

**DETERMINANTS OF PESTICIDE USE AND RISK PROTECTIVE  
BEHAVIOUR IN BRINJAL PRODUCTION**

**MD. LALON MIYA**



**DEPARTMENT OF AGRICULTURAL STATISTICS  
SHER-E-BANGLA AGRICULTURAL UNIVERSITY  
SHER-E-BANGLA NAGAR, DHAKA -1207**

**DECEMBER, 2021**

**DETERMINANTS OF PESTICIDE USE AND RISK PROTECTIVE  
BEHAVIOUR IN BRINJAL PRODUCTION**

**BY**

**MD. LALON MIYA**

**REGISTRATION NO : 19-10335**

A Thesis Submitted to the Department of Agricultural Statistics, Sher-e-Bangla  
Agricultural University, Dhaka-1207, in partial fulfillment of the requirements for the

degree of

**MASTER OF SCIENCE**

**IN**

**AGRICULTURAL STATISTICS**

**SEMESTER: JULY-DECEMBER, 2021**

**Approved by:**

---

**Dr. Md. Mizanur Rahman Sarker**  
**Professor**  
**Dept. of Agricultural Statistics**  
**Sher-e-Bangla Agricultural University**  
**Supervisor**

---

**Zulfikar Ahmed Reza**  
**Professor**  
**Dept. of Agricultural Statistics**  
**Sher-e-Bangla Agricultural University**  
**Co-supervisor**

---

**Professor Md. Zakir Hossain**  
**Chairman**  
**Examination Committee**  
**Department of Agricultural Statistics**  
**Sher-e-Bangla Agricultural University**



## Department of Agricultural Statistics Sher-e-Bangla Agricultural University

Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh.

---

### CERTIFICATE

*This is to certify that thesis entitled, "DETERMINANTS OF PESTICIDE USE AND RISK PROTECTIVE BEHAVIOUR IN BRINJAL PRODUCTION " submitted to the Department of Agricultural Statistics, Sher-e-Bangla Agricultural University, Dhaka-1207, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURAL STATISTICS**, embodies the result of a piece of bona fide research work carried out **MD. LALON MIYA**, Registration No. **19-10335** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

*I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.*

***Dated: December, 2021***

***Place: Dhaka, Bangladesh***

---

**Dr. Md. Mizanur Rahman Sarker**  
**Professor**  
**Dept. of Agricultural Statistics**  
**Sher-e-Bangla Agricultural University**  
**Supervisor**

**DEDICATED**

**TO**

**MY BELOVED PARENTS**

## **ABSTRACT**

Farmers are working extremely hard to boost crop yields by using more pesticides and fertilizer as a result of the rising global demand for food and the shrinking amount of arable land. But using pesticides in agriculture has had unfavorable repercussions on the environment and human health. The study was conducted to examine the determinants of pesticide use and risk protective behaviour in brinjal production in some selected areas of Bogura district in Bangladesh. Besides, attempt had given to describe the socio-economic characteristics of the brinjal farmers, to identify the factors that significantly influence farmers use of pesticides in brinjal production, to compare the use of pesticides among brinjal farmers and investigate the comparison of risk protective behaviour among brinjal farmers. Two upazilas called Shibganj and Shahjahanpur under the Bogura districts was selected purposively for the study on the basis of extensive brinjal production. Simple sampling procedure was used to select a sample of 102 respondents. Data were analyzed using descriptive statistics, Multiple linear regression coefficients of contributing determinants related to the determinants of pesticide use in brinjal. Results indicated that safety behaviors in pesticide use were inadequate, particularly in majority of the farmers were overusing insecticides, fungicides and herbicide. The majority of the farmers (40) did not use mask as a result of low education levels, high cost and low availability. Due to their low levels of education, high costs, and lack of access, the majority of farmers (34) did not know about pesticide toxicity. Findings from the Multiple linear regression coefficients model estimation indicated that use of NPK and plot size are significant at 1% level and experience, highest education level of the family and family size are significant at 5% level and significantly influenced the amount of pesticide usage. In order to allow correct pesticide usage for improved livelihoods and environmental protection, the study advised the implementation of risk protective measures, safety training programs and suitable extension services. In terms of public policy, developing and executing targeted interventions aiming at encouraging the limit of detrimental consequences of excessive pesticide use on human health and the environment.

## ACKNOWLEDGEMENT

All praise is due to Allah, the Merciful, the Almighty, who made it possible and allow me to continue my studies in Agricultural Statistics and to successfully finish the research and writing of my thesis for the Master of Science in Agricultural Statistics degree.

I now want to express my sincere gratitude to my supervisor, Dr. Md. Mizanur Rahman Sarker, Professor Department of Agricultural Statistics, Sher-e-Bangla Agricultural University, Dhaka-1207, for his inspirational leadership, insightful criticism, and helpful advice throughout the thesis preparation and research process. This task would not have been finished without his astute intellectual advice, precise constructive criticism, and help. I would like to express my appreciation to my esteemed co-supervisor, Zulfikar Ahmed Reza, Professor, Department of Agricultura Statistics, Sher-e-Bangla Agricultural University, Dhaka-1207, for his suitable direction, motivational cooperation, and encouragement throughout the research process and thesis preparation.

I also like to thank my supervisor, Dr. Md. Mizanur Rahman Sarker, who is a professor in the department of agricultural statistics at Sher-e-Bangla Agricultural University, for his openness, enlightening suggestions, and encouragement as my thesis was being developed. I owe a great deal of gratitude to each and every one of my esteemed instructors for their important advice, support, and collaboration during the course of my studies.

I'd want to convey my appreciation to the 102 farmers who participated actively in this survey and, more significantly, helped me understand their efforts and actions linked to brinjal production. Their amazing assistance throughout the data gathering procedure is much appreciated.

I would like to express thanks to Maruf Khan my younger brother who helped me in this study period

Insufficient words exist to adequately express my thanks to my parents for their unwavering commitment and unwavering support, as well as for their sacrifice and steadfast efforts to help me realize my goal of pursuing a higher education.

December,2021

Md. Lalon Miya

## CONTENTS

CHAPTER	TITLE	PAGE NO
	ABSTRACT	i
	ACKNOWLEDGEMENT	ii
	CONTENTS	iii-v
	LIST OF TABLES	vi
	LIST OF FIGURES	vi
	ACRONYMS AND ABBREVIATIONS	vii
<b>CHAPTER 1</b>	<b>INTRODUCTION</b>	<b>1-7</b>
	1.1 Background of the Study	1-3
	1.2 Production of Brinjal in Bangladesh	4
	1.3 Production of Brinjal in Bogura	5
	1.4 Scope of the Study	5
	1.5 Objectives of the Study	6
	1.6 Limitation of the Study	7
<b>CHAPTER 2</b>	<b>REVIEW OF LITERATURE</b>	<b>8-19</b>
<b>CHAPTER 3</b>	<b>METHODOLOGY</b>	<b>20-39</b>
	3.1 Introduction	20
	3.2 Selection of the Study Area	21-24
	3.3 Sampling Technique and Sample Size	24
	3.4 Data Collection	25
	3.4.1. Questionnaire Design	26
	3.4.2. Pre-testing the questionnaire	26
	3.4.3. Finalization of the Questionnaire & Method of Data Collection	26
	3.4.4. Data Editing and Coding Data editing and coding	27
	3.5 Data Processing	27
	3.6 Processing, Tabulation of Data	27
	3.7 Data Analysis	28
	3.8 Variable to be used	29

## CONTENTS

CHAPTER	TITLE	PAGE NO
	3.8.1 Dependent Variable	30
	3.8.2 Independent Variables	30
	3.8.3 Measurement of Dependent Variable	30
	3.8.4 Measurement of Independent Variable	30
	3.8.4.1 Age	31
	3.8.4.2 Education	31
	3.8.4.3 Highest Education Level of family	31
	3.8.4.4 Experience	31
	3.8.4.5 Family Size	31
	3.8.4.6 Members Involve In Agriculture	32
	3.8.4.7 Plot Size	32
	3.8.4.8 NPK	32
	3.8.4.9 Knowledge About Pesticide Toxicity	32
3.9	Conceptual Frame work	33-34
<b>CHAPTER 4</b>	<b>RESULTS AND DISCUSSION</b>	<b>35-53</b>
4.1	Socio-economic Characteristics of the Respondent	35
	4.1.1 Age	36
	4.1.2 Education	37
	4.1.3 Highest Education Level of the family	38
	4.1.4 Members Involve In Agriculture	39
	4.1.5 Comparison of Fungicide use	40
	4.1.6 Comparison of Insecticide use	41
	4.1.7 Comparison of Herbicide use	42
4.2	Determinanats of Pesticide use in Brinjal Production	<b>43-45</b>



