critical health implications of pesticide exposure.

2.5 Impact of agrochemicals

Pesticides have been implicated in human studies of leukemia, lymphoma and cancers of the brain, breasts, prostate, testes and ovaries. Reproductive harm from pesticides includes birth defects, still birth, spontaneous abortion, sterility and infertility. Adverse effects on non-target Animal In Bangladesh biodiversity is declining due to the effect of excess use of pesticide and fertilizer. Population of native fish species is now endangered and the traditional fish-rice systems have disappeared. The bird and other small wild animals are in threat because of the use of pesticides in rice and vegetables. The rice-based agroecosystem is showing signs of unsustainability. Most of the rice farmers (96%) in Comilla district are dependent on insecticides for pest control during dry season, but due to the prevalence of insecticide use, elderly farmers reported that insect pests are now more difficult to control than in their youth (Barzman and Das, 2000).

The Brown Plant Hopper (BHP) outbreak in 1991 in Nilphamari and Rangpur districts of Bangladesh has been attributed to the excessive use of pesticides. A survey was conducted in 1999 indicated that, following the aerial spraying cows, calves, goats, fish, honey bees, dragon flies, lady beetles, birds and many other useful insects and animals had been seriously affected (Sultana and Nobukazu, 2001).

Khan and Law (2005) have provided an extensive review of the adverse effects of pesticides and other chemicals on the enzyme and hormone systems of fish, amphibians and reptiles. Most fish species are sensitive to enzyme and hormone disruptors. Chronic exposure to low levels of pesticides can produce subtle in behavior and physiology that lead to metabolic disturbances, inhibition of important enzymes, retardation of growth and reduction in the fecundity and longevity. In addition to direct acute toxicity, some herbicides may produce sub-lethal effects on fish that lessen their chances for survival and threaten the population as a whole. Glyphosate or glyphosate containing products can cause sub-lethal effects such as erratic swimming and labored breathing, which increase the fish's chance of being eaten (Liong et.al., 1988). Herbicides 2,4-D caused physiological stress responses in sockeye salmon and reduced the food-gathering abilities of rainbow trout (Little, 1990)

Herbicides are designed to kill plants. So it is not surprising that they can injure or kill desirable species if they are applied directly onto them. In addition to killing non-target plants outright, pesticide exposure can cause sublethal effects on plants. Phenoxy herbicides, including 2,4-D, can injure nearby trees and shrubs if they drift onto leaves (Dreistadt et.al., 1994). Exposure to

herbicide glyphosate can severely reduce seed quality (Locke et.al., 1995). It can also increase the susceptibility of certain plants to disease (Brammall and Higgins, 1988). This poses a special threat to endangered plant species. Plants can also suffer indirect consequences of pesticide application when soil microorganisms and beneficial insects are harmed. Herbicide contamination of water could have also devastating effects on aquatic plants. In one study, oxadiazon was found to severely reduce algal growth (U.S. EPA, 1996).

Heavy treatment of soil with pesticides and other agrochemicals can decline the populations of beneficial soil microorganisms. Overuses of chemical fertilizers and pesticides have effects on the soil organisms that are similar to overuse of antibiotics in human. Indiscriminate use of chemicals might work for a few years, but after a while, there are not enough beneficial soil organisms to hold on to the nutrients. Glyphosate reduces the growth and activity of free-living nitrogenfixing bacteria in the soil (Santos and Flores, 1995). 2,4- D reduces nitrogen fixation by the bacteria that live on the roots of bean plants (Fabraet.al., 1997). It also reduces the growth and activity of nitrogen-fixing bluegreen algae (Singh and Singh, 1989) and inhibits the transformation of ammonia into nitrates (Martens and Bremner, 1993).

Although the agricultural soil is the primary recipient of agrochemicals, water bodies that are adjacent to agricultural areas are usually the ultimate recipient for agrochemicals residues. There is a suspicion that agrochemicals residues are common in surface water system, especially in irrigation drains, which ultimately pollute the pond and river water, and can harm aquatic environment (Pereira et.al., 2009)

A study of pesticide residues in some selected ponds of Bangladesh showed the residue level of malathion was 0.0241 to 0.463 ppm, carbofuran was 0.0302 to 0.0629 ppm and cypermethrin (pyrethroid) was 0.0141 to 0.09 ppm (Amin Uddin et.al.,2012). The residue level of diazinon and chlorpyriphosin Meherpurregion of Bangladesh ranged from 0.033 to 0.079 ppm and 0.010 to 0.471 ppm, respectively. Among carbamate pesticides, carbofuran was identified from two samples ranged from 0.0143 to 0.0387 ppm. Limit of detection (LOD) was 0.01 ppm in pond water (Amin Uddin et.al.,2013).

Pesticides are toxicants, capable of affecting all taxonomic groups of biota, including non-target organisms. So, it is important to ensure the use of right pesticide at right time and in right doses. The under dose of pesticides may give poor results along with increasing the immunity of the insects whereas their overdose may cause harmful effects to the environment and other forms of life. Therefore, the insecticide use should be optimized in order to reduce the

environmental contamination while maximizing its effectiveness against the target insect. (Sharma, N., & Gavkare, O. 2014)

2.6 Consequences of indiscriminate pesticide use (Sharma, N., & Gavkare, O. 2014)

The problems from applying chemical pesticides arise not so much from pesticide use but from the pesticide misuse which includes over application of the pesticides, repeated application of the same pesticide and poor application technology.

Major consequences due to the indiscriminate use of the pesticides are:

Development of resistance to pesticides: The repeated use of the same pesticide over time leads to the evolutionary selection of those pest organisms that have developed resistance to a particular pesticide or family of pesticides. More than 500 species of insect pests have been demonstrated to have developed insecticidal resistance to insecticidal pressure.

Pest resurgence: It is a situation where a population, after having been suppressed, rebounds to numbers greater than before the suppression occurred. Maximum cases of resurgence belong to order Homoptera (44%) followed by Lepidoptera (24%) and phytophagous mites (26%).

Toxicity to beneficial fauna: The indiscriminate use of pesticides on the crops result in wide spread mortality of beneficial insects (natural enemies, pollinators etc.) and therefore one should prefer to use those pesticides which are safer to the beneficial fauna.

Pesticide residues: According to FAO, the reports of high levels of pesticide residues in food crops in India is an indication that pesticides are used in a wrong way. There are two types of sources of pesticide residues - direct and indirect. Field application of the pesticides on the crops are the direct sources of residues. On the other hand indirect sources of residues include drifting, run-off from the fields, volatilization of the pesticides and spillage.

Others:

Outbreaks of secondary pests.

Bioaccumulation.

Biomagnification.

Environmental pollution.

Occupational hazards.

2.7 Safe use of insecticides

One can make safe use of insecticides by:

A. Minimizing exposure

- a. Avoid frequent applications of the pesticide. Never exceed the application rate indicated in the instruction.
- b. When applying pesticides, follow all precautions listed on the label, such as wearing the protective clothing to protect from exposure even when applying the safest pesticides.
- c. Minimally, protective wear should include rubber gloves, eye protection, a long-sleeved shirt, long pants, and closed shoes.
- d. Make sure any baits, traps or pesticide formulations are kept out of reach of children and pets. - Never dump leftover pesticides in the garbage, on the lawn, or down the drain, where it could contaminate the soil or drinking water

B. Minimizing Spray Drift

- a. Avoid spraying when there is strong wind.
- b. Use nozzles that do not produce small droplets.
- c. Use large orifice nozzles at relatively low pressure.
- d. Adjust boom height as low as practical.
- e. Do not spray at high travel speeds.
- f. Spray when soil is coolest and relative humidity is highest.
- g. Use nonvolatile pesticides.
- h. Use drift control additives when permitted by the pesticide label.

2.8 Some safety measures (Sharma, N., & Gavkare, O. 2014)

A. While handling and mixing pesticides

- I. Mixing and loading operations are the most hazardous because they generally result in possible of exposure i.e spills.
- II. Obtain proper equipment, including protective clothing, etc.
- III. Mix chemicals outside or in a well-ventilated area. - Clean up spilled pesticides immediately from skin, clothing etc.
- IV. Persons engaged in mixing, handling or applying pesticides should not smoke eat or drink while working.
- V. Do not use mouth to siphon a pesticide from the container.

B. During storage of the pesticides

Proper storage of pesticides will protect the health and wellbeing of people, help protect against environmental contamination and protect the chemical shelf life. Attention must be paid to the following criteria:

- I. The storage warehouse must be located away from highly populated area, from wells or domestic water storage tanks and a well-drained land.
- II. The site should be accessible from all sides, to help firefighting.
- III. The storage buildings should be made of non-combustible materials.
- IV. The flooring should be of cement and should have a slope to drain off any spillage.
- V. A wash basin with running water and emergency shower should be placed in a suitable area.
- VI. Warning signs in local languages should be placed on the outside of all walls of the warehouse. - Roof should be leak proof and the material should be handled with care.
- VII. The stores must be well lit. The electrical fittings should be sound and must be properly earthed.

C. During transportation

To ensure safe handling and transportation of pesticides the following points need to be taken into consideration:

- I. The best type of vehicle is the open type such as a pick-up truck.
- II. Wettable powders and dust formulation in paper containers should be protected from rain.
- III. Avoid puncturing or tearing paper containers when handling them during loading or unloading or storing.

2.9 Judicious pesticide use:

Judicious use of pesticides can be made by considering the following:

- A. Waiting periods of chemicals,
- B. Economic threshold levels,
- C. Compatibility of chemicals with natural enemies,
- D. Nature of chemicals,
- E. The recommended doses,
- F. Time of application, and
- G. Application technology etc.

Different measures for judicious pesticide use are:

- i. Choosing the right pesticide.
- ii. Right time of application.
- iii. Application of correct pesticide doses.
- iv. Proper application technology.
- v. Use of specific formulations.
- vi. Use of soft insecticides.
- vii. Consulting the label before application.
- viii. Integration of new molecules of insecticides with IPM.

Choosing the right pesticide

Pesticide selection depends on properties of the compound, biological activity on the target pest and the effects on the non-target organisms.

Application of pesticides in time

Most appropriate time to control the pests depends upon economic thresholds or the time when the most vulnerable stage of insect life is apparent. The application should be timed to reduce the frequencies and dosage of insecticides application, to save the natural enemies and pollinators. - Timing of application depends upon suitable weather windows. - Sometimes application is governed by crop growth stages at the period when damage is likely to occur (a specific crop growth stage).

Application of correct pesticide doses

The pesticides should be use in the recommended doses to:

- a) Avoid excessive residues on crops for feed and food.
- b) Achieve optimum pest control with minimum danger to desirable organisms.
- c) Avoid chemical damage to the crops.
- d) Obtain the most economical control of pests.



Application technique

Selection of method of application should be in such a way so as to use minimum dose while controlling the pests below the Economic Threshold Level (ETL). The insecticides can be used without any detrimental effect on the parasitoids and predators by selective placement or spot application. Proper application technique improves the targeting for rationale pesticide use. Controlled Droplet Application is good example of a rational pesticide use (RPU) technology. By controlling the droplet size, ultra-low volume (ULV) or very low volume (VLV), application rates of pesticidal mixtures can achieve similar (or sometimes better) biological results by improved timing and dose-transfer to the biological target (i.e. pest). Other efficient application techniques include banding, baiting, specific granule placement, seed treatments, use of rotary atomizers etc.

Pesticide application equipment

The correct usage of equipment and its proper maintenance affects the ability to place pesticides on target more economically and effectively. The choice of the equipment depends on its specific use and the need of a particular pest control measure.

Use of specific formulations

- I. Encapsulated and slowly release pesticides prevents the leaching as well as the volatilization of the pesticide molecules while spraying.
- II. Granular formulations are safe to parasitoids, predators and pollinators.
- III. Use of micro capsulation and controlled release formulations which may allow less frequent or lower rates of application in the field.

Use of soft insecticides

Soft-insecticides are those which are less toxic to nontargets, more environment friendly, quickly biodegradable, selective and have low use rates. E.g.: neonicotinoids, chitin synthesis inhibitors, insect growth regulators, Juvenile Hormone (JH) analogues, bacterial fermentation products etc.

Farmers in Bangladesh seem reluctant to purchase zinc phosphide (Zn_3P_2) for use in rodent control, primarily because of a concern over the quality of the technical powder available from local distributors. During 1988, packets of Zn_3P_2 were purchased from the shelves of 23 distributors in Bangladesh and analyzed for technical purity. Only 2 of 23 distributors sold Zn_3P_2 containing at least 80%, while 14 distributors sold material ranging from 15% to nondetectable. Such a lack of quality control is not acceptable if farmers in Bangladesh are to use this material as a primary method of rodent control in agriculture. (Bruggers *et. al.*, 1995).

The study suggested that the best weed control option for wheat is to use a pre-emergence (pendimethalin or oxadiargyl) followed by (fb) a post-emergence (2,4-D or ethoxysulfuron) herbicides depending upon weed species which would benefit the farmers by providing high weed control efficacy at lower cost compared to manual weeding. (Ahmed *et. al.*, 2019).

A total of 452 male and 178 female farmers from seven towns were interviewed in 2016. The results show that there are gender differences regarding knowledge of pesticide impacts, pesticide use practices and protective behaviors. Male farmers had a better knowledge of

pesticide use and greater awareness of associated health risks. More men than women used pesticides and disposed of the pesticide containers correctly, but fewer men applied protective measures or behaviors when using pesticides. Canonical correspondence analysis indicated that participation in farmer professional cooperatives differed by gender and contributed greatly to the protective behaviors of farmers ($p < 0.05$). These results suggest that gender-sensitive educational programs should be implemented to increase the awareness of safety amongst farmers, and protective measures should be encouraged to reduce exposure to pesticide risks in China. (Wang et. al., 2017).

Most of the farmers in the present study reported that they preferred to get advice on pesticide usage from pesticide dealers (Amuwitagama I. 2002), groups or peer groups also significantly influenced farmers' decisions. Chemical company agents had the highest influence, followed by extension technicians, spouses, neighbors and village heads, respectively. Previous studies reported that about 61% of farmers received advice from pesticide dealers while selecting pesticides and their doses. In addition, 65% of farmers received advice from pesticide sales agents in selecting products and doses, 18% from neighbors, 8% from relatives, and the remaining 9% from extension workers. (Mannan MA, 2012)

CHAPTER 3

METHODOLOGY

Research methodology is the general research strategy that outlines the way in which research is to be undertaken and, among other things, identifies the methods to be used in it. These methods, described in the methodology, define the means or modes of data collection or, sometimes, how a specific result is to be calculated. Methodology does not define specific methods, even though much attention is given to the nature and kinds of processes to be followed in a particular procedure or to attain an objective.

Without an appropriate methodology the researchers are unable to collect valid and reliable data and it is important to analyze and interpret those data to reach at correct summary and conclusion. The methods and procedures followed in conducting this study have been described in this chapter.

3.1 Design of the study

An ex-post facto explanatory cross sectional research design was used for the study. The study was quasi-experimental and tried to predict the relationship of the selected characteristics of the respondents with their farmers' awareness of available agrochemicals regarding judicious use in the agricultural field. It was conducted following "diagnostic and descriptive research design". Data were collected through survey. It was conducted on the basis of collection of data by interviewing the villagers of Dumuria upazila. It was designed to investigate the consequences and consequences of using agrochemicals as perceived by the farmer at dumuria upazila of khulna district.

3.2 Locale of the study

The study was conducted at few villages under five unions of Dumuria upazila of Khulna district. The villages were deliberately selected by the researchers. The area of Dumuria upazila are 454.23 sq km and 18 kilometers away from Khulna sadar. The peoples of the the two upazila largely depends on agriculture for their livelihood.

3.3 Population and Sampling

The farmers who were cultivating crops were treated as population of the area. The researchers selected 105 farmers as respondents to conduct this survey. The respondents were from villages of Atlia, Bhandar Para, Kharnia, Shovna, Gutudia and Magurghona union of Dumuria upazila. Total number of the farmers of the upazila is the population. The researchers purposively selected the respondent farmers from the upazila. The distribution of the respondent farmers are shown in Table 3.1

Table 3.1 Distribution of the respondent farmers in the study area

Name of Upazila	Name of Union	Number of Respondent
Dumuria	i. Atlia	26
	ii. Bhandar Para	17
	iii. Kharnia	33
	iv. Shovna	14
	v. Gutudia	10
	vi. Maguraghona	15

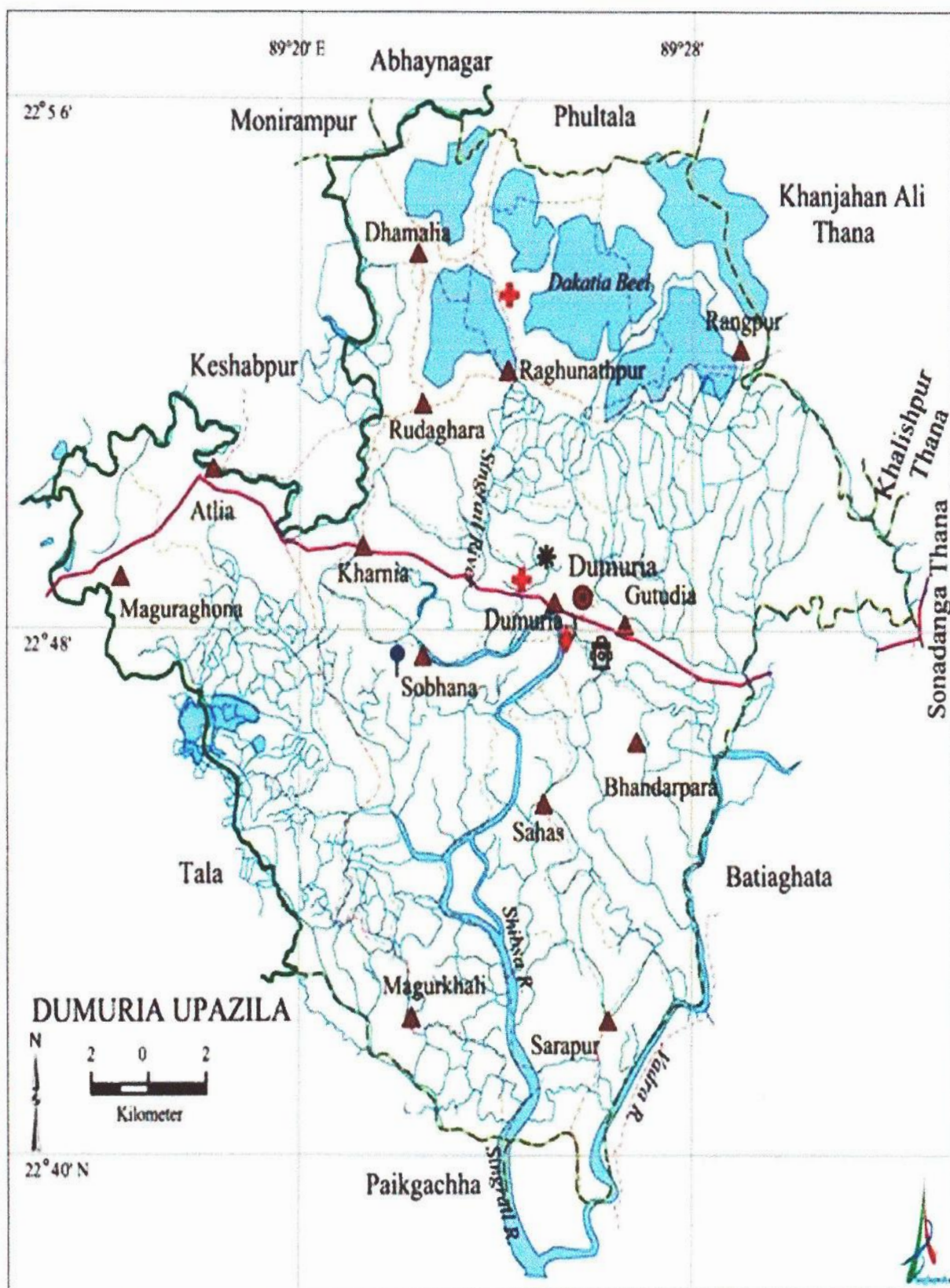


Figure 3.1 Map of Dumuria Upazila, Khulna District

3.4 Instruments for data collection

An interview schedule was used as the instrument to collect data from the respondents. The interview schedule was prepared very carefully to fulfill the objective of the objectives of the study. The interview schedule contained both open and closed ended, simple and direct form of questions to collect data on the basis of the selected variables. After preparation of the interview schedule, it was pretested.

3.5 Methods and time of data collection

Data were collected through face to face interview from the farmers using the interview schedule during 25 January to 7 February, 2022. The local people as well as the Sub-assistant Agriculture Officers (SAAO) of the concerned area helped the researcher to collect the data by providing useful information. The researchers tried enough to establish rapport with the respondents to make them feel free to answer. The researchers made all possible efforts to explain the purpose of the study so that they could provide right information.

3.6 Specification and measurement of variables

3.6.1 Specification of the variables

Specification and measurement of variables is an important task in survey research. A research hypothesis contains at least two elements, an independent variable and dependent variable. The researcher should have adequate care in selecting the variables of the study. The researcher visited the study area and the farmers before the commencement of the study. On the basis of the observed socioeconomic factors of the farmers along with extensive literature review the researcher selected the socioeconomic characteristics of the respondents as independent variables and farmers' awareness as dependent variables.

The researcher considered the following characteristics of the respondents as follows:

- I. Age
- II. Educational qualification
- III. Family Size
- IV. Farming Experience

- V. Knowledge of agriculture
- VI. Farm size
- VII. Monthly family income
- VIII. Training
- IX. Cosmopolitanism
- X. Organizational participation
- XI. Extension media contact

3.6.2 Measurement of independent variables

3.6.2.1 Age

Age of the respondent was determined by counting their age from birth to time of data collection. It was expressed in terms of complete years. It was scored for each year of their age. It was included in the interview schedule as the item no. 1 (Appendix A). According to age, the respondents were classified into three categories as shown in Table 3.2

Table 3.2 Categories of the respondents according to their age

Categories	Age limits (Years)
Young	≤ 35
Middle	36-55
Old	> 55

3.6.2.2 Educational qualification

The level of the education was measured by the years required to achieve formal education. A score was given to the respondents for each year of schooling on the basis of passed class. The respondent who are illiterate was given a score 0 and the respondent who can sign only was given a score of 0.5. This variable is in the interview schedule as item no. 2 (Appendix A). Based on education qualification score, the respondents were grouped into the following categories as presented in Table 3.3

Table 3.3 Categories of respondents according to their education qualification

Categories	Score (Schooling year)
Illiterate	0
Sign	0.5
Primary	1-5
Secondary	6-10
HSC	11-12
Undergraduate	13-16
Postgraduate	17-18

3.6.2.3 Family Size

Family size of the respondent was determined by the total members of the family including the respondent himself, his wife, children and other dependents. This variable is in the interview schedule as item no. 3 (Appendix A). Based on family size respondents were categorized as follows in Table 3.4

Table 3.4 Categories of the respondent according to their family size

Categories	Score
Small	≤ 4
Medium	5-6
Large	> 6

3.6.2.4 Farming experience

Farming experience of the respondents were determined by their involvement in agriculture in terms of year. This variable is in the interview schedule as item no. 4 (Appendix A). Based on farming experience the respondents were categorized as follows in Table 3.5

Table 3.5 Categories of the respondent according to their farming experience

Categories	Score (Years)
Low	<10
Medium	10-20
High	>20

3.6.2.5 Knowledge on agriculture

Knowledge on agriculture was measured by asking 5 different questions in relation to the agricultural practices. This category was set for farmers of the upazila. It was composed of basic knowledge and practices commonly used in the field. It appears in item No.7 in the interview schedule (Appendix A). The assigned score for each correct answer was 2. If the answer is partially correct, it is scored 1, A zero was given for wrong or no answer. The total score obtained by a respondent determined his/her knowledge on agriculture. The score could range from 0 to 10 where 0 means no knowledge on agriculture and 10 meaning high knowledge on agriculture. According to knowledge, respondents are classified into following categories as shown in Table 3.6

Table 3.7 Categories of the respondent according to their farm size

Categories	Score (Hectare)
Landless	≤ 0.01
Marginal	0.02-0.2
Small	0.21-1.0
Medium	1.0-3.0
Large	> 3

3.6.2.7 Monthly family income

Family income (monthly) was estimated by considering total earning in the last year from different source viz. agriculture, business, service and others. Family income is included in the interview schedule as item No.9 and (Appendix A). The respondents were classified into following categories according to monthly income as shown in Table 3.8

Table 3.8 Categories of respondents according to their monthly family income

Categories	Taka (BDT)
Low	< 15000
Medium	15000-25000
High	> 25000

3.6.2.8 Training received

Training frequency of the respondent was measured depending on the number of training he/she had received by different organization such as DAE, BRAC, NGOs, BFRI (Bangladesh forest research institute), Syngenta, BLUE GOLD, ACI, ISPAHANI AGRO LTD, BLRI (Bangladesh livestock research institute), SHAFOL. Percentage of training frequency was calculated and ranked them as the organization provide training respectively. Respondents who have received training, were computed. And rest of respondents were also computed as not training receiver. Training received is included in the interview schedule as item No.10 (appendix A).