4.3	Risk Protective Behaviour in Brinjal Production	<b>45-49</b>
4.3.1	Wearing mask when spraying pesticide	45
4.3.2	Wearing gloves when spraying pesticide	46
4.3.3	Changing cloths after spraying pesticide	46
4.3.4	Showering emidietly after spraying pesticide	47
4.3.5	Never discarding empty pesticide containers in the field	48
4.3.6	Carefully reading the instruction on the pesticide labels	48
4.3.7	Knowledge about pesticide toxicity	49
4.3.8	Knowledge about pesticide effect on the body	49

## **CONTENTS**

<b>CHAPTER 5</b>	<b>SUMMARY, CONCLUSIONS AND RECOMMENDECTIONS</b>	<b>50-59</b>
5.1	Summary of Findings	
5.1.1	Social Profile of the respondents	50-51
5.1.2	Risk Protective Behaviour in Brinjal Production	52
5.2	Conclusions	52
5.3	Recommendations	53-54
	<b>REFERENCES</b>	<b>55-62</b>
	<b>APPENDIX</b>	<b>63-68</b>

## LIST OF TABLES

TABLE NO	PARTICULARS	PAGE NO
1.1	Total brinjal production area and total production	4
3.1	Description of Dependent and Independent Variables	29
4.1	Binary logistic regression coefficients of contributing determinants related to the determinants of pesticide use in Brinjal	43
4.2	Risk Protective Behaviour in Brinjal Production	47

## LIST OF FIGURES

FIGURE NO	PARTICULARS	PAGE NO
3.1	The study area showing villages of Shahjahanpur Upazila	22
3.2	The study area showing villages of Shibganj Upazila	23
3.3	Conceptual frame work	36
4.1	Age of the Farmer	37
4.2	Education Level of the farmer	38
4.3	Highest Education Level of the farmer	39
4.4	Members involve in agriculture	40
4.5	Comparison of Fungicide use in between Shahjahanpur and Shibganj	41
4.6	Comparison of Insecticide use in between Shahjahanpu and Shibganj	42
4.7	Comparison of Herbicide use in between Shahjahanpu and Shibganj	43

## ACRONYMS AND ABBREVIATIONS

BARI : Bangladesh Agricultural Research Institute

BBS : Bangladesh Bureau of Statistic

BDT : Bangladeshi Taka

BER : Bangladesh Economic Review

DAE : Department of Agricultural Extension

NGO : Non-Government Organization

HYV : High Yielding Variety

NPK : Nitrogen, Phosphorus and Potassium

MoP : Muriate of Potash

DAP : Diammonium Phosphate

TSP : Triple Super Phosphate

et al. : and others (at elli)

ha : Hectare

kg : Kilogram

ml : Milliliter

mt : Metric Ton

t : Ton

# CHAPTER 1

## INTRODUCTION

### 1.1. Background of the study

Brinjal commonly known as eggplant is one of the most important vegetables grown throughout the country for its purple, green or white pendulous fruit. It is a member of the Solanaceae family and is closely related to tomatoes and potatoes. It's one of the leading agricultural crops where, Bangladesh's national economy has been growing and staying stable thanks in large part to agriculture (Sharmin *et. al.*, 2018).our nation's primary agricultural products include a variety of vegetables, wheat, pulses, and jute. Due to their high nutritional value, comparatively larger output, and better return, vegetables are regarded as one of the most significant food crops (Sharmin, 2015). In addition to its nutritional value, it aids in the creation of jobs, raises incomes, and decreases poverty in developing nations like Bangladesh (SOFA team *et.al.* 2011; Weinberger & Genova, 2005). In Bangladesh, vegetable production has increased dramatically during the past 40 years. The agricultural GDP, which is close to 9.71 percent, is significantly boosted by the contribution of the vegetables and crops subsector (MoF, 2018). Since vegetables are typically labor-intensive crops, they hold great promise for boosting rural job prospects. In addition to assisting farmers with self-employment, eradicating poverty, and generating money, homestead crop production systems, particularly those that grow horticultural crops, can significantly contribute to ensuring food and nutrition security. Unlike other vegetable crops, brinjal requires extreme care to attain satisfactory yield. Brinjal is a primary source of cash income for resource-poor farmers in Bangladesh. However, attack by insects/pests is one of the most important hurdles in

the massive production of brinjal. Insect pests and diseases not only reduce the yield but also sometimes account for a complete crop failure (SN Alam, 2011). In order to feed its more than 170 million inhabitants, of which more than 15 million are farming household. Bangladesh is one of the most densely populated and intensive agricultural countries. In 2018-2019 the country's GDP contribution from agriculture was 13.3 percent, and it produced 38 million tons (MT) of cereals, 0.4 MT of pulses, 1.0 MT of oilseed, 0.5 MT of vegetables, and 2.5 MT of spices and condiments (BBS, 2020). From 758 metric tons in 1960 and 3028 metric tons in 1980 to nearly 19,000 metric tons in 2000, pesticide application has risen. 48,690 metric tons of pesticides were applied to fields nationwide in 2008 (Islam *et. al.*, 2016; Miah *et. al.*, 2014), and over 47% of farmers in Bangladesh overuse chemicals (Dasgupta *et. al.*, 2005). In order to provide increased crop yields and to safeguard crops from pests, pesticides are crucial to agricultural development (Damalas and Eleftherohorinos, 2011). over 5 billion kg of plant protection products are used annually worldwide, more than 40% of potential crop loss due to pest infestation (Oerke, 2006). The use of pesticides is increasing in developed countries in the European Union region (Antonini and Argilés-Bosch, 2017) as well as in developing countries like Bangladesh due to intensive farming practices. However, along with the wide use of pesticides come the negative effects that pesticides have on the non-target pests, the food chain, and biodiversity (Calliera *et. al.*, 2013; Verger and Boobis, 2013). The global crop protection chemicals size is estimated to be valued at USD 63.7 billion in 2020 and is projected to reach a value of USD 74.1 billion by 2025. According to FAO, global pesticide use almost doubled between 1990 and 2018, increasing from 2.3 to 4.1 million tones. The 7 billion global population is projected to grow by 70 Million per annum, increasing by 30 % to 9.2 billion by 2050 (EU, 2021).

Pests are a major cause of crop yield losses. FAO estimates that plant pests and diseases are accountable for the reduction of between 20 and 40 percent of global crop yields per year (FAO, 2021). The world health organization (WHO) estimates that nearly 4.0 million people suffer from acute pesticide poisoning and at least 20,000 die in each year in the world (Sarker *et. al.* 2002). Increasing population density is expected to increase the demand for food production by 70% mainly due to the change in eating habits in developing countries towards high-quality food. The availability of additional agricultural land is limited (Popp *et. al.*, 2013). Therefore, we need to grow food on less land, use less water and use less energy, fertilizers, and pesticides than we do today. In view of these limitations, there is an urgent need for high-level sustainable production. Reducing the current yield loss caused by pests and diseases is the main challenge facing agricultural production. Pesticides have proved to be beneficial in many ways from increasing food quality (size, color, and shape) and quantity, extending the storage life of food crops, and decreasing food prices. Farmers worldwide depend on pesticides for a variety of reasons, including obtaining higher yields, minimizing operating costs, and reducing post-harvest losses (USITC, 2020). However, market-oriented production and agricultural intensification are leading farmworkers to increase pesticide use at a rapid rate. Because agricultural crops and their productivity are dependent on synthetic pesticides, there has been a significant increase in pesticide usage. The usage of all agricultural pesticides (insecticides, herbicides, and fungicides) increased five-fold between 1990 and 2020. Pesticides are the main method used to manage agricultural pests in Bangladesh. Bangladesh uses a lot of insecticides on vegetables like brinjal. To increase productivity, brinjal growers in Bangladesh have been applying pesticides for high production.

## 1.2. Production of Brinjal in Bangladesh

Brinjal is mostly planted as a Rabi crop throughout the winter. In Bangladesh, the production of vegetables, particularly brinjal, is rising daily. In terms of overall growing area and productivity among all the vegetables grown in the nation, brinjal commands a significant portion. It grows in all the districts of Bangladesh but plenty of brinjal are produced in the region of Dhaka, Chattogram, Rajshahi, Rangpur, Barishal, Khulna, Mymensingh and Sylhet.