3.6.2.9 Cosmopolitanism

The cosmopolitanism of a respondent was measured based on the frequencies of visits to the places outside of his own society. It was determined counting number of visited made in five different places which indicate the extent of visit as frequently, occasionally, rarely and not at all and the scores were 3, 2, 1 and 0 respectively. The score range was 0 to >10. Based on cosmopolitanism the respondents were categorized as follows in Table 3.9

Table 3.9 Categories of the respondent according to their Cosmopolitanism



Categories	Score
Low	≤ 5
Medium	6-10
High	>10

3.6.2.10 Organizational participation

Organizational participation of the respondents measured on the basis of the number of involvement in different organizations with duration. The respondent involvement in organization was accordingly as no involvement, general member, executive member, executive officer and was scored as 0, 1, 2, 3 respectively. Based on organizational participation the respondents were categorized as follows in Table 3.10

Table 3.10 Categories of the respondent according to their Organizational participation

Categories	Score
Low	≤ 7
Medium	8-14
High	>14

3.6.2.11 Extension media contact

Extension contact of the respondent was determined as the degree of exposure to different extension medium and person acting as extension agent. A list of different sources of media for extension were included in the interview schedule as item no. 13 (Appendix A). Based on the extension contact the respondents were categorized as follows in Table 3.11

Table 3.11 Categories of the respondent according to their extension media contact

Categories	Score
No	0
Rare	1-24
Occasional	25-48
Often	49-70
Regular	>70

3.7 Measurement of dependent variables

3.7.1 Data collection for available agrochemicals

Firstly, I have visited local markets of my study areas where I searched for available agrochemical such as pesticides (Fungicide, Miticide, Insecticide, Rodenticide, Herbicide, Nematicide), Fertilizer and plant growth regulator used by the famers. I found some regular used agrochemical and I listed all that chemical. After, I prepare interview schedule with listed agrochemical with their common name, trade name, name of the registration holder, recommended crop, dosage (collected from local market). With all these information in the interview schedule I also want to know farmer knowledge whether they know about the listed or any other agrochemical. Then, information were collected about purpose of using and used dosage through interview schedule. In case of dosage data are collected by asking respondents whether they use Standard dosage or less than standard dosage or more than standard dosage. Thus, way frequency of farmer knowledge about agrochemical, purpose of using and used dosage were determined, from this data percentage were calculated. The initial list of all agrochemical given below.

Table 3.12 List of available fungicides identified from local market

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^a (mL ⁻¹ gkg ⁻¹)
1	Azoxystrobin (20%) + Cyproconazole (8%)	Dover 28SC	Agritech	mango Chilli	1 mL ⁻¹ of water
2	Azoxystrobin (20%) + Difenconazole (12.5%)	Amistar Top	Syngenta Bangladesh Limited	Tea	750
				Rice Potato Mango Betel vine Onion Chilli	1 mL ⁻¹ of water
3	Azoxystrobin (20%) + Tebuconazole (15%)	D-Hit 35SC	ADR Crop Care	Tea	750 ml
				Sweet gourd	1 mL ⁻¹ of water
4	Azoxystrobin (20) + Tricyclazole (6%)	ForGreen Ultra 56SC	Forward International (BD) Ltd.	Tea	750 ml
5	Azoxystrobin (6%) + Chlorothalonil (50%)	Azonil 56EC	Haychem (Bangladesh) Limited	Tea	750 ml
6		Agrobin 56EC	Agro Business Support Ltd.	Sweet gourd	1 mL ⁻¹ of water
7	Benalaxyl (8%) + Mancozeb (64%)	Galben M	FMC Chemical International AG	Potato, Tomato Cucumber	2 gL ⁻¹ of water
8	Bismethiazol	Bactrol 20 WP	Surovi Agro Industries Limited	Potato	2 gL ⁻¹ of water
9	Carbendazim	Bavistin DF	BASF Bangladesh Limited	Sugarcane Rice	500 g 500 g
				Wheat	1 mL ⁻¹ of water
10	Carbendazim (32.5%) + Hexaconazole (2.5%)	Defense 35 SC	Haychem (Bangladesh) Limited	Wheat Onion	1 mL ⁻¹ of water
				Mango	0.5 mL ⁻¹ of water
				Tea	750 ml

Table 3.13 List of available Miticides identified from local market.

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha^{-1} (mL L^{-1} gkg $^{-1}$)
1	Ethion	Ethion 46.5 EC	FMC Chemical International AG	Tea	1.26 L
				Jute	1.68 L
				Cotton	2.50 L
2	Ethion (5%) + Thiamethoxam (20%)	Taba 25WDG	Alif Agro	Chilli	100 g
3	Fenpropathrin	Danitol 10 EC	Shetu Corporation Limited	Brinjal	1 mL of water
				Tea	1.00 L
4	Hexythiazox	Hexarite 5 EC	Naafco (Private) Limited	Tea	1.00 L
5	Propargite	Omite 57 EC	Shetu Corporation Limited	Tea	1.00 L
				Brinjal	
6	Sulphur	Microthiol Special 80 WP	Shetu Pesticides Limited	Tea	2.20 kg
				Rice	2.25 kg

Table 3.14 List of available Nematicides identified from local market

Serial	Common Name of Products	Recommended Crops	Dosage rate ha^{-1} (mL L^{-1} gkg $^{-1}$)
1.	NEMATOX 1% WP	Paddy, Cotton, Sugar Cane, Groundnut, Turmeric,	10 gmKg $^{-1}$ seed

Table 3.15 List of available Insecticides identified from local market.

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha ⁻¹ (mL ⁻¹ kg ⁻¹)
1	Abamectin (1.8%)	Vertimec 1.8 EC	Syngenta Bangladesh Limited	Tea	1.25 L
2	Abamectin (1%) + Beta Cypermethrin (2%)	Emithrin Plus 3% WDG	Eminence Chemical Industries Ltd	Brinjal	1.20 L
3	Acephate	Asataf 75 SP	Auto Crop Care Limited	Cotton	750 g
				Rice	750 g
				Bean, Potato	1 gL ⁻¹ of water
				Mango	5 gL ⁻¹ of water
4	Alpha Cypermethrin	Fastac 2 EC	BASF Bangladesh Limited	Tea	500 g
				Brinjal	500 ml
				Cabbage	500 ml
				Mustard	500 ml
5	Bifenthrin	Talstar 2.5 EC	FMC Chemical International AG	Mango	1 mL ⁻¹ of water
				Tea	2.25 L
				Cotton	900 ml
					2.00 L
				Tea	0.5 L
					1.00 L
				Mango	1 mL ⁻¹ of water
6	Carbofuran	Brifur 5G	ACI Formulations Limited	Brinjal	2 mL ⁻¹ of water
				Rice	10.00 kg
					20.00 kg
				Sugarcane	40.00 kg
				Tea	165 gM ⁻³
7	Chlorpyrifos (50%) + Cypermethrin (5%)	Nitro 505 EC	Auto Crop Care Limited	Potato	1 mL ⁻¹ of water
				Cotton	600 ml
				Tea	4.0 L
8	Chlorpyrifos (20%) + Methomyl (10%)	Harpoon 30 EC	Sea Trade Fertilizer Limited	Rice	800 ml
				Sugarcane	1.50 L
9	Chlorpyrifos (18%) + Phoxim (30%)	Nacstar 48 EC	National AgriCare Import & Export Ltd	Rice	750 ml
10	Cyhexatin	Sunxatin 600 SC	McDonald Bangladesh (Pvt) Limited	Tea	625 ml
11	Cypermethrin	Arrivo 10 EC	FMC Chemical International AG	Cotton	0.70 L
				Mango	1 mL ⁻¹ of water
				Tea	500 ml

Table 3.16 List of available Herbicides identified from local market

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^a (mL ⁻¹ gkg ⁻¹)
1	2,4-D	Salix	S S Vision Limited	Rice	450 gacare ⁻¹
2	2,4-D Butyl Ester	Rampitox 45WP	SAM Agro Chemical	Rice	125 g
3	Acetachlor	Offer 50EC	Nokon Limited	Rice	250 g
4	Bensulfuran methyl (4%) +	Changer 18 WP	National AgriCare Import & Export Ltd	Rice	750 g
5	Bensulfuron methyl (18%) + Pretilachlor (4%)	Londax Powder	Petrochem Agro Industries Ltd.	Rice	9.88 kg
6	Bensulfuron methyl (3%) + Mefenacet (50%)	Super Clean 53 WP	National AgriCare Import & Export Ltd	Rice	450 g
7	Butachlor	Golteer 5G	Auto Crop Care Limited	Rice	25.00 kg
8	Carfentrazone Ethyl (50%) + Isoproturon (0.75%)	Affinity 50.75 WP	FMC Chemical International AG	Wheat	1.50 kg
9	Carfentrazone Ethyl	Aim 40 DF	FMC Chemical International AG	Rice	62.50 g
				Potato	62.5 g

Table 3.17 List of available Rodenticides identified from local market

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^a (mL ⁻¹ gkg ⁻¹)
1	Bromadiolone	Lanirat	Novartis (Bangladesh) Limited	Crops field	2-3 times should be eaten
2	Zinc Phosphide	Zinc Phosphide	United Phosphorus (Bangladesh) Ltd	"	2% bait

Table 3.18 List of available fertilizer in local market

Serial	Name	Chemical Formula
1.	Sodium nitrate	NaNO_3
2.	Calcium Nitrate	$\text{Ca}(\text{NO}_3)_2$
3.	Potassium Nitrate	KNO_3
4.	Ammonium sulphate	$(\text{NH}_4)_2\text{SO}_4$
5.	Ammonium Phosphate	$\text{NH}_4\text{H}_2\text{PO}_4$
6.	Triplet super phosphate	$\text{Ca}(\text{H}_2\text{PO}_4)_2$
7.	Monoammonium phosphate	$(\text{NH}_4)\text{H}_2\text{PO}_4$
8.	Dai ammonium phosphate	$(\text{NH}_4)_2\text{HPO}_4$
9.	Potassium chloride	KCl
10.	Potassium sulfate	K_2SO_4
11.	Ammonium Chloride	NH_4Cl
12.	Anhydrous ammonia	NH_3
13.	Ammonium nitrate	NH_4NO_3
14.	Urea	$\text{CO}(\text{NH}_2)_2$
15.	Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
16.	Magnesium sulfate	$\text{MgSO}_4 \cdot \text{H}_2\text{O}$
17.	Zinc sulfate	$\text{ZnSO}_4 \cdot \text{H}_2\text{O}$

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Serial	Name	Chemical Formula
18.	Zinc oxide	ZnO
19.	Boric acid	H ₃ BO ₃
20.	Solubor	Na ₂ B ₈ O ₁₅ .4H ₂ O
21.	Manganese (II) sulfate	MnSO ₄ .H ₂ O
22.	Ammonium molybdate	(NH ₄) ₆ Mo ₇ O ₂₄ .2H ₂ O
23.	Sodium molybdate	Na ₂ MoO ₄ .2H ₂ O
24.	MOP	K ₂ O

Table 3.19 List of available plant growth regulators

Serial	Name	Chemical Formula
1	Auxins	C ₁₈ H ₃₂ O ₅
2	Gibberellins	C ₁₉ H ₂₂ O ₆
3	Cytokinins	6-(4-hydroxy-3-methylbut-2-enylaminopurine)
4	Absciscic acid	C ₁₅ H ₂₀ O ₄
5	Ethylene	C ₂ H ₄
6	Alfa Naphthail Acitic Acid	C ₁₀ H ₇ CH ₂ CO ₂ H

3.7.2 Measurement of awareness of the respondents

Awareness as perceived by respondents about effect of agrochemicals on environment and human health was treated as dependent variable.

A number of 16-statements related to effect of agro-chemical incorporated in the interview schedule (Appendix A). Each of the respondents was asked to indicate extent of agreement and disagreement with the statements as strongly agree (5), agree (4), undecided (3), disagree (2) and strongly disagree (1). To determine the perception score of the respondents, all the score obtained against 16-statement were added. The perception score of a respondent could range from 16-80 where 16 means very low and 80 indicates very high perception. Based on perception score the respondents were grouped into five categories.

Table 3.20 Category of respondents based on their perception score.

Category	Score
Very low	Up to 16
Low	17-32
Medium	33-48
High	49-64
Very high	65-80

For comparing among the 14-statements, a perception index (PI) was calculated using following formula-

$$\% \text{ PI} = \frac{\text{OPIS}}{\text{HPPIS}} \times 100$$

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this chapter is to describe the findings Farmers' Awareness of Available Agrochemicals Regarding Judicious Use in the Agricultural Field at Dumuria upazila. The findings and discussion are presented here in three sections:

- a. Description of the selected characteristics of the farmers
- b. To identify the specific use of agrochemicals as perceived by farmers.
- c. To find out judicious dose and application of the agrochemicals.
- d. To assess awareness of farmer about effect of agrochemical on environment, on human health and on crop production.

4.1 Distribution of respondents farmer according to their personal characteristics

In this section findings on the selected characteristics of farmers of Dumuria have been discussed. The characteristics were age, education, family size, farm size, farming experience, knowledge on agriculture, organizational participation, extension contact, cosmopolitanism and agricultural training.

The age of the respondents ranged from 22-85 years with mean of 44.50 and standard deviation of 12. 59 respectively. Data presented in Table 4.1 shows that the majority of the farmers (43.8%) were middle aged compared to 29.5% old aged and 26.7% young aged.

Tabassum (2017) found that the highest proportion (45.6%) of the respondents belonged to middle aged, while 39.4% belonged to young aged category.

The participation of middle age farmers is more due to the higher experience than young aged farmers and more energy to work than old aged farmers.

Table 4.1: Distribution of the respondents according to their personal characteristics

Serial	Characteristics	Categories	Score	Respondent N=105		Mean $\pm$ Standard deviation	Range	
				Frequency	Percentage		Min.	Max.
1.	Age (years)	Young	≤ 35	28	26.7	44.50 $\pm$ 12.59	22	85
		Middle	36-55	46	43.8			
		Old	> 55	31	29.5			
2.	Educational qualification (Education years)	Illiterate	0	7	6.7	6.49 $\pm$ 4.69	00	17
		Sign	0.5	21	20.0			
		Primary	1-5	21	20.0			
		Secondary	6-10	42	40.0			
		HSC	11-12	8	7.6			
		Undergraduate	13-16	3	2.9			
		Postgraduate	17-18	3	2.9			
3.	Family size	Small	≤ 4	42	40.0	5.44 $\pm$ 2.46	2	20
		Medium	5-6	35	33.3			
		Large	> 6	28	26.7			
4.	Farm size (Hectare)	Landless	≤ 0.01	0	0	1.32 $\pm$ 1.07	0.05	6.07
		Marginal	0.02-0.2	5	4.8			
		Small	0.21-1.0	35	33.3			
		Medium	1.01-3	59	56.2			
		Large	> 3	6	5.7			

Serial	Characteristics	Categories	Score	Respondent N=105		Mean $\pm$ Standard deviation	Range	
				Frequency	Percentage		Min.	Max.
5.	Farming experience (Years)	Low	<10	32	30.50	14.81 $\pm$ 7.04	4	38
		Medium	10-20	53	50.50			
		High	>20	20	19			
6.	Monthly family Income ("000" BDT per month)	Low	<15000	34	32.38	16520 $\pm$ 8367	5000	80000
		Medium	15000- 25000	46	43.80			
		High	>25000	25	23.81			
7.	Knowledge On agriculture (Score)	Low	≤ 3	0	0	9.23 $\pm$ 1.59	5	10
		Medium	4-6	19	18.1			
		High	>6	86	81.9			
8.	Organizational Participation (Score)	Low	≤ 7	84	80.0	4.32 $\pm$ 6.42	00	40
		Medium	8-14	16	15.2			
		High	>14	5	4.8			
9.	Cosmopolitanism (Score)	Low	≤ 5	52	49.5	5.35 $\pm$ 2.17	1	12
		Medium	6-10	52	49.5			
		High	>10	1	1			
10.	Extension media contact (Score)	No	0	0	0	30.46 $\pm$ 12.68	8	59
		Rare	1-24	39	37.10			
		Occasional	25-48	57	54.30			
		Often	49-70	9	8.6			
		Regular	>70	0	0			

The observed scores for educational qualification of the respondents ranged from 0-18 with mean of 6.49 and standard deviation of 4.68 respectively. The data in Table 4.1 indicate that highest portion (40%) of the respondents had secondary level of education while 21% could only sign, 21% had primary level of education, 7.6% had higher secondary level of education, 6.7% were illiterate, 2.9% had bachelor degree and 2.9% were graduate.

Rahman (2008) found that 22% of the farmers could write their name only, It was found that 8%, 34% and 9% of the farmers had primary, secondary and above secondary level of education respectively.

From the discussion with farmer it was known that higher education was not possible due to poverty, ignorance towards education and their traditional lifestyle.

The family size of the respondents ranged from 2-20 with a mean of 5.44 and standard deviation of 2.46 respectively. In the data of the Table 4.1 highest portion (40%) of the respondents had small sized family while 33.3% of the respondents had medium sized family and 26.7% of the respondents had large sized family.

Kabir (2012) found small family size constitutes the highest proportion (76.7%) of the farmers followed by 19.4% with medium family size.

This indicates that the respondents are concerned about family planning as highest portion of the respondents had small sized family.

The farm size of the respondents ranged from 0.05-6.07 hectare with a mean of 1.3205 hectare and standard deviation of 1.07230. On the basis of farm size respondents were classified into 5 categories as presented in above Table. Majority of the respondents (56.2%) had medium sized farm while 33.3% of the respondents had small sized farm and only 5.7% of the respondents had large farm. There were no landless but 4.8% marginal farmer among the respondents.

Islam (2017) found that small farmers constitute the highest proportion 68.86% and medium farmers were 29.25%.

The average farm size of the farmers of the study area were found higher than that of national average (0.60 ha/148.263 decimal) of Bangladesh (BBS, 2018).

According to above result maximum farmer have small and medium sized farm, those farmers were landless generally work on other farm or they lease land from other for cultivation. In this

locality, agriculture is main occupation and but agricultural land is getting reduced due to division of father land inheritance among his children.

Farming experience of the respondents ranged from 4-38 with a mean of 14.8190 and standard deviation of 7.0415 respectively. About half (50.5%) of the respondents had medium farming experience while 30.5% of the respondents had lowest farming experience and 19% of the respondents had high farming experience.

The respondents with vast experience of farming were involved in farming from very early life and thus had spent long time with agricultural activities, on the other hand respondents with low farming experience indicates less involvement in farming.

Data presented in above Table indicate that most (81.9%) of the respondent had high knowledge on agriculture while 18.1% had medium knowledge on agriculture and there no person of farmer had not any knowledge.

Above table showed that cosmopolitan participation both in low and medium category had same percentage (49.5%) and only 1% were high cosmopolitan. The percentage (49.5%) of medium cosmopolitanism indicates that people have an orientation to out of his own social system which may help to change their attitude towards different appearing situation whereas same 49.5% of the respondent who are low cosmopolitan have not such opportunity to broaden their outlook.

Arafat (2018) found that 50.5% of the farmers had medium cosmopolitanism.

It is assumed that cosmopolitanism broaden a person knowledge and motivate people to adopt new practice, experience and problem solving capacity. Usually, farmers of these localities are dependent on agriculture and busy with work on their own land and carry on most of the agricultural activities by themselves. They hardly have much time to visit other places. So, their visit to other area is very low.

Data presented in above Table shows that majority of respondents had low (80%) organizational participation. Where 15.2% had medium and only 4.8% had high organization participation.

Islam (2017) found 80% of the respondents had low organizational participation.

The respondents did not want support from organizations. Organizational participation helps an individual to find out solutions to their own problems as well as other social issues. The

farmers had less interest in organizational participation. Generally, much educated persons are involved in organizational participation. Moreover, they are busy in earning their livelihood, so most of the farmers were indifferent to organizational participation.

Data presented in above Table indicate that most (54.3%) of the respondent had occasional extension contact exposure while 37.1% had low extension contact exposure and only 8.6% had often extension contact exposure.

Bhuiyan (2008) found majority (58%) of the respondents had medium extension media contact.

Extension media contact increases knowledge and creates awareness. As a result, attitude of people changes which helps to adopt new technologies.

4.2 Training exposure

Among the 105 respondents, 59 respondents are facilitated with agricultural training and rest 46 respondents do not have agriculture training. Table shows the training which they have received.

Table 4.2 Distribution of the respondents according to agricultural training

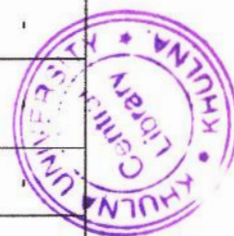
Serial	Name of the training Providing Organization	Frequency	Percentage	Ranked
1.	DAE	32	30.47	1 st
2.	BRAC	19	18.09	2 nd
3.	NGOs	12	11.42	3 rd
4.	ISPAHANI AGRO LTD.	8	7.61	4 th
5.	ACI	7	6.66	5 th
6.	Syngenta	3	2.85	6 th
7.	BFRI	1	0.95	7 th (=)
8.	BLUE GOLD	1	0.95	7 th (=)
9.	BLRI	1	0.95	7 th (=)
10.	SHAFOL	1	0.95	7 th (=)

The data of the Table 4.9 shows that different training providing organization such as DAE, BRAC, NGOs, BFRI, Syngenta, BLUE GOLD, ACI, ISPAHANI AGRO LTD, BLRI, SHAFOL has provided training to the respondents. Among these training, maximum agricultural training provided by DAE, after that BRAC and NGOs play vital role in this aspect, as result DAE ranked 1st and followed by BRAC and other NGOs ranked 3rd and 4th respectively.

Many organizations provide training on different agricultural aspect. But all the respondents do not have training because of their lack of interest and they think that it is waste of time

Table 4.4 List of available Fungicide

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha ⁻¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematicides	Less than SD	Standard Dosage (SD)	More than SD
1.	Azoxystrobin (20%) + Cyproconazole (8%)	Dover 28SC	Agrotech	Mango Chilli	1 mL ⁻¹ of water	22.86 (24)	55.24 (58)	-	-	-	-	-	-	55.24 (58)	-
2.	Azoxystrobin (20%) + Difenoconazole (12.5%)	Amistar Top	Syngenta Bangladesh Limited	Tea	750 ml	35.23 (37)	68.57 (72)	-	11.43 (12)	-	-	-	-	68.57 (72)	11.43 (12)
				Rice Potato Mango Betel vine Onion Chilli	1 mL ⁻¹ of water										
3.	Azoxystrobin (20%) + Tebuconazole (15%)	D-Hit 35SC	ADR Crop Care	Tea	750 ml	-	-	-	-	-	-	-	-	-	-
				Sweet gourd	1 mL ⁻¹ of water										
4.	Azoxystrobin (20%) + Tricyclazole (6%)	ForGreen Ultra 56SC	Forward International (BD) Ltd.	Tea	750 ml	-	-	-	-	-	-	-	-	-	-



Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha ⁻¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard (SD)	More than SD
5.	Azoxystrobin (6%) + Chlorothalonil (50%)	Azonil 56EC	Haychem Bangladesh Limited	Tea	750 ml	12.38 (13)	26.66 (28)	-	-	-	-	-	-	26.66 (28)	-
6.	Benalaxyl (8%) + Mancozeb (64%)	Galben M	FMC Chemical International AG	Potato, Tomato, Cucumber	2 gL ⁻¹ of water	15.23 (16)	44.76 (47)	-	-	-	-	-	-	44.76 (47)	-
7.	Bismethiazol	Bactrol 20 WP	Surovi Agro Industries Limited	Potato	2 gL ⁻¹ of water	-	-	-	-	-	-	-	-	-	-
8.	Carbendazim	Bavistin DF	BASF Bangladesh Limited	Sugarcane, Rice	500 g, 500 g	19.04 (20)	52.38 (55)	-	-	-	-	-	-	52.38 (55)	-
				Wheat	1 mL ⁻¹ of water										