**Table 1.1:** Total brinjal production area and total production

<b>Division</b>	<b>Total Area (Acre)</b>	<b>Total Production (MT)</b>
<b>Dhaka</b>	10917	57595
<b>Chattogram</b>	10502	35712
<b>Rajshahi</b>	14813	70622
<b>Khulna</b>	14244	59065
<b>Mymensingh</b>	13126	61939
<b>Rangpur</b>	13429	64424
<b>Sylhet</b>	2784	12599
<b>Barishal</b>	3118	10914

Source: BBS 2020

### **1.3 Production of brinjal in Bogura**

Brinjal is grown on many different types of soil, but does best in a rich, well-drained soil with a high moisture-holding capacity. High humus content in the soil will provide better aeration and water penetration. If a soil is low in organic matter, stable or green manures can be supplied. Brinjal grows best on a neutral or slightly acid soil (pH 6.0 to 6.5). According to agricultural statistics yearbook-2020 in bogura total area of brinjal cultivation in winter season (Rabi) is 2114 acre and total production is 7557 MT. (BBS 2020).

### **1.4 Scope of the Study**

Brinjal is a chief source of income and employment among farmers. The crop is however characterized by high pesticide use due to its vulnerability to insect pest and disease attack. This is confounded by consumer preference for blemish-free and high-quality brinjal. To respond to the expanding market demand and consumer preferences, brinjal farmers heavily rely on pesticides for crop protection so as to improve its yields and quality. Improper use of pesticides while controlling agricultural pests has undesirable effects on human health, environment, and even death due to direct exposure. In addition, inappropriate pesticide use may lead to an increase in the cost of production. In spite of efforts by government extension service providers to educate brinjal farmers on pesticide use, there is little knowledge about determinants of the level of pesticide usage among brinjal farmers. Hence, it is on the foregoing that this study was geared towards filling these knowledge gaps among brinjal farmers in Bangladesh. This research will assist policymakers in determining the use of pesticides, recommending and providing benefits for farmers, and encouraging farmers to utilize pesticide use in brinjal.



### **1.5 Objectives of the study**

The following specific objectives were developed to provide the research the right direction in light of the aforementioned problem:

- a) To explore the socioeconomic traits of those brinjal farmers.
- b) To identify the factors that significantly influence farmers use of pesticides in brinjal production.
- c) To compare the use of pesticides among Shibganj and Shahjahanpur farmers.
- d) To investigate the comparison of risk protective behaviour among Shibganj and Shahjahanpur farmers.

## **1.6 Limitation of the Study**

The goal of this study was to discover more about a better knowledge of the current status of pesticide use in brinjal cultivation as well as to investigate their link with certain specific features. Given the researcher's limited time, money, and other resources, as well as the need to make the study useful and manageable, the researcher had to impose the following limitations:

1. The study was confined to two upazilas named Shibganj and Shahjanpur in Bogura district northern region of Bangladesh.
2. The selected main issues in this study included precautionary pesticide use behaviour, determinants of the level of pesticide usage as well as the role of risk protective behaviour and socio-economic characters among brinjal farmers.
3. The findings in this study though useful were limited in that farmers interviewed hardly kept records on pesticide use.
4. Out of many characteristics of brinjal only few characteristics were selected for investigation in this study.
5. Consequently, most of the answers to questions were based on the farmer's memory.
6. However, thorough probing was undertaken to ensure respondents gave accurate data.

## CHAPTER 2

### REVIEW OF LITERATURE

The goal of this chapter is to review significant material with the issue of **Determinants of Pesticide use and Risk Protective Behaviour in Brinjal Production**. Again, some of these studies might not be totally relevant to the current study, but their conclusions, analytical methods, and recommendations have a significant impact on it. Below is a review of several recent research studies that are pertinent to the current studies. Which have been conducted in the recent past, are discussed below. Which have been conducted in the recent past, are discussed below.

**Sarker et. al. (2021)** conducted a study on the uncertain fate and transport pathways of applied pesticides are the key hidden threats with respect to the safety and quality evaluation of foodstuffs in Bangladesh. The risk assessment of and uncertainty about applied pesticides are poorly explored due to weak regulatory systems, farmer ignorance, intensive agricultural practices, and lack of available research data on improper handling of pesticides on farming lands with poor phytosanitary management. However, increasing evidence suggests that the prevalence of pesticides in common foodstuffs is due to their uptake by crops and improper management of crop protection practices. Therefore, this review summarizes the findings of existing literature on pesticide residue in foodstuffs and points out the weaknesses in the regulatory system and risk assessments for highlighting the critical challenges to food safety in Bangladesh as compared to global food policy. In addition, strategies for the sustainable management of residual pesticides are also discussed.

**Sarkar, S. et. al. (2021)** found that this study provides a broad perspective on the main trends regarding the use of pesticides in developing countries and their impacts on human health and food security. Information is provided on the challenges of controlling these hazardous substances. Recommendations are intended to improve the ability for all people, including future generations, to have access to healthy food.

**Muhammad & Javed (2020)** observed that developing countries of Asia like Bangladesh, India, and Pakistan need a continuous increase in food production. This increase is only possible with increased per unit yield from the existing land and natural resources available for food products, including cereals, fruits and vegetables (Sharma *et. al.*, 2000). For an increase in per unit yield of food crops, minimization of pest-associated losses is a practical approach which is reported up to 14% of total agriculture production (Oerke *et. al.*, 2012). Brinjal is one of the most important and nutritious vegetable, available all around the year in the market at a reasonable price. The increasing demand for brinjal, importing countries are focused on quality production without or with reduced use of insecticides.

**Barau, A. et. al. (2020)** found that the knowledge on pesticide use in vegetable production in narsingdi district. Farmers use various pesticides indiscriminately in their vegetable fields throughout the cropping seasons in bangladesh. Therefore, examined farmers' extent of adoption and knowledge on pesticide use in vegetable production. Interview-schedule was used for collection of data. Both descriptive and inferential statistics were used in the analysis. Results revealed that most of the respondents were 35 years above, literate, had less than seven family members, small farm size (0.02-1.01 ha), moderate contact with information sources (80.9%), low annual income (66.4%) and received

training (64.54 %) on pesticide use. Brinjal and cucurbits had the highest pesticide use among the vegetables, while the mostly used pesticides were Topten 1.8 EC. Actara insecticide and Thiovit fungicide. The extent of pesticide adoption was high (91.0%) and all(100.0%) of the respondents had low to moderate knowledge on pesticide use. Contact with information sources ( $r = 0.32$ ) showed significant relationship with knowledge on pesticide use. Hence, government should strengthen information and regulations in order to raise awareness on safe use of pesticide.

**Zabed, H. M. *et.al.* (2019)** investigated that composition of pesticides and factors determining use of pesticides were examined using survey data from 81 randomly selected ‘contract hybrid vegetable and cereal seed growers’ in northwestern bangladesh. Twenty-seven brands of pesticides were used including a substantial number of banned pesticides. Of the pesticide users, 35% reported use of organophosphates, ranked from extremely to highly hazardous by the world health organization. About 87% of farmers used pesticides at least once in a crop. Pesticide cost accounts for 6.9% of the gross value of output in hybrid seeds of vegetables and 3.2% in cereals. Cultivation of vegetables is the prime determinant of pesticide use. Farmers treat pesticides as complement to fertilizers, indicated by the negative influence of fertilizer prices on pesticide use. Increase in cereal price increases pesticide use. Large farmers use more pesticides. Farmers who perceive pesticide has harmful effects use significantly less pesticides whereas those who use a facemask as precaution during pesticide application apply a significantly higher amount. Major thrust for pesticide regulation and effective implementation, increasing farmers’ awareness on effects of pesticide use and expansion of the IPM practices .

**Begum, S. et. al. (2019)** found that pesticide residues in vegetables have become a major concern associated with food safety issues. Five types of winter vegetables like brinjal, bean, cauliflower, tomato, and cabbage were collected from six markets of Rajshahi district during January, 2019 in Bangladesh. A quick, easy, cheap, effective, rugged and safe method was used for sample preparation. Out of 30 samples, pesticide residues were found only in one brinjal and two tomato samples. The result showed that tomato samples collected from Shaheb Bazar and Kharkhari Bazar of Rajshahi city contained 0.047 mg/kg and 0.139 mg/kg dimethoate residue, respectively.

**Chowdhury, M. G. F. et. al. (2019)** conducted a survey in seven districts namely Bogura, Rajshahi, Jashore, Narsingdi, Cumilla, Jamalpur and Gazipur to assess the present status of the usage of pesticides in major vegetable crops such as brinjal, tomato, country bean and bitter melon. A total of 280 respondents having 40 respondents from each district were selected randomly for the study. The maximum number of vegetable growers belonged to the age group of 21-40, which is about 50%. About 41% and 25% of farmers accomplished their primary and secondary education in the study areas. Almost all of the vegetable growers were used synthetic pesticides for protecting their crops from pests and most of them used own hand pump sprayer. Farmers of the study areas applied synthetic pesticides frequently with much higher dosages than the recommendation. Seventy five percent farmers had protective measure during insecticide-pesticide spray and about 40% growers felt uncomfortable after hand spray to the crops. It is strongly recommended to use IPM technology for controlling insects and pest and to create awareness regarding pesticides use practice and safety precautions.