Table 4.6 List of available Insecticide

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^{ha} ⁻¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage	More than SD
1.	Abamectin (1.8%)	Vertimec 1.8 EC	Syngenta Bangladesh Limited	Tea	1.25 L	-	-	-	-	-	-	-	-	-	-
2.	Abamectin (1%) + Beta Cypermethrin (2%)	Emithrin Plus 3% WDG	Eminence Chemical Industries Ltd	Brinjal	1.20 L	36.17 (38)	-	-	54.28 (57)	-	-	-	-	46.66 (49)	7.61 (8)
3.	Acephate	Asataf 75 SP	Auto Crop Care Limited	Cotton	750 g	36.17 (38)	-	-	-	-	-	-	-	-	-
				Rice	750 g		-	-	-	-	-	-	-	-	-
				Bean, Potato	1 gL ⁻¹ of water		-	-	47.61 (50)	-	-	-	-	37.1 (39)	10.47 (11)
				Mango	5 gL ⁻¹ of water		-	-	-	-	-	-	-	-	-
4.	Alpha Cypermethrin	Fastac 2 EC	BASF Bangladesh Limited	Tea	500 g	26.66 (28)	-	-	-	-	-	-	-	-	-
				Brinjal	500 ml		-	-	52.38 (55)	-	-	-	-	52.38 (55)	-
				Cabbage	500 ml		-	-	-	-	-	-	-	-	-
				Mustard	500 ml		-	-	-	-	-	-	-	-	-
5.	-	Venom 25WBC	Econ Agro Industries Ltd.	Mango	1 mL ⁻¹ of water	-	-	-	-	-	-	-	-	-	-
				Tea	2.25 L	-	-	-	-	-	-	-	-	-	-
5.	-	Venom 25WBC	Econ Agro Industries Ltd.	-	-	22.85 (24)	-	-	40.95 (43)	-	-	-	-	40.95 (43)	-

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha ⁻¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage (SD)	More than SD
6.	Carbofuran	Brifur 5G	ACI Formulations Limited	Rice	10.00 kg	40.95 (43)	-	-	40.95 (43)	-	-	-	-	40.95 (43)	-
					20.00 kg		-	-	-	-	-	-	-	-	-
				Sugarcane	40.00 kg		-	-	-	-	-	-	-	-	-
				Tea	165 gm ⁻³		-	-	-	-	-	-	-	-	-
7.	Chlorpyrifos (50%) + Cypermethrin (5%)	Nitro 505 EC	Auto Crop Care Limited	Potato	1 mL ⁻¹ of water	53.33 (56)	-	-	54.28 (57)	-	-	-	-	54.28 (57)	-
				Cotton	600 ml		-	-	-	-	-	-	-	-	-
				Tea	4.0 L		-	-	-	-	-	-	-	-	-
8.	Chlorpyrifos (20%) + Methomyl (10%)	Harpoon 30 EC	Sea Trade Fertilizer Limited	Rice	800 ml	20.95 (22)	-	-	48.57 (51)	-	-	-	-	48.57 (51)	-
				Sugarcane	1.50 L		-	-	-	-	-	-	-	-	-
9.	Chlorpyrifos (50%) + Cypermexin (5%)	Erad 55EC	Genetica Industries Limited	Cotton	600ml	40 (42)	-	-	40 (42)	-	-	-	-	40 (42)	-
10.	Organocarbamate	Katap 50SP	Petrochem (Bangladesh) Limited	Rice	6g 10L ⁻¹	55.23 (58)	-	-	76.19 (80)	-	-	-	-	76.19 (80)	-

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha ⁻¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard (SD)	More than SD
11.	Acetamipride	Manik 20SP	Mimpex Agrochemicals Limited	Bean Brinjal	200g	56.19 (59)	-	-	69.52 (73)	-	-	-	-	62.85 (66)	6.66 (7)
12.		Finis	-	-	-	91.42 (96)	-	-	100 (105)	-	-	-	-	79.04 (83)	20.95 (22)
13.	Thiram (10%) Emicloroprid (25%)	Thimid 35SC	-	-	-	31.42 (33)	-	-	31.42 (33)	-	-	-	-	31.42 (33)	-

4.4.2 Miticide

Miticide, also called Acaricide, any chemical substance used to control mites or ticks, which are not susceptible to commonly used insecticides. Many miticides kill eggs and larval stages as well as adult animals. In study area farmer are not well known to it, they perceived that the insecticide they use is enough to kill such organism. As the result they are not used to using miticide purposively. From above table we can see only 6.66% respondents know about miticide as pesticide. These 6.66% farmer use Omite 57 EC among all listed miticide and they use standard dose of it.

4.4.3 Insecticide

Insecticides are substances used to kill insects. Different insecticides are available in local market, farmer use all these when their field crop affected with insect. Farmer generally buy from dealer without any proper knowledge of crop specific insecticide. We found that farmers are well known to Emithrin plus 3% (36.17% respondents), Asataf 75 SP (36.17% respondents), Fastac 2 EC (26.66% respondents), Venom 25 WBC (22.85% respondents), Brifur 5 G (40.95% respondents), Nitro 505 EC (53.33% respondents), Harpon 30 EC (20.95% respondents), Erad 55 EC (40% respondents), Katap 20SP (55.23% respondents), Manik 20 SP (56.19% respondents), Finis (91.42% respondents), and Thimid 35SC (31.42). Among these chemical 100% respondents use finis as insecticide where 79.04% respondents use standard dosage and 20.95% use more than standard dosage considering in mind it can kill others insecticidal organism existing in soil surface. 69.85% respondents use Manik 20 SP in standard dosage without 6.66% respondents. Katap 20SP used by 76.19% respondent in standard dosage and Fastac 2 EC used by 52.38% respondents in standard dosage. 7.61% and 10.47% respondents use Emithrin plus 3% WDG and Asataf 75 SP respectively.

Table 4.7 List of available Herbicide

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^a (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard (SD)	More than SD
1.	2,4-D	Salix	S S Vision Limited	Rice	450 g	-	-	-	-	-	-	-	-	-	-
2.	2,4-D Butyl Ester	Rampitox 45WP	SAM Agro Chemical	Rice	125 g	-	-	-	-	-	-	-	-	-	-
3.	Acetachlor	Offer 50EC	Nokon Limited	Rice	250 g	-	-	-	-	-	-	-	-	-	-
4.	Bensulfuran methyl (4%) +	Changer 18 WP	National AgriCare Import & Export Ltd	Rice	750 g	-	-	-	-	-	-	-	-	-	-
5.	Bensulfuron methyl (18%) + Pretilachlor (4%)	Londax Powder	Petrochem Agro Industries Ltd.	Rice	9.88 kg	-	-	-	-	-	-	-	-	-	-
6.	Bensulfuron methyl (3%) + Mefenacet (50%)	Super Clean 53 WP	National AgriCare Import & Export Ltd	Rice	450 g	78.09 (82)	-	-	-	50.47 (53)	-	-	16.19 (17)	34.28 (36)	

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^{ha⁻¹} (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage (SD)	More than SD
7.	Butachlor	Golteer 5G	Auto Crop Care Limited	Rice	25.00 kg	-	-	-	-	-	-	-	-	-	-
8.	Carfentrazone Ethyl (50%) + Isoproturon (0.75%)	Affinity 50.75 WP	FMC Chemical International AG	Wheat	1.50 kg	-	-	-	-	-	-	-	-	-	-
9.	Carfentrazone Ethyl	Aim 40 DF	FMC Chemical International AG	Rice	62.50 g	-	-	-	-	-	-	-	-	-	-
				Potato	62.5 g		-	-	-	-	-	-	-	-	-
10.	-	L-Quat 250	The limite Agroproducts Ltd.	Banana	3g	77.14 (81)	-	-	2.85 (3)	48.57 (51)	-	-	-	28.57 (30)	22.85 (24)
				Tea, Rubber	2.2g		-	-	-	-	-	-	-	-	-
11.	-	Limset	The limite Agroproducts Ltd.	Tea	3.7 L	55.23 (58)	-	-	-	25.71 (27)	-	-	-	6.66 (7)	19.04 (20)
12.	Bensulfuron methyl (3%) + Mefenacet (50%)	Super power	ACI Ltd.	Rice	150g	78.09 (82)	-	-	-	50.47 (53)	-	-	-	16.19 (17)	34.28 (36)

4.4.4 Herbicide

Herbicide used to control weed in fallow field or crop field. There are various group herbicide in market of different register holder. In our study we find farmer know about only four herbicide that are Super clean 53 WP (78.09% respondents), Super power 10 wp (78.09%), L-Quat (77.14% respondents) and Limset (55.23% respondents). Though farmers are well known to these four herbicides better than others available according to percentage index, only 50.47% use super clean and super power but concern is when they use it one third percent (34.28%) respondents use more quantity than the standard dosage, just 16.19% use standard dosage of these herbicide. In case of L-Quat 48.57% use as herbicide and 2.85% think it can be use for harmful insect. As a result 28.57% use standard dosage and 22.85% use more than SD. 25.71% respondents use limset herbicide with standard dosage (19.04%) and more than SD (6.66%).

The study suggested that the best weed control option for wheat is to use a pre-emergence (pendimethalin or oxadiargyl) followed by a post-emergence (2,4-D or ethoxysulfuron) herbicides depending upon weed species which would benefit the farmers by providing high weed control efficacy at lower cost compared to manual weeding. (Ahmed *et al*, 2019).

Farmer use super power, l-quat, Limset randomly for any weed species. We knew that sometimes they use high quantity than standard dosage.

Table 4.8 List of available Rodenticide

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ¹ (ml ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage (SD)	More than SD
1.	Bromadiolone	Lanira	Novartis (Bangladesh) Limited	Crops field	2-3 times should be eaten	-	-	-	-	-	-	-	-	-	-
2.	Zinc Phosphide	Zinc Phosphide	United Phosphorus (Bangladesh) Ltd	"	2% bait	24.76 (26)	-	-	-	-	31.42 (33)	-	-	31.42 (33)	-
3.	-	Poison Bait	-	-	-	82.85 (87)	-	-	-	-	82.85 (87)	-	-	58.09 (61)	24.76 (26)

Table 4.9 List of available Nematicide

Serial	Common Name of Products	Recommended Crops	Dosage rate ha^{-1} ($\text{mL}^{-1}\text{gkg}^{-1}$)	Well Known to Farmer % (Frequency)	Purpose of using						Use of dosage		
					Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematicides	Less than SD	Standard Dosage	More than SD
1.	NEMATOX 1% WP	Paddy, Cotton, Sugar Cane, Groundnut, Turmeric,	10 gmKg^{-1} seed	-	-	-	-	-	-	-	-	-	-
2.	Granular Medicine	-	-	17.14 (18)	-	-	-	-	-	24.76 (26)	-	19.04 (20)	5.71 (6)

4.4.5 Rodenticide

Rodenticides are chemicals made and sold for the purpose of killing rodents. Lanirat, Zinc phosphite both are available in local market. But very few farmers are well known to Zinc phosphite about 24.76% respondents, 31.42% respondents use it to kill rat with standard dosage.

Highest percent of respondents (82.85%) use local rodenticide named poison bait. Respondents answered eagerly about using poison bait. Among them 58.09% respondents use standard dosage and 24.76% respondents consider more enough than standard dosage.

Farmers in Bangladesh seem reluctant to purchase zinc phosphide (Zn_3P_2) for use in rodent control, primarily because of a concern over the quality of the technical powder available from local distributors. During 1988, packets of Zn_3P_2 were purchased from the shelves of 23 distributors in Bangladesh and analyzed for technical purity. Only 2 of 23 distributors sold Zn_3P_2 containing at least 80%, while 14 distributors sold material ranging from 15% to nondetectable. Such a lack of quality control is not acceptable if farmers in Bangladesh are to use this material as a primary method of rodent control in agriculture. (Bruggers *et al*, 1995).

Rodenticides are generally organic or inorganic compounds. Chemical control includes the use of zinc phosphide, brodifacoum, bromadiolone, flocoumafen, and Yusidion. These are the main registered rodenticides available in Bangladesh. Zinc phosphide is generally used at 2 to 3%.

All anticoagulant rodenticides are available in the form of ready-made baits. Farmers use a large variety of locally made traps, including snap traps, wooden traps, bamboo traps, earthen traps, and cage traps. The most common type of snap trap used by farmers in houses is Kachi kall.

4.4.6 Nematicide

In study area farmers are not aware about use of nematicide. They were not well known to it. Some respondents (17.14%) said they use unknown granular medicine collected from local market. 19.04% use standard dosage as direction by seller and 5.71% said they use more quantity.

Table 4.10 List of available Fertilizer

Serial	Name	Chemical Formula	Well Known to Farmer % (Frequency)	Purpose of using			Use of dosage		
				Nutrition	Disease	Others	Less than SD	Standard Dosage (SD)	More than SD
1.	Sodium nitrate	NaNO_3	-	-	-	-	-	-	-
2.	Calcium Nitrate	$\text{Ca}(\text{NO}_3)_2$	-	-	-	-	-	-	-
3.	Potassium Nitrate	KNO_3	96.19 (101)	100.00 (105)	-	-	-	100.00 (105)	-
4.	Ammonium sulphate	$(\text{NH}_4)_2\text{SO}_4$	95.23 (100)	100.00 (105)	-	-	-	100.00 (105)	-
5.	Ammonium Phosphate	$\text{NH}_4\text{H}_2\text{PO}_4$	100.00 (105)	100.00 (105)	-	-	-	100.00 (105)	-
6.	Triplet super phosphate	$\text{Ca}(\text{H}_2\text{PO}_4)_2$	100.00 (105)	100.00 (105)	-	-	-	100.00 (105)	-
7.	Monoammonium phosphate	$(\text{NH}_4)\text{H}_2\text{PO}_4$	90.46 (95)	100.00 (105)	-	-	-	100.00 (105)	-
8.	Dai ammonium phosphate	$(\text{NH}_4)_2\text{HPO}_4$	100.00 (105)	100.00 (105)	-	-	-	100.00 (105)	-

Serial	Name	Chemical Formula	Well Known to Farmer % (Frequency)	Purpose of using			Use of dosage		
				Nutrition	Disease	Others	Less than SD	Standard Dosage (SD)	More than SD
9.	Potassium chloride	KCl	100.00 (105)	100.00 (105)	-	-	-	100.00 (105)	-
10.	Potassium sulfate	K ₂ SO ₄	-	-	-	-	-	-	-
11.	Ammonium Chloride	NH ₄ Cl	-	-	-	-	-	-	-
12.	Anhydrous ammonia	NH ₃	-	-	-	-	-	-	-
13.	Ammonium nitrate	NH ₄ NO ₃	-	-	-	-	-	-	-
14.	Urea	CO(NH ₂) ₂	100.00 (105)	100.00 (105)	-	-	-	100.00 (105)	-
15.	Gypsum	CaSO ₄ ·2H ₂ O	100.00 (105)	100.00 (105)	-	-	-	100.00 (105)	-
16.	Magnesium sulfate	MgSO ₄ ·H ₂ O	-	-	-	-	-	-	-

Serial	Name	Chemical Formula	Well Known to Farmer % (Frequency)	Purpose of using				Use of dosage		
				Nutrition	Disease	Others	Less than SD	Standard Dosage (SD)	More than SD	
17.	Zinc sulfate	$ZnSO_4 \cdot H_2O$	-	-	-	-	-	-	-	-
18.	Zinc oxide	ZnO	71.42 (75)	100.00 (105)	-	-	-	100.00 (105)	-	-
19.	Boric acid	H_3BO_3	76.19 (80)	100.00 (105)	-	-	-	100.00 (105)	-	-
20.	Solubor	$Na_2B_8O_{15} \cdot 4H_2O$	-	-	-	-	-	-	-	-
21.	Manganese(II) sulfate	$MnSO_4 \cdot H_2O$	-	-	-	-	-	-	-	-
22.	Ammonium molybdate	$(NH_4)_6Mo_7O_{24} \cdot 2H_2O$	-	-	-	-	-	-	-	-
23.	Sodium molybdate	$Na_2MoO_4 \cdot 2H_2O$	-	-	-	-	-	-	-	-
24.	MOP	K_2O	100.00 (105)	100.00 (105)	-	-	-	100.00 (105)	-	-

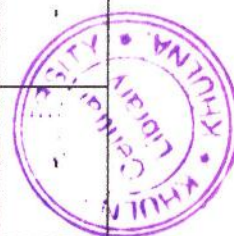


Table 4.11 List of available Plant Growth regulator

Serial	Name	Chemical Formula	Well Known to Farmer % (Frequency)	Purpose of using			Use of dosage		
				Growth regulator	Disease	Others	Less than SD	Standard Dosage (SD)	More than SD
1.	Auxins	$C_{18}H_{32}O_5$	21.90 (23)	34.28 (36)	-	-	-	34.28 (36)	-
2.	Gibberellins	$C_{19}H_{22}O_6$	30.47 (32)	40.95 (43)	-	-	-	40.95 (43)	-
3.	Cytokinins	6-(4-hydroxy-3-methylbut-2-enylaminopurine)	-	-	-	-	-	-	-
4.	Absciscic acid	$C_{15}H_{20}O_4$	-	-	-	-	-	-	-
5.	Ethylene	C_2H_4	63.80 (67)	35.23 (37)	-	-	-	29.52 (31)	5.71 (6)
6.	Alfa Naphthail Acitic Acid	$C_{10}H_7CH_2CO_2H$	26.66 (28)	49.52 (52)	-	-	-	49.52 (52)	-

4.5 Farmers' knowledge about available fertilizers and their judicious use

Fertilizers are vital for plant nutrition. In the early stage or medium stage farmer use various fertilizer. Farmer awareness about fertilizer more than others agrochemical. They try always to appropriate dosage of fertilizer in appropriate time. Ammonium phosphate, Monoammonium phosphate, Di ammonium phosphate, triple super phosphate, Urea, Gypsum and MOP all of these are well known to farmers. They use all of these common fertilizer for the nutrition of crop plant in standard dosage. Two third farmer know about boric acid, zinc sulfide, potassium sulphate, potassium nitrate, potassium chloride but these are also used in standard dosage.

Farmers stressed the importance of using balanced doses of fertilizers and this is in agreement with previous studies that have suggested applying organic materials mixed with nitrogen fertilizer to minimize pest prevalence in the rice field. (Aslam *et al*, 1979)

4.6 Farmers' knowledge about available plant growth regulator and their judicious use

Plant growth regulator are rarely used by farmers. More than half of respondents (63.80%) well known to ethylene, 29.52 % used ethylene in standard dosage among 35.23% respondents. 5.71% respondents consider high dosage. Farmer knew about Auxin (21.90%), Gibberellins (30.47%). About half percent farmer (49.52%) use Alfa Naphthyl acetic acid as plant growth regulators in standard dosage.

4.7 Awareness as perceived by farmers related to impact of agrochemical

The perception of the respondents on 16 statements related impact of agrochemical is presented in the following Table 12. Relative position of the statements relative to effect of agrochemical on agricultural environment as well as human life.

Table 4.12 Perception of awareness issue

Serial	Perception	PI		Rank Order
		OPIS	%	
1.	Damaged soil fertility	473	90.09	1 st
2.	Excessive production cost	433	82.47	2 nd
3.	Contamination of surface water sources	415	79.05	3 rd (=)
4.	Human diseases resulting from pesticide residues in food	415	79.05	3 rd (=)
5.	Dependence on chemicals for every issue	402	76.57	4 th
6.	Need of maintain precautions	362	67.04	5 th
7.	Reduction of beneficial species	356	66.80	6 th
8.	Health risks of farm workers	344	65.52	7 th
9.	Direct injury from agrochemical	343	65.33	8 th
10.	Effect on fetus	338	64.38	9 th
11.	Hampered growth and production of fish	334	63.61	10 th
12.	Harm to domestic animals	333	63.42	11 th
13.	Spices extinction	332	63.24	12 th
14.	Enhanced pest resistance	331	63.04	13 th (=)
15.	Secondary Pest resurgence	331	63.04	13 th (=)
16.	Specific chemical for specific crop	304	57.90	14 th

Agrochemical greatly damaged soil fertility with highest extent (90.09%), as perceived by the respondents. Followed by agrochemical caused excessive production cost (82.47%). From the Table 4.12 it was found that Contamination of surface water sources and human diseases resulting from pesticide residues in food hold same percentage (79.05%) and ranked 3rd, followed by dependence on chemicals for every issue (ranked 4th with 76.57%). Need of maintain precautions, reduction of beneficial species, health risks of farm workers, direct injury from agrochemical, effect on fetus, hampered growth and production of fish, harm to domestic animals, spices extinction hold ranked 5th, 6th, 7th, 8th, 9th, 10th, 11th and 12th respectively. Again, same percentage index and ranked by statements enhanced pest resistance and secondary pest

resurgence. And least percentage index for specific chemical for specific crop which ranked 14th.

A total of 452 male and 178 female farmers from seven towns were interviewed in 2016. The results show that there are gender differences regarding knowledge of pesticide impacts, pesticide use practices and protective behaviors. Male farmers had a better knowledge of pesticide use and greater awareness of associated health risks. More men than women used pesticides and disposed of the pesticide containers correctly, but fewer men applied protective measures or behaviors when using pesticides. Canonical correspondence analysis indicated that participation in farmer professional cooperatives differed by gender and contributed greatly to the protective behaviors of farmers ($p < 0.05$). These results suggest that gender-sensitive educational programs should be implemented to increase the awareness of safety amongst farmers, and protective measures should be encouraged to reduce exposure to pesticide risks in China. (Wang et al, 2017).

Farmers habitually apply fertilizers and hazardous insecticides in high quantities without assessing the actual field requirements due to inadequate knowledge. This indiscriminate input can accelerate insecticide resistance, pest resurgence, and secondary pest outbreak, leading to environmental contamination, persistent residual toxicity and destruction of beneficial insects. In the absence of a natural enemy population, the pest population can then multiply and enhance the extent of yield loss. (Dash AN et al, 2006)

Pesticides have become an integral part of modern farming, and play a major role in increasing agricultural productivity. However, the indiscriminate and extensive use of pesticides represents one of the major environmental and public health problems. If improperly used, pesticides can lead to secondary pest outbreaks, destruction of non-target species, soil, water, and air contamination, and residues in primary and derived agricultural products that endanger both the environment and human health. Farm workers' exposure to pesticides has been associated with adverse health effects like cancer and birth defects resulting in hundreds of fatalities, the majority of which occur in study area. Farmers, and especially those directly involved in the handling of pesticides, are at a high risk of exposure to pesticides through contact with pesticide residues on treated crops, unsafe handling, storage and disposal practices, poor maintenance of spraying equipment, and the lack of protective equipment or failure to use it properly.

The perception and attitude of farmers regarding risk from pesticide exposure, and to lack of education and poor knowledge and understanding of safe practices in judicious pesticide use.

4.8 Distribution of the respondents according to perception about the effect of agrochemical

The perception score of the respondents ranges from 47-62 with the mean and standard deviation of 55.37 and 4.13 respectively. The distribution of respondents according to their perception is shown in following Table

Table 4.13 Distribution of the respondents according to perception

Categories	Score	Respondent(N=105)		Mean	SD	Min.	Max.
		Frequency	Percentage				
Very low	Up to 16	0	0	55.37	4.13	47	62
Low	17-32	0	0				
Medium	33-48	21	20				
High	49-64	84	80				
Very High	65-80	0	00				
Total		105	100				

Data presented in Table 4.13 show that about 80% of the respondent had high perception followed by medium perception (20%) about the impact of agrochemical on environment and human life. Farmers of Bangladesh accustomed to use different kinds of agrochemical. They also know more or less about the effect of all agrochemicals, this experience can help them to realize and take any fruitful step against effect of agrochemical.

CHAPTER 5

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

We observed in our survey area about farmers' awareness of available agrochemical considering knowledge and judicious use at Dumuria upazila from 25 January to 7 February, 2022. At that area we conducted study to find out what were attitude of farmer and how much they were concerned about pest infestation, and what is the condition of farmers about using pesticide with other available agrochemical. Majority of the farmers were aware about pest control through using pesticide, but they were not concern about actual knowledge of pesticide, plant growth regulators with their judicious use as well as their effect on environment and their life. they do not have much idea about crop specific or pest specific control measure and use of agrochemical, though they have enough knowledge about fertilizer and dosage of it for plant nutrition.