**Bhandari, L. R. (2019)** this study has analyzed the trend of pesticides use in vegetable farming in third world country like Nepal, and its impact in public health. This study tried to find out the increasing trend of pesticides use in vegetable farming and its optimum impact in human health that has also focused for the protection of environmental and human health. In order to study the trend of pesticides use and its health impact, primary data were collected from the vegetable farmers who operate farming at the village area. A purposive sampling method was applied to collect data from 110 farmers who use pesticides in vegetable farming. Sample was drawn in such a way that all kinds of farmers might be included into the sample. Statistical tools such as percentage tables were used to analyze the data, and finding revealed that varieties of pesticides were used by farmers, but awareness associated with pesticides application was not found as we expected among the respondents. Although farmers showed favorable attitudes about the risks of pesticides uses, they did not use protective tools while applying pesticides. Less than half respondents (42.27%) have got primary education whereas only less than one third (30%) respondents have secondary level of education. More than two third majority (95.45%) respondents have given their view that pesticides are ultimately harmful for human health although it helps to increase the production. Air pollution, land pollution, and harmful to non-target organisms were also found from the study. In order to study the using trend and practice of pesticides, vegetable farmers were using different types of pesticides based on their decision. No proper advices from stakeholders and extension agent were taken, and no safety tools were used at the time of pesticides application. Educational awareness, pest control, safe work habits, safety tools, policy, innovative method of farming, and organic farming are recommended for the policy maker from the study

**Kinuthia, C. W.*et. al.* (2019)** investigated that the increasing demand for food and the diminishing agricultural land has resulted in farmers putting great efforts to increase crop yields by using more fertilizer and pesticides. Pesticide use in agricultural production has, however, produced undesirable effects on human health and the environment. Thus, the study aimed at contributing to sustainable agricultural intensification through safe pesticide use and uptake of alternative pest control methods among small-scale tomato farmers in nakuru county, kenya. Specific objectives of the research study were; to evaluate precautionary behaviors in pesticide use among small-scale tomato farmers and to determine socioeconomic and institutional factors that influence the level of pesticide usage among small-scale tomato farmers. The study also sought to establish the role of risk perception, institutional and socio-economic characteristics on the intensity of uptake of alternative pest control methods among small-scale tomato farmers. Results indicated that safety behaviors in pesticide use were inadequate, particularly in the use mask (0.52%), gloves (18.49%) and hats (26.30%). Majority of the small-scale farmers were overusing insecticides (97.66%) and fungicides (91.93%). A significant proportion of the tomato farmers were underusing herbicide (83.33%). Findings from the trivariate ordered probit model estimation indicated that gender, farming experience, distance to the market and number of contacts with the extension service provider positively influenced the level of pesticide usage. While farm size and participation in off-farm activities had a negative effect on the intensity of uptake of alternative methods. The study concluded that a significant proportion of small-scale farmers overuse pesticide while managing insect pests and diseases.



**Ahmed & Sardar (2018)** found that the samples of the brinjals were analyzed to assess the residue level of insecticides. Out of analyzed 75 collected samples of brinjal from farmer's field of Jessore, Gazipur and Rangpur, 38.67% were found to be contaminated with insecticides. Multiple product residues representing 13.79% of the total contaminated samples and the rest 86.21% contained single insecticide residue. About 13.33% of the total samples had residues exceeding the maximum residue limit irrespective of single or multiple insecticide residues. The presence of highest residue levels of insecticides in brinjals may be due to its irrational and repeated use before harvest.

**Nguyen & Havukainen (2018)** observed that the pesticide use in vegetable production : A survey of vietnamese farmers' knowledge. Plant protection concerns about inappropriate storage, application rates, and disposal practices of pesticides prompted this case study of vietnamese farmers knowledge, attitudes, and practices. Farmers reported inappropriate mixing of pesticides and disposal methods. Many also reported ill-timed applications posing potential hazards to the human health and environment. Community based training and education, jointly funded by local, national, and international agricultural production and food safety groups, would be a cost-effective method of minimizing pesticide applications and improving food safety.

**Yasmin & Nahar (2017)** analyzed that the study was to determine the pesticide control measures practiced by the farmers in sadar upazila of gazipur district of bangladesh. Data were collected through personal interview during the period of november 2016 to march 2017. Safety measures were not taken by most of the respondents. Education, training, experience, extension contact and knowledge towards practices of pesticide use had significant positive relationships (at 1% level) with the

pesticide use for vegetable cultivation. Age, farm size, family size, farming experience and annual income of the respondents had no significant relationships with the pesticide use for vegetable cultivations. The above findings suggested that the farmers did not use knapsack sprayer. Applicators usually spray their field with different types of hand sprayer machine for vegetable cultivation. In this regard take bath right after spraying was the highest and use shoes/head cover/glasses when applied pesticide was the lowest scores. Majority of the farmers were aware about safety measures about after using pesticide they took bath but most of the farmers were not aware of using of shoes, head cover and glasses while using pesticide in their field.

**Islam, Alam & Zabir (2016)** conducted that the survey study was among two hundred farmers from Patuakhali and Comilla district, Bangladesh to determine the farmers awareness about farm land pesticide application on major crops with beneficial and harmful effects, pesticide use trends in last five years (2011–2016), crop harvesting time after pesticide application and determinants. Survey result showed that pesticide application intensity (3/4/more times in a cropping season) higher in Cumilla region compared to that of Patuakhali region. Vegetables harvesting time within 24 or 48 hrs after application of pesticides will be alarming for consumers due to toxicity development of pesticide residue. Application of pesticides more than the recommendation limits increasing the environmental, animal and human health risk at the studied area. It is concluded that effective implementation of government policy, continuous monitoring as a whole growing farmers awareness about the pesticide use are suggested for sustainable and quality crop production and healthy consumption.

**Damalas and Khan (2016)** found that Age, income, education level, training, and farming experience have been reported as determinants of usage of pesticide product labels by farmers. Better educated farmers tend to use pesticides judiciously and are careful to follow the recommended guidelines to the latter, unlike less educated or illiterate farmers. This might be attributed to awareness of the ill effects associated with misusing pesticides since they have access to that information. Knowledge level of pesticide use and safety was low among the majority of the farmers. For instance, farmers who failed to read labels had lower income, a low level of education and training and higher age than their counterparts. On the contrary, there was no significant relationship between farm size and reading pesticide labels.

**Ibrahim, S. A. et. al. (2016)** conducted the study as one of the biggest challenges faced by Sierra Leonean farmers is pest control. Birds, insects, rodents, crustaceans and other organisms can drastically reduce yields. In order to prevent these organisms from destroying their crops, farmers use pesticides. However there are reports that these chemicals are being misused and are having negative impact on the environment and the health of the farmers. This research aimed to investigate pesticide use in rice fields and its potential effects on the environment and the health of rice farmers. It was found that the prevalence of pesticide use on rice farms is high and the chemicals are misused.

**Schreinemachers, P. et. al. (2016)** observed that the farmers desire to increase yields, improve product quality and manage pests drives them to use chemical pesticides. However, indiscriminate use of pesticide has become a significant public health and environmental concern specifically in less developed countries. Precautionary practices in pesticide use could minimize the adverse effects of pesticide use. Some

examples of the safety practices include applying a recommended dose, wearing personal protective equipment, appropriate disposal, safe storage, observing proper personal sanitation during and after pesticide application among others.

**Miah & Hoque (2014)** found that unsafe use of pesticide and its impact on health of farmers in burichong upazila farmers of bangladesh frequently use different types of pesticides in vegetable fields following the advice of untrained traders or salespersons. Three-fourths of farmers adopt safety measures partially but cannot avoid skin, eye, gastro-intestinal, urine and sexual and other diseases. Most farmers spray two days in a week but sometimes apply pesticides every day and harvest vegetable soon after; more than three-fourths don't know about the waiting period before collection. Consequently, pesticide residues are detected in 67% of marketed vegetables which are above acceptable daily intake. Respondents strongly believe that vegetables.

**Karunamoorthi, K. et al. (2012)** found that lack of knowledge and training in pest management and information source was attributed to poor pesticide handling practices in Kenya and Ethiopia. For example, a significant number of Ethiopian farmers were reusing empty pesticide containers for various household purposes.

**Sarker, M.M.R.et. al. (2010)** observed that the empirical analysis on the determinants of arsenicosis patients perception about chronic arsenic poisoning and social and psychological implications of arsenicosis. In this study, cross-sectional data were collected from the matlab and hajiganj upzillas of chandpur district which are known to be highly contaminated with arsenic in their underground water. Respondents informed that arsenic poisoning causes a wide range of social and psychological problems. The study found that arsenicosis has negative social and

psychological implications which leads to social discrimination, uncertainty, injustice, human rights violation and threats to family and conjugal life, child development problems, mental despondency etc. Besides health effects, arsenicosis also generates problems in social and daily life and disturbs the marriage system. The results indicate that with the increase in schooling years and house-hold income of the patient, the probability of the respondents heightened perception about arsenicosis would be greater. Socio-economic status variables were related to the knowledge of the health problems of arsenic exposure.

**Damalas and Hashemi (2010)** evaluated the use of personal protective gears and risk perception of pesticide use among cotton growers in northern Greece. The findings suggested that younger farmers had a heightened perception of pesticide use hazards as compared to old farmers. Moreover, younger farmers were more positive toward the uptake of integrated pest management practices, even though adoption scores were low. Female workers perceived pesticide use to be risky to their health and thus employed precautionary behaviors.

**Sheheli Islam & Nazneen Afrin (2009)** observed that the problem statement Increased use of chemicals on vegetables started gaining momentum and continued its up-trend in Bangladesh. Wide spread use of pesticides in agriculture concern of residue accumulation, which may remain in food and agricultural environment causing concern of human health and risking ecological balance. Method used permitted the determination of these pesticides in brinjal at concentration level demanded by current legislation. Attention paid on excess use or abuse of pesticides by judicious application for safety of public health in Bangladesh.

The above reviewed literature indicated that very few study measure the determinants of pesticide use in brinjal production till to date both in home and abroad. But this study is of great importance in pesticide use and risk protective behaviour of the farmers. Considering the perspectives the present study has been undertaken to fill up the knowledge gap. It is expected that the present study will serve as the base for further studies in the determinants of pesticide use in brinjal production.

## CHAPTER 3

### METHODOLOGY

#### 3.1. Introduction

The study's methodology determines how well a statistical study turns out. Excellent research requires the application of suitable methodology. The nature, objectives, and goals of a study heavily influence the design of any survey. The availability of the needed materials, time, and resources is also a factor. There are numerous methods for gathering data for statistical study. Data collection for statistical analysis requires the analyst's judgment in selecting data collection strategies within the restrictions imposed by the work's resources. Statistical research typically involves gathering information from individual farmers.

The survey approach was used in this research for two key reasons:

- i. The survey allows for rapid study of a large number of instances and
- ii. The findings are more widely applicable.

The survey approach has a significant drawback in that the investigator must depend on the farmers' memories. To address this issue, researchers conducted several trips to the study region to gather data, and in the event of any omissions or contradictions, farmers were contacted again to get the missing and/or accurate information. The following stages were used in the survey design for this investigation.

### **3.2. Selection of the Study Area**

In any statistical study, choosing the study area is an important step. The site was suitable for the study's specific objective and the potential for farmer cooperation. Bogura district was purposefully chosen as the study area since it is one of the top producing areas for brinjal in Bangladesh. The upazila is the second lowest tier of administrative government in Bangladesh. The districts of Bangladesh are divided into sub-districts called upazilas (Sarker, M. M. R. 2010). Spatial variation of different household characteristics was found in the different studies in Bangladesh (Sarker, M. M. R. 2012). The study area was arbitrarily chosen from the upazilas of Shajahanpur and Shibgonj. To learn more about the pesticide use in brinjal production, and risk protective behaviour of farmers out in a few villages in those upazilas in the Bogura district. Some villages were chosen at random as the study region after the initial visit: Darigasi, Amtoli, Mohasthangor, and Shajahanpur. Most farmers in these communities used to cultivate high yielding brinjal types and sell their goods to various middlemen.

Shibganj and Shahjahanpur in the bogura district are the most major places where brinjal is grown widely, despite the fact that it is produced throughout Bangladesh.



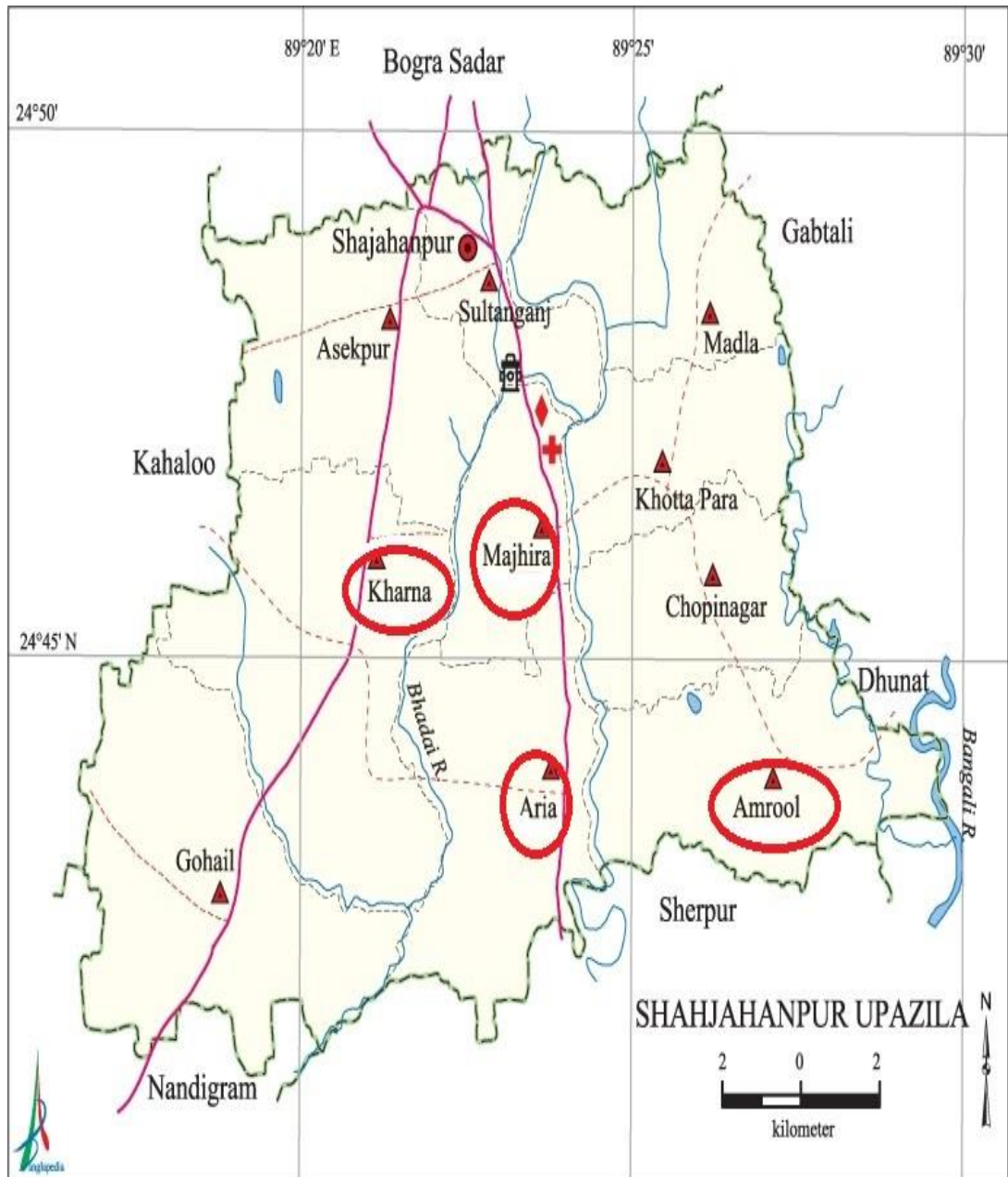
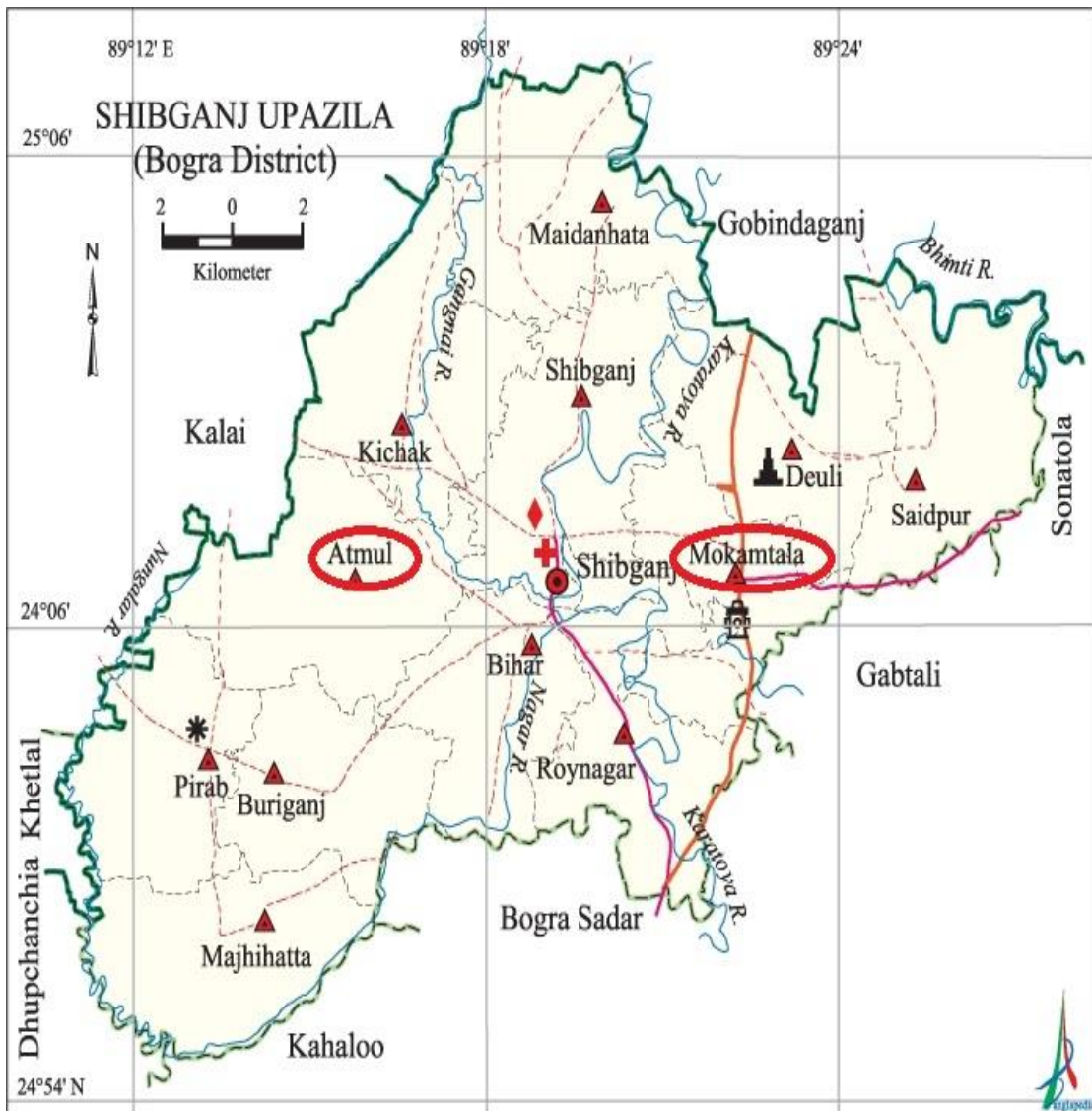