5.1.1 Selected characteristics of the respondents

Findings in respect of the selected characteristics of the farmers are summarized below:

Age: Age of the farmers ranged from 22 to 87 years with the average of 44.50 and most (43.5%) of the respondent farmers was middle age.

Education: Education of the respondent farmers ranged from 0 to 17 years of schooling with the average of 6.49. Among them 20 percent had primary and 40 percent had secondary level of education.

Family size: Family size of the respondent ranged from 2 to 20 members with a mean of 5.44, the highest proportion (40 percent) of the farmers had small sized family.

Farm size: Farm size of the respondents in the study area 0.05 hectare to 6.07 hectare with a means 1.32. Mostly (56.2%) of the respondents had medium farm size. While about 33 percent belonged to small farm size.

Farming experience: Farming experience of the respondents ranged from 4-38 with a mean of 14.81 and standard deviation of 7.04 respectively. Among all 50.50% of the respondents had medium farming experience while 30.50% of the respondents had low farming experience.

Organizational participation: The scores of organizational participation of the respondents varied from 0 to 40. Among all respondents 80% respondents had low participation to no participation.

Extension media contact: The scores of extension media contact of the respondents varied from 8 to 59. About 54.30% farmers had occasional extension media contact with extension agent.

Cosmopolitanism: Cosmopolitanism scores of the respondents varied from 1 to 12. 49.5% of the respondents had low cosmopolitanism and same percent had medium cosmopolitanism.

Training: Among the 105 respondents 59 respondents are facilitated with agricultural training and rest 46 respondents have not any agricultural training. Different government and private organization provide training but DAE provide maximum training.

5.1.2 Farmers' knowledge about available agrochemicals (pesticides, fertilizer, plant growth regulators) and their judicious use

Fungicide and its judicious use

We had Kazim 80 WC with highest percentage (59.04%) familiarity among all fungicide with farmer. Highest number of respondents use Kazim 80 WC where 72.38% use standard dosage of it and 15.23% use more than standard dosage, these percentage of people consider it congenial for other pesticidal organism. Same result observed for Trooper 75 WP, 65.71% respondents use it as fungicide and 18.09% use for insecticide, 74.28% use standard dosage and 9.52% use more than standard dosage. Same usage of dosage and purpose of using found in case of Amistar Top.

Miticide and its judicious use

We surveyed in study area farmer are not well known to it, they perceived that the insecticide they use is enough to kill such organism. As the result they are not used to using miticide purposively. From above table we can see only 6.66% respondents know about miticide as

pesticide. These 6.66% farmer use Omite 57 EC among all listed miticide and they use standard dose of it.

Insecticide and its judicial use

We found that farmers are well known to Emithrin plus 3% (36.17% respondents), Asataf 75 SP (36.17% respondents), Fastac 2 EC (26.66% respondents), Venom 25 WBC (22.85% respondents), Brifur 5 G (40.95% respondents), Nitro 505 EC (53.33% respondents), Harpon 30 EC (20.95% respondents), Erad 55 EC (40% respondents), Katap 20SP (55.23% respondents), Manik 20 SP (56.19% respondents), Finis (91.42% respondents), and Thimid 35SC (31.42). Among these chemical 100% respondents use finis as insecticide where 79.04% respondents use standard dosage and 20.95% use more than standard dosage considering in mind it can kill others insecticidal organism existing in soil surface. 69.85% respondents use Manik 20 SP in standard dosage without 6.66% respondents. Katap 20SP used by 76.19% respondent in standard dosage and Fastac 2 EC used by 52.38% respondents in standard dosage. 7.61% and 10.47% respondents use Emithrin plus 3% WDG and Asataf 75 SP respectively.

Herbicide and its judicial use

In our study we find farmer know about only four herbicide that are Super clean 53 WP (78.09% respondents), Super power 10 wp (78.09%), L-Quat (77.14% respondents) and Limset (55.23% respondents). Though farmers are well known to these four herbicides better than others available according to percentage index, only 50.47% use super clean and super power but concern is when they use it one third percent (34.28%) respondents use more quantity than the standard dosage, just 16.19% use standard dosage of these herbicide. In case of L-Quat 48.57% use as herbicide and 2.85% think it can be use for harmful insect. As a result 28.57% use standard dosage and 22.85% use more than SD. 25.71% respondents use limset herbicide with standard dosage (19.04%) and more than SD (6.66%). Farmer use herbicide in severe case of weed infestation.

Rodenticide and its judicious use

Highest percent of respondents (82.85%) use local rodenticide named poison bait. Respondents answered eagerly about using poison bait. Among them 58.09% respondents use standard dosage and 24.76% respondents consider more enough than standard dosage. very few farmers

are well known to Zinc phosphite about 24.76% respondents, 31.42% respondents use it to kill rat with standard dosage.

Nematicide and its judicial use

In study area farmers are not aware about use of nematicide. They were not well known to it. Some respondents (17.14%) said they use unknown granular medicine collected from local market. 19.04% use standard dosage as direction by seller and 5.71% said they use more quantity.

Fertilizer and their judicious use

Farmer awareness about fertilizer more than others agrochemical. They try always to appropriate dosage of fertilizer in appropriate time. Ammonium phosphate, Monoammonium phosphate, Dai ammonium phosphate, triple super phosphate, Urea, Gypsum and MOP all of these are well known to farmers. They use all of these common fertilizer for the nutrition of crop plant in standard dosage.

Plant growth regulator and its judicial use

Plant growth regulator are rarely used by farmers. More than half of respondents (63.80%) well known to ethylene, 29.52 % used ethylene in standard dosage among 35.23% respondents. 5.71% respondents consider high dosage. Farmer knew about Auxin (21.90%), Gibberellins (30.47%). About half percent farmer (49.52%) use Alfa Naphthail acitic acid as plant growth regulators in standard dosage.

5.1.3 Farmers' knowledge and perception related to impact of agrochemical

According to the respondent effect of agrochemical greatly damaged soil fertility with highest percentage index (90.09), which ranked 1st, after that use of different type agrochemical caused excessive production cost which ranked 2nd as per farmer opinion. From the Table it was found that Contamination of surface water sources and human diseases resulting from pesticide residues in food hold same percentage (79.05%) and ranked 3rd, followed by dependence on chemicals for every issue ranked 4th with 76.57% percentage index.

5.1.4 Perception about the effect of agrochemical

about 21% of the respondent had medium perception followed by 80% high perception about the impact of agrochemical on environment and human life

5.2 Conclusion

- I. In the study area, most (43.5%) of the respondent farmers was middle age. Among all 20% had primary and 40% had secondary level of education, 40% of the farmers had small sized family. Maximum (56.2%) of the respondents had medium farm size. 50.50% of the respondents had medium farming experience while 30.50% of the respondents had low farming experience. Among the 105 respondents 59 respondents are facilitated with agricultural training.
- II. Farmer use various agrochemical in their agricultural field according to their instruction from dealers. They don't use crop specific agrochemical, sometimes they use common pesticide for different purpose.
- III. Generally, respondents used standard dosage of agrochemical in some case. Besides they also used high quantity than standard dosage. Very few farmers were well known to miticide and rodenticide. But they were aware about fertilizers than others and used standard dosage for plant nutrition.
- IV. Farmers habitually apply fertilizers and hazardous insecticides in high quantities without assessing the actual field requirements due to inadequate knowledge. This indiscriminate input can accelerate insecticide resistance, pest resurgence, and secondary pest outbreak, leading to environmental contamination, persistent residual toxicity and destruction of beneficial insects.

5.3 Recommendations

Recommendations based on the findings and conclusions:

- I. Make research investments and policy changes that emphasize development of integrated pest management and application technologies that pose reduced health risks and are compatible with ecologically.
- II. Promote scientific and social initiatives to make development and use of alternatives to pesticides more competitive in a wide variety of managed and natural ecosystems.

- III. Increase the ability and motivation of agricultural workers to lessen of different aspect of agrochemical.
- IV. Reduce adverse off-target effects by judicious choice of chemical, determination of economic and environmental impact for pesticide and fertilizer.
- V. Identify the circumstances under which chemical may be required in future pest management.
- VI. Determine what types of chemical products are the most appropriate tools for ecologically based on crop specific management.
- VII. Explore the most promising opportunities to increase benefits and reduce health and environmental risks of chemical use.
- VIII. Recommend an appropriate role for the public sector in research, product development, product testing and registration, implementation of pesticide use strategies, and public education about chemical use.
- IX. Obtaining the ecological and evolutionary biological method of pest control necessary for design and implementation of specific management systems.
- X. Examining residue management, environmental fate (biological, physical, and chemical), and application technology to monitor and reduce environmental damage and adverse health effects of chemical.
- XI. Create more opportunity for farmer about biological method of control and make them aware about weed infestation.
- XII. There is a need for inception of IPM program, ICM program and IFM program, creating awareness among the farmers about the judicious use and banning of the ecologically disruptive pesticides.

CHAPTER 6

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APPENDIX A
Agrotechnology Discipline
Life Science School
Khulna University, Khulna-9208

Title: Farmer's Awareness of Available Agrochemicals Regarding Judicious Use in the Agricultural Fields (Interview Schedule)

(Please answer the following questions & put a tick mark (✓) whenever applicable)

1. Age of the respondent.....years
2. Educational qualification:
3. Family size:
Number of family members.....
4. Farming experience..... years
5. Address:
6. Cell Phone:
7. Knowledge on agriculture

SL NO.	Question	Correct (2)	Partially Correct(1)	Wrong(0)
1.	Do you transplant or broadcast the boro rice			
2.	How can you keep hybrid crop seed for next season			
3.	When you apply urea in the field			
4.	Why perching is important for pest control			
5.	Do you discuss with others about any farm problems			

8. Farm size (ha): (Please Furnish information about your lands according to use)

SL No.	Use of land	Area of land	
		Local unit	Hectare or acre
A1	Homestead		
A2	Own land under cultivation		
A3	Land given to others on borga		
A4	Land taken from others on borga		
A5	Land taken from others on lease		

A6	Others		
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$$FS = A1 + A2 + 1/2(A3 + A4) + A5 \pm A6$$

9. Monthly family income

Please mention information's about your family income (annual) from different sources:

SL No.	Sources of income	Amount of income (taka)
1.	Agriculture: a. Fishing b. Farming c. Crop Cultivation d. Livestock	
2.	Business	
3.	Service	
4.	Others	
5.	Total	

10. Training Received: Do you receive any agricultural training?

a. Yes ☐ b. No ☐

Name of the training	Duration (Days)	Organized by

11. Please mention the nature and number of your participation in the following organizations

SL No:	Name of Organizations	Nature of Participation (with number)				Duration
		Executive Committee Officer(3)	Executive Committee Member(2)	Ordinary Member(1)	Not involved(0)	
1.	Farmers Cooperative Society					
2.	School / Mardrashah Committee					
3.	Mosque/Mondir/Churge/Pagoda Committee					
4.	IPM/ICM Club					
5.	NGO conducted committee					
6.	Union council					
7.	Youth club					
8.	Cricket / Football Club					

12. Cosmopolitanism

Please indicate the number of times you have visited the following places within the specified period:

SL No.	Place of visit	Nature of visit			
		Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)
1.	Relative or other Known persons located outside of your own village	5-6 times/month	3-4 times/month	1-2 times/month	0 times/month
2.	Union parishad office	8-10 times/month	5-6 times/month	2-3 times/month	0 times/month
3.	Own upazila/ distric sadar	5-6 times/month	3-4 times/month	1-2 times/month	0 times/month
4.	Other district upazila/ sadar	4 times/year	3 times/year	1-2 times/year	0 times/year
5.	Capital and other cities	3 times/year	2 times/year	1 times/year	0 times/year

13. Extension media contact

Categories		Regularly (4)	Often (3)	Occasionally (2)	Rarely (1)	Not at all (0)
a. Mass media	1. Radio					
	2. Television					
	3. Poster					
	4. Leaflets					
	5. Newspaper					
	6. Exhibition/Agri-culture fair					
	7. Magazine					
	8. Online Agricultural Apps					
b. Group Contact	1. Farmers field					
	2. School					
	3. IPM/ICM club					
	4. Tours					
	5. Lecture					
c. Personal cosmopolites	1. Office call (SAAO)					
	2. Office call (AEO/UAO)					
	3. Email					
	4. Personal letter					
	5. Mobile					
	6. Farm & home visit by SAAO					
d. Personal locality	1. Friends					
	2. Relatives					
	3. Neighbor					
	4. Dealer (pesticide)					
	5. Model farmer					