Figure 3.1: The study area showing villages Majhira, Aria, Kharna and Amrool.



Source: www.google.com

Figure 3.2: The study area showing the villages Atmul and Mokamtala.

The main economic sector in this area is agriculture. Some of the major crops farmed in the region are brinjal, tomato, maize, beans, wheat, carrots, peas, onions, and other fruits. Cattle, poultry, goats, and sheep are some of the livestock raised in the region. The research region is depicted on a map in Figures 3.1 and 3.2. Two upazilas in the bogura district, Shibganj and Shahjahanpur, were specifically chosen for the study because to the higher amount of brinjal output.

The following were the main decision elements for the research topic:

- a. The research region contained a big number of brinjal farmers.
- b. These villages had certain similar physical features for growing brinjal, such as topography, soil, and climatic conditions.
- c. In these communities, there was anticipated to be easy access and
- d. Adequate communication facilities, as well as a high level of cooperation from the respondents in order to acquire trustworthy data.

### **3.3. Sampling Technique and Sample Size**

Sample selection is an important part of survey work. It is generally not possible to make census survey. When choosing samples for a research, two criteria must be taken into account. The sample size should be as big as possible to ensure that the statistical analysis has enough degrees of freedom. Field research administration, data processing, and analysis, on the other hand, should be manageable within the constraints imposed by physical, human, and financial resources (Mannan 2001). However, because to the variability of the technological and human environments, it is required to sample a large number of people before drawing any conclusions. As a result, sampling is used to pick a subset of the population that is representative of the whole population (Rahman 2000). Due to time, money, and manpower constraints, it was not feasible to enroll all of the farmers in the research region. A total of 102 farmers were chosen at random. The current research used a purposive random sample strategy to save money and time while still achieving the study's main goals. A simple random sampling method was followed in selecting samples and collecting data from the respondents. From these two upazila, total 102 brinjal vegetable cultivating farmers were selected randomly for a face-to-face interview. 45 from Shibganj upazila and 57

from Shahjahanpur upazila. Thus, a total of 102 farmers were interviewed from the selected areas of the Bogura district.

### **3.4 Data Collection**

Any study's outcome depends on the correctness and dependability of the data collected, which is a crucial stage. Data collection techniques have a big impact on the accuracy and dependability of the data. The primary source of data for the study was a set of field-level primary data that was gathered from the chosen participants using interviewing protocols that had been thoroughly tested. Through direct interviews done by the researcher himself with the chosen respondents, field level primary data were obtained. Each chosen respondent was interviewed independently after creating the schedule. Each respondent received a brief introduction on the scope and goals of the study prior to the start of the actual interview. Then the inquiries were made in a straightforward order. The answers were immediately noted on the interview schedules. The researcher had to rely on the respondents' meager memories because, in general, the respondents at the grass roots level do not retain written records of their various activities. The interviewer used a systematic approach to questioning and provided explanations as needed. To ensure that the answers had been accurately recorded, the schedule was checked and validated after each interview. Data were gathered in local units to save time and make it easier to interpret. Data collecting is viewed as an important aspect of a survey since it has a substantial influence on the quality of the findings. Given its significance, the following precautions were taken throughout the development of the questionnaire as a data gathering tool:

### **3.4.1. Questionnaire Design**

A questionnaire is an effective tool for gathering data since it asks questions with multiple dimensions. Without a clear objective and purpose, a questionnaire would always overlook important subjects and make respondents and enumerators waste their time by answering pointless questions. To the best of our ability, we took into account each of these concerns when creating the survey questionnaire.

### **3.4.2. Pre-testing the questionnaire**

The questionnaire was pre-tested to determine the amount of time required to complete the interview, its reliability (i.e., if it caught the information sought), and its consistency (i.e., whether the information acquired was relevant to the survey's overall goal). The test also aimed to assess the logistics necessary for the survey's effective operation. Pre-testing was conducted in rural areas of Shibganj and Shahjahanpur within Bogura district in 2022 before to the survey to assure the optimal performance of the questionnaire in terms of data collecting, processing, and analyzing. As replies, the farmers wsa picked at random.

### **3.4.3. Finalization of the Questionnaire & Method of Data Collection**

The questionnaire was sent to my supervisor after addressed all of the adjustments based on the pre-test suggestions. My supervisor also made a significant contribution to the survey. With the permission, the questionnaire was finally completed. Following the questionnaire, a face-to face interview was conducted.

#### **3.4.4. Data editing and coding**

Other critical aspects of the survey included data editing and coding, both of which were required for data processing. Prior to data processing, it should be finished. In the instance of this survey, coding was done concurrently with questionnaire construction so that the enumerator could mark the correct responses quickly and precisely. The process of verifying and cleaning data that had previously been obtained from the field was referred to as data editing.

#### **3.5. Data processing**

Data processing included a number of procedures that were critical because they influenced survey findings based on the steps involved. The following actions were conducted during data processing.

1. Data input
2. Appending and merging files
3. Data validation (additional computer checking, editing, and imputation)
4. Final judgment on mistakes
5. Completion of data processing and production of data files
6. Final documentations and
7. Storage of all files

#### **3.6. Tabulation of data**

The information gathered was manually modified and coded. After then, all of the data was compiled and thoroughly examined. Furthermore, data analysis was performed using the applications Microsoft Excel and STATA and SPSS (16.0). It should be remembered that information was first gathered in local units.