14. Sources for pesticide selection

Sources for pesticide selection	
Pesticide dealers	
Company agent	
Extension worker	
Fellow farmers	
Radio or television	
Relatives	
Neighbors	

15. Pesticide:

15.1 List of available Fungicide:

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^a (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage (SD)	More than SD
1.	Azoxystrobin (20%) + Cyproconazole (8%)	Dover 28SC	Agritech	Mango Chilli	1 mL ⁻¹ of water										
2.	Azoxystrobin (20%) + Difenoconazole (12.5%)	Amistar Top	Syngenta Bangladesh Limited	Tea	750 ml										
				Rice Potato Mango Betel vine Onion Chilli	1 mL ⁻¹ of water										
3.	Azoxystrobin (20%) + Tebuconazole (15%)	D-Hit 35SC	ADR Crop Care	Tea	750 ml										
				Sweet gourd	1 mL ⁻¹ of water										
4.	Azoxystrobin (20%) + Tricyclazole (6%)	ForGreen Ultra 56SC	Forward International (BD) Ltd.	Tea	750 ml										

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^{ha} ⁻¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage (SD)	More than SD
5.	Azoxystrobin (6%) + Chlorothalonil (50%)	Azonil 56EC	Haychem Bangladesh Limited	Tea	750 ml										
6.	Benalaxyl (8%) + Mancozeb (64%)	Galben M	FMC Chemical International AG	Potato, Tomato, Cucumber	2 gL ⁻¹ of water										
7.	Bismethiazol	Bactrol 20 WP	Surovi Agro Industries Limited	Potato	2 gL ⁻¹ of water										
8.	Carbendazim	Bavistin DF	BASF Bangladesh Limited	Sugarcane, Rice	500 g 500 g										
				Wheat	1 mL ⁻¹ of water										

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha ⁻¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematicides	Less than SD	Standard (SD)	More than SD
9.	Carbendazim (32.5%) + Hexaconazole (2.5%)	Defense 35 SC	Haychem Bangladesh Limited	Wheat	1 mL ⁻¹ of water										
				Onion	0.5 mL ⁻¹ of water										
				Mango	1 of water										
				Tea	750 ml										
10.	Tricyclazol	Trooper 75WP	QA Group	Banana	30g 10L ⁻¹										
				Mango	300hec ⁻¹										
11.	Carbendazim	Kazim 80WC	Square Pharnasidil cal Limited	Crookneck pumpkin	178. 12g										
12.	Carbendazim (12%)	Mancer 75WP	Semco Internatiol Bagladesh Limited	Tea	75g										

15.2 List of available Miticide:

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^a (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematicides	Less than SD	Standard Dosage	More than SD
1.	Ethion	Ethion 46.5 EC	FMC Chemical International AG	Tea	1.26 L										
				Jute	1.68 L										
				Cotton	2.50 L										
2.	Ethion (5%) + Thiamethoxam (20%)	Taba 25WDG	Alif Agro	Chilli	100 g										
3.	Fenpropathr in	Danitol 10 EC	Shetu Corporation Limited	Brinjal	1 mL ⁻¹ of water										
				Tea	1.00 L										
4.	Hexythiazox	Hexarite 5 EC	Naafco (Private) Limited	Tea	1.00 L										
5.	Propargite	Omite 57 EC	Shetu Corporation Limited	Tea	1.00 L										
				Brinjal											
6.	Sulphur	Microthiol Special 80 WP	Shetu Pesticides Limited	Tea	2.20 kg										
				Rice	2.25 kg										

15.3 List of available Insecticide:

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ¹ (ml ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage	More than SD
1.	Abamectin (1.8%)	Vertimec 1.8 EC	Syngenta Bangladesh Limited	Tea	1.25 L										
2.	Abamectin (1%) + Beta Cypermethrin (2%)	Emithrin Plus 3% WDG	Eminence Chemical Industries Ltd	Brinjal	1.20 L										
3.	Acephate	Asataf 75 SP	Auto Crop Care Limited	Cotton	750 g										
				Rice	750 g										
				Bean, Potato	1 gL ⁻¹ of water										
				Mango	5 gL ⁻¹ of water										
4.	Alpha Cypermethrin	Fastac 2 EC	BASF Bangladesh Limited	Tea	500 g										
				Brinjal	500 ml										
				Cabbage	500 ml										
				Mustard	500 ml										
5.	-	Venom 25WBC	Econ Agro Industries Ltd.	Mango	1 mL ⁻¹ of water										
				Tea	2.25 L										
				-	-										

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^{ha⁻¹} (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard (SD)	More than SD
6.	Carbofuran	Brifur 5G	ACI Formulations Limited	Rice	10.00 kg										
					20.00 kg										
				Sugarcane	40.00 kg										
				Tea	165 gm ⁻³										
7.	Chlorpyrifos (50%) + Cypermethrin (5%)	Nitro 505 EC	Auto Crop Care Limited	Potato	1 mL ⁻¹ of water										
				Cotton	600 ml										
				Tea	4.0 L										
8.	Chlorpyrifos (20%) + Methomyl (10%)	Harpoon 30 EC	Sea Trade Fertilizer Limited	Rice	800 ml										
				Sugarcane	1.50 L										
9.	Cloropyrifos (50%) + Cypermexin (5%)	Erad 55EC	Genetica Industries Limited	Cotton	600ml										
10.	Organocarbamate	Katap 50SP	Petrochem (Bangladesh) Limited	Rice	6g 10L ⁻¹										

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage (SD)	More than SD
11.	Acetamipride	Manik 20SP	Mimpex Agrochemicals Limited	Bean Brinjal	200g										
12.	.	Finis	-	-	-										
13.	Thiram (10%) Emicloroprid (25%)	Thimid 35SC	-	-	-										

15.4 List of available Herbicide:

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha ⁻¹ (ml L ⁻¹ kg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard (SD)	More than SD
1.	2,4-D	Salix	S S Vision Limited	Rice	450 g										
2.	2,4-D Butyl Ester	Rampitox 45WP	SAM Agro Chemical	Rice	125 g										
3.	Acetachlor	Offer 50EC	Nokon Limited	Rice	250 g										
4.	Bensulfuron methyl (4%) +	Changer 18 WP	National AgriCare Import & Export Ltd	Rice	750 g										
5.	Bensulfuron methyl (18%) + Pretilachlor (4%)	Londax Powder	Petrochem Agro Industries Ltd.	Rice	9.88 kg										
6.	Bensulfuron methyl (3%) + Mefenacet (50%)	Super Clean 53 WP	National AgriCare Import & Export Ltd	Rice	450 g										



Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ^{ha⁻¹} (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage (SD)	More than SD
7.	Butachlor	Golteer 5G	Auto Crop Care Limited	Rice	25.00 kg										
8.	Carfentrazone Ethyl (50%) + Isoproturon (0.75%)	Affinity 50.75 WP	FMC Chemical International AG	Wheat	1.50 kg										
9.	Carfentrazone Ethyl	Aim 40 DF	FMC Chemical International AG	Rice	62.50 g										
				Potato	62.5 g										
10.	-	L-Quat 250	The limite Agroproducts Ltd.	Banana	3g										
				Tea, Rubber	2.2g										
11.	-	Limset	The limite Agroproducts Ltd.	Tea	3.7 L										

15.5 List of available Rodenticide:

Serial	Common Name of Products	Trade Name of Products	Name of Registration Holder	Recommended Crops	Dosage rate ha ⁻¹ (mL ⁻¹ gkg ⁻¹)	Well Known to Farmer % (Frequency)	Purpose of using						Use of Dosage		
							Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematocides	Less than SD	Standard Dosage (SD)	More than SD
1.	Bromadiolone	Lanira	Novartis (Bangladesh) Limited	Crops field	2-3 times should be eaten										
2.	Zinc Phosphide	Zinc Phosphide	United Phosphorus (Bangladesh) Ltd	"	2% bait										
3.	-	Poison Bait	-	-	-										

15.6 List of available Nematicide:

Serial	Common Name of Products	Recommended Crops	Dosage rate ha^{-1} ($\text{mL} \cdot \text{gkg}^{-1}$)	Well Known to Farmer % (Frequency)	Purpose of using						Use of dosage		
					Fungicide	miticide	Insecticide	Herbicide	Rodenticide	Nematicides	Less than SD	Standard Dosage	More than SD
1.	NEMATOX 1% WP	Paddy, Cotton, Sugar Cane, Groundnut, Turmeric,	10 gmKg^{-1} seed										
2.	Granular Medicine	-	-										

16. List of available Fertilizer:

Serial	Name	Chemical Formula	Well Known to Farmer % (Frequency)	Purpose of using			Use of dosage		
				Nutrition	Disease	Others	Less than SD	Standard Dosage (SD)	More than SD
1.	Sodium nitrate	NaNO_3							
2.	Calcium Nitrate	$\text{Ca}(\text{NO}_3)_2$							
3.	Potassium Nitrate	KNO_3							
4.	Ammonium sulphate	$(\text{NH}_4)_2\text{SO}_4$							
5.	Ammonium Phosphate	$\text{NH}_4\text{H}_2\text{PO}_4$							
6.	Triplet super phosphate	$\text{Ca}(\text{H}_2\text{PO}_4)_2$							
7.	Monoammonium phosphate	$(\text{NH}_4)\text{H}_2\text{PO}_4$							
8.	Dai ammonium phosphate	$(\text{NH}_4)_2\text{HPO}_4$							

Serial	Name	Chemical Formula	Well Known to Farmer % (Frequency)	Purpose of using			Use of dosage		
				Nutrition	Disease	Others	Less than SD	Standard Dosage (SD)	More than SD
9.	Potassium chloride	KCl							
10.	Potassium sulfate	K ₂ SO ₄							
11.	Ammonium Chloride	NH ₄ Cl							
12.	Anhydrous ammonia	NH ₃							
13.	Ammonium nitrate	NH ₄ NO ₃							
14.	Urea	CO(NH ₂) ₂							
15.	Gypsum	CaSO ₄ ·2H ₂ O							
16.	Magnesium sulfate	MgSO ₄ ·H ₂ O							

Serial	Name	Chemical Formula	Well Known to Farmer % (Frequency)	Purpose of using			Use of dosage		
				Nutrition	Disease	Others	Less than SD	Standard Dosage (SD)	More than SD
17.	Zinc sulfate	$\text{ZnSO}_4 \cdot \text{H}_2\text{O}$							
18.	Zinc oxide	ZnO							
19.	Boric acid	H_3BO_3							
20.	Solubor	$\text{Na}_2\text{B}_8\text{O}_{15} \cdot 4\text{H}_2\text{O}$							
21.	Manganese(II) sulfate	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$							
22.	Ammonium molybdate	$(\text{NH}_4)_6\text{Mo}_7\text{O}_{24} \cdot 2\text{H}_2\text{O}$							
23.	Sodium molybdate	$\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$							
24.	MOP	K_2O							

17. List of available Plant Growth regulator:

Serial	Name	Chemical Formula	Well Known to Farmer % (Frequency)	Purpose of using			Use of dosage		
				Growth regulator	Disease	Others	Less than SD	Standard Dosage (SD)	More than SD
1.	Auxins	$C_{18}H_{32}O_5$							
2.	Gibberellins	$C_{19}H_{22}O_6$							
3.	Cytokinins	6-(4-hydroxy-3-methylbut-2-enylaminopurine)							
4.	Absciscic acid	$C_{15}H_{20}O_4$							
5.	Ethylene	C_2H_4							
6.	Alfa Napthail Acitic Acid	$C_{10}H_7CH_2CO_2H$							

18. Farmer perception about agro-chemical effect

Code: 1. Strongly disagree, 2. disagree, 3. neutral, 4. agree, 5. Strongly agree						
SL	Parameters	Code				
1	Reduction of beneficial species	1	2	3	4	5
2	Enhanced pest resistance	1	2	3	4	5
3	Secondary Pest resurgence	1	2	3	4	5
4	Damaged soil fertility	1	2	3	4	5
5	Hampered growth and production of fish	1	2	3	4	5
6	Health risks of farm workers	1	2	3	4	5
7	Harm to domestic animals	1	2	3	4	5
8	Contamination of surface water sources	1	2	3	4	5
9	Human diseases resulting from pesticide residues in food	1	2	3	4	5
10	Spices extinction	1	2	3	4	5