### 3.7 Data Analysis

Linear regression coefficients of contributing determinants of pesticides use in Brinjal. The following is the model for this study:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \beta_8 X_{8i} + \epsilon_i$$

Where,

$Y_i$  = Amount of Pesticide use (ml/ha)

$\beta_0$  = Intercept

$\epsilon_i$  = Random Error

$\beta_1$ = Co-efficient of age	$X_1$ = Age
$\beta_2$ = Co-efficient of education	$X_2$ = Education
$\beta_3$ = Co-efficient of highest educational level of the family	$X_3$ = Highest education
$\beta_4$ = Co-efficient of experience	$X_4$ = Experience
$\beta_5$ = Co-efficient of family size	$X_5$ = Family size
$\beta_6$ = Co-efficient of members involve in agriculture	$X_6$ = Members involve in agriculture
$\beta_7$ = Co-efficient of plot size	$X_7$ = Plot size
$\beta_8$ = Co-efficient of NPK use	$X_8$ = NPK use

SPSS software was used to conduct the analysis. A probability of 5% (0.05) was utilized to reject the null hypothesis. Asterisks (\*) indicate the significance of coefficient values at the 0.05 level, while two asterisks (\*\*) indicate the significance of coefficient values at the 0.01 level.

### 3.8 Variables to be used

A variable is any property that may take on varied or distinct values in subsequent individual occurrences (Ezekiel and Fox, 1959).

**Table 3.1:** Description of Dependent and Independent Variables

Variable	Types	Measuring Technique
Amount of pesticide use	Continuous	Total amount of pesticide use by the farmers
Age	Continuous	1 for 1 years of old
Education	Discrete	1 for 1 years of schooling and 0 for not
Highest education level of family	Discrete	1 for 1 years of schooling
Experience	Continuous	1 for 1 years of cultivation
Family size	Discrete	1 for 1 family member
Members involve in agriculture	Discrete	1 for 1 member involve in agriculture
Plot size	Continuous	Total cultivated area by the farmers
NPK	Continuous	Amount NPK used by farmers



### **3.8.1 Dependent Variable**

The dependent variable is the variable that is assessed in an experiment or the variables that are altered during research. In this study the dependent variable is Amount of Pesticide use (ml/ha.) in brinjal production. So the Pesticide as used in this study refers to synthetic compounds used by farmers in crop protection from pests. Some examples of pesticides include insecticides, fungicides, and herbicides.

### **3.8.2 Independent Variables**

The independent variables are those that the researcher modifies in order to examine the dependent variables or variables that may take on changing values and thereby affect the values of other variables. The researcher chose eight qualities of the respondent as independent variables in this study. The independent variables for this study are- age, education, highest education level of family, experience, family size, members involve in agriculture, plot size and NPK.

### **3.8.3 Measurement of Dependent Variable**

Amount of pesticide use in brinjal production in ml/ha was the dependent variable for the study. The variable was measured on the basis of whether the farmers used the amount of pesticide in brinjal production.

### **3.8.4 Measurement of Independent Variables**

For the research to be carried out in accordance with its objectives, it was crucial to measure the independent variables. The independent variables were age, education level, highest education level of family, experience, family size, plot size, NPK used by farmer. Procedures for measuring these variables are described below:

#### **3.8.4.1 Age**

Age of the farmers was measured in terms of actual years from his birth to the time of interview, which was found on the basis of the verbal response of the rural people (Rashid, 2014). A score of one (1) was assigned for each year of one's age.

#### **3.8.4.2 Education**

Education was measured based on their response to engage in any Schooling. Those who was involved in any schooling was given a score and who was not involved in any schooling was given score 0.

#### **3.8.4.3 Highest Education Level of family**

Highest education level of the family was defined as an individual respondent's ability to read and write, or the formal education obtained up to secondary level in that family. Each year of education was granted a score. As a example if a responder passed the HSC he received a score of 12 and so on.

#### **3.8.4.4 Experience**

Experience of respondent was measured on the basis of the nature of their experience in brinjal production. A score of one (1) was assigned for each year of one's experience.

#### **3.8.4.5 Family Size**

Refers to an individual plus her/his dependents who have lived together for six months or more. The members are answerable to one person as the head and share a meal together.

#### **3.8.4.6 Members Involve in Agriculture**

The members or households whom are directly involve with agricultural production and marketing. Also contribute to the family income.

#### **3.8.4.7 Plot Size**

Plot size is the amount of space allocated for the agricultural production as a whole including amount of land use for rice, maize, potato, brinjal etc.

#### **3.8.4.8 NPK**

Fertilizer are used in production of brinjal where NPK refers the amount use of nitrogen, phosphorus, potassium.

Here,

**N** = Nitrogen

**P** = Phosphorus

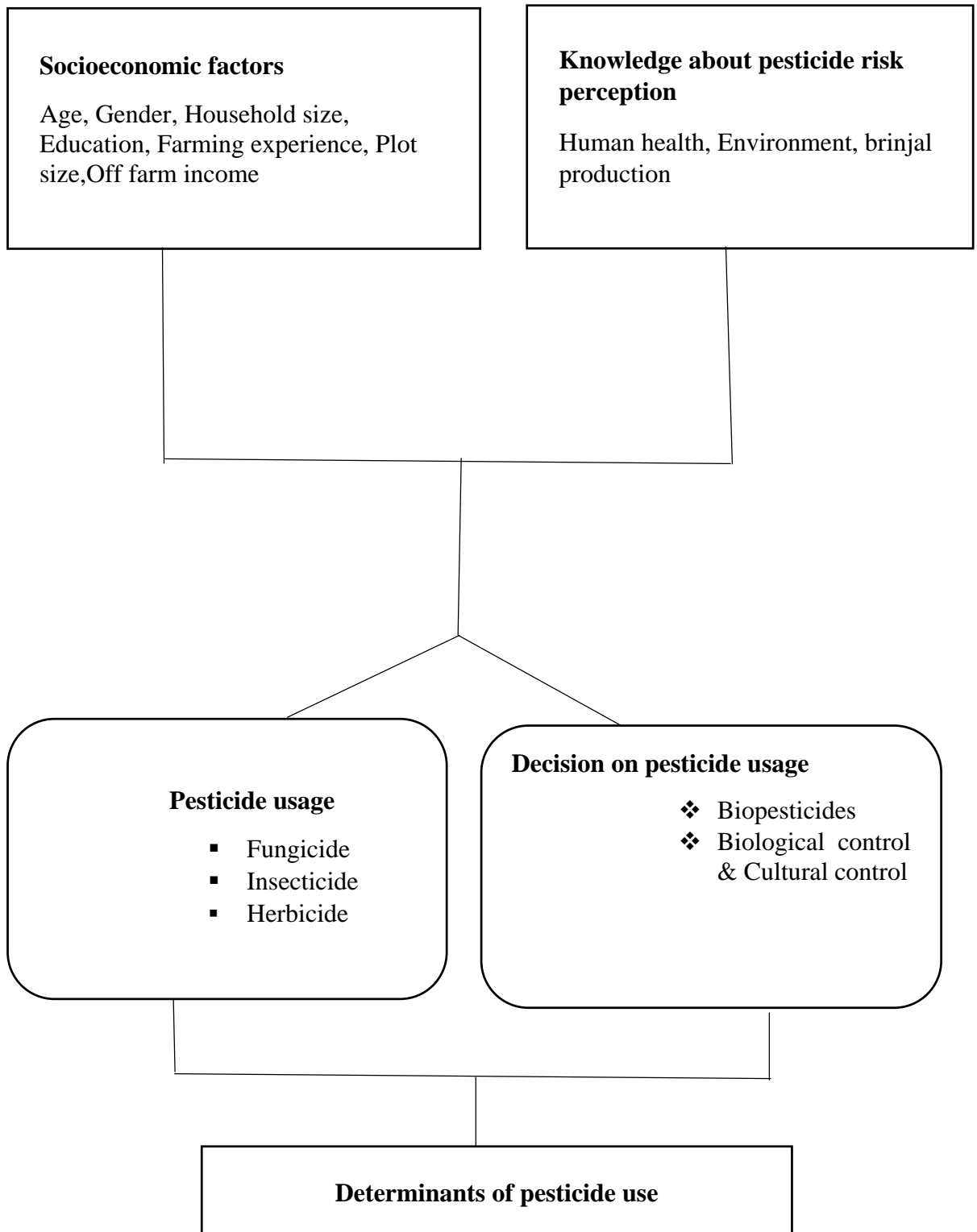
**K** = Potassium

#### **3.8.4.9 Knowledge About Pesticide Toxicity**

Knowledge about pesticide toxicity refers to responses made by a brinjal farmer to safeguard himself or herself against pesticide-related hazards. In this study refers to farmer`s attitude towards risk associated with pesticide use.

### **3.9 Conceptual Framework**

From the figure (3.3) farmers encounter various factors which influence their decision making process aimed at maximizing their utility. Socioeconomic attributes such as level of education, age, gender, family size, farming experience, plot size and risk protective behaviour affect farmer`s decision. Risk protective behaviour and socioeconomic factors have a great influence on farmer decision on the level of pesticide usage. Furthermore, socioeconomic attributes and risk protective behaviour affect farmers decision on the intensity of pesticide use. Figure 3.3 indicates a representation of factors that can influence farmers decision on the intensity of determinants of pesticide usage.



**Figure 3.3:** Conceptual framework on determinants of pesticide usage.

## **CHAPTER 4**

### **RESULTS AND DISCUSSION**

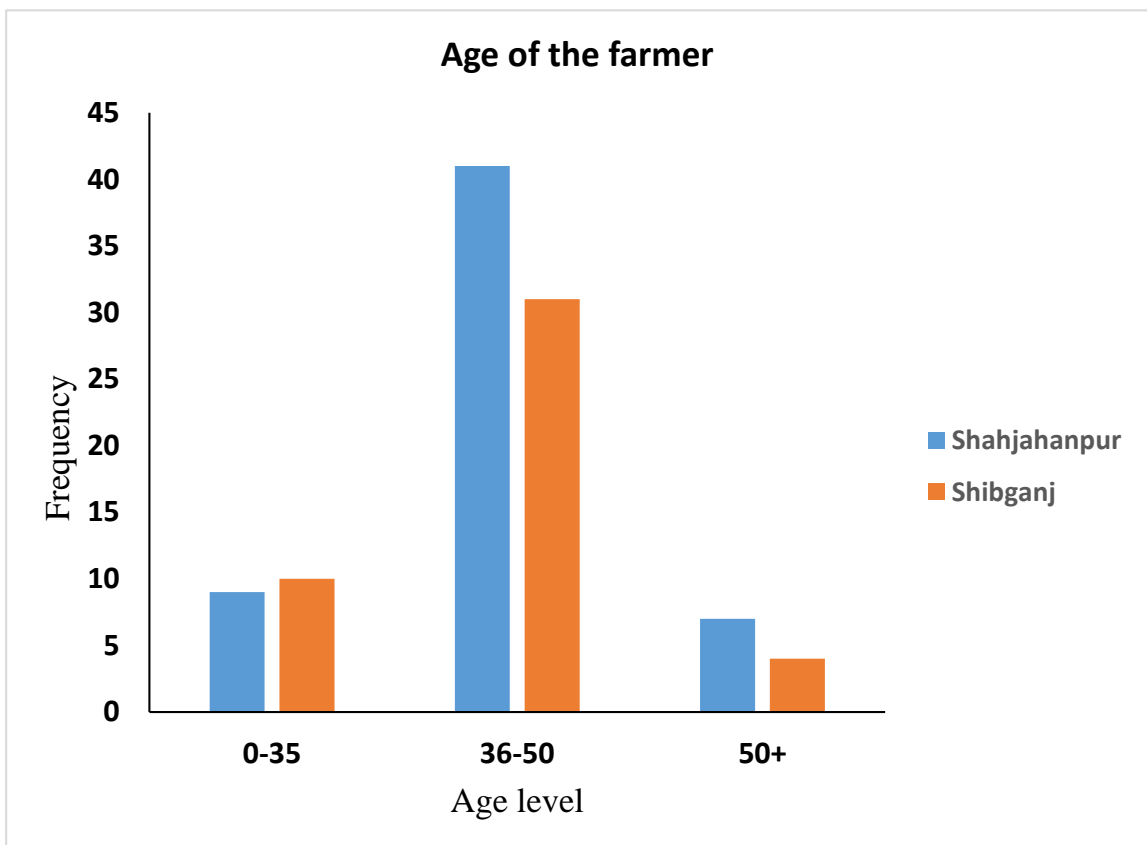
This Chapter presents a conclusive and extensive explanation of the scientific research study's conclusions. This part provides the findings and discussion of the study. Descriptive statistics of brinjal farmers household characteristics and precautionary risk behaviour in pesticide use were presented in tables. This Chapter is divided into three subsections. The first segment examined social profile of the respondents. The second portion discussed the determinants of pesticide use in the study area. Finally, the final segment explored the factors that influence determinants of pesticide use in brinjal production.

#### **4.1 Socio-economic Characteristics of the Respondent**

Decision making behavior of an individual is determined to a greater extent by his socio-economic characteristics. It is therefore, considered to study some of the socioeconomic characteristics because behavior of farmer pesticides use depends on their various socioeconomic characteristics. An attempt has been made here to investigate into some important as well as relevant socio-economic characteristics of the sampled borrowers. Their age, education, highest education of the family, family size etc are different socioeconomic characteristics of these farmers.

### 4.1.1 Age

Figure (4.1) showed that samples (102) were taken from two upazilas called Shibganj (45) and Shahjahanpur (57) respectively to reflect the whole population. In Shibganj upazila contains 10 of samples were up to 35 years old, 31 were 36-50 years old, and 4 were above 50 years old. In shahjahanpur upazila, 9 of samples were up to 35 years old, 41 were 36-50 years old, and 7 were above 50 years old. (Figure 4.1) and overall 19% were up to 35 years old, 72% were 36-50 years old and 11% were above 50 years old in the study area. In each upazila, the majority of persons were between the ages of 36 and 50.

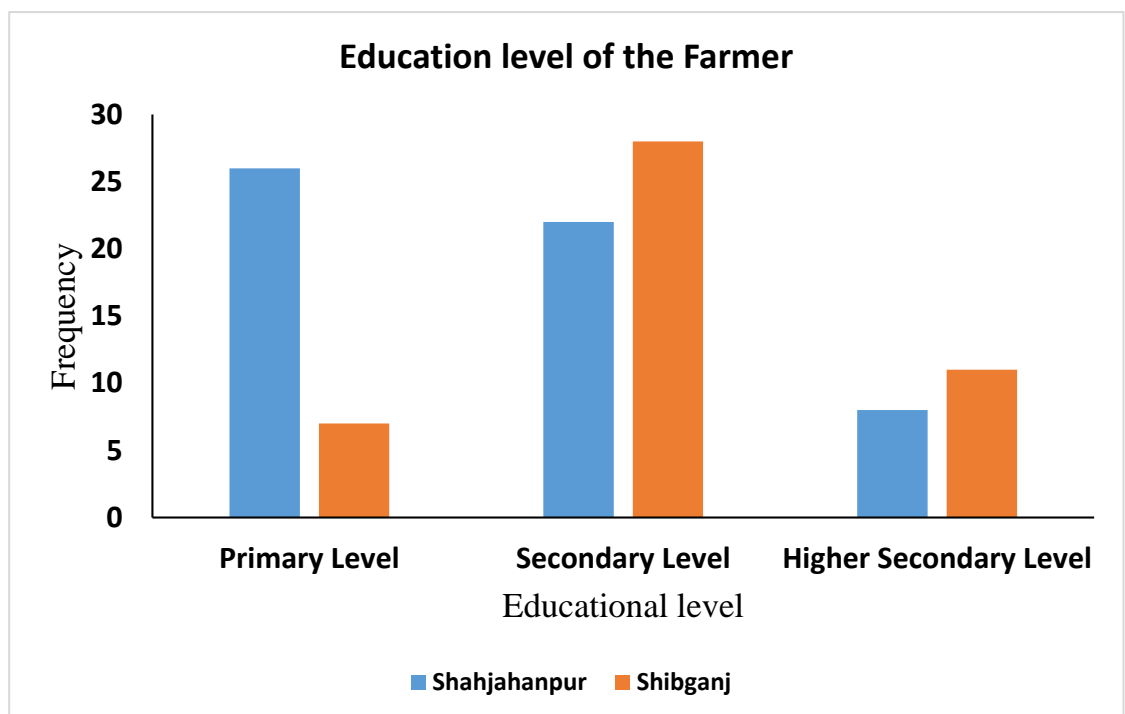


Source: Field survey, 2022

**Figure 4.1:** Age of the respondent by Study Area

#### 4.1.2 Education

According to figure (4.2), around 7 of individuals have a primary level of education, approximately 28 have a secondary level of education, and 11 have a higher secondary level of education in Shibganj upazila. Around 26 of individuals have a primary level of education, 22 have a secondary level of education, and 8 have a higher secondary level of education in Shahjahanpur upazila. And overall, we can see from this number that 33% have a primary level of education, 50% have a secondary level of education and 20% have a higher secondary level of education in the study area. Finally, the majority of individuals in each upazila have a secondary education. Sarker *et. al.* (2010) reported that out of 100 farmers 9% are illiterate, 30% are the primary level passed, 42% are high school passed which is the maximum among them and 19% are graduates.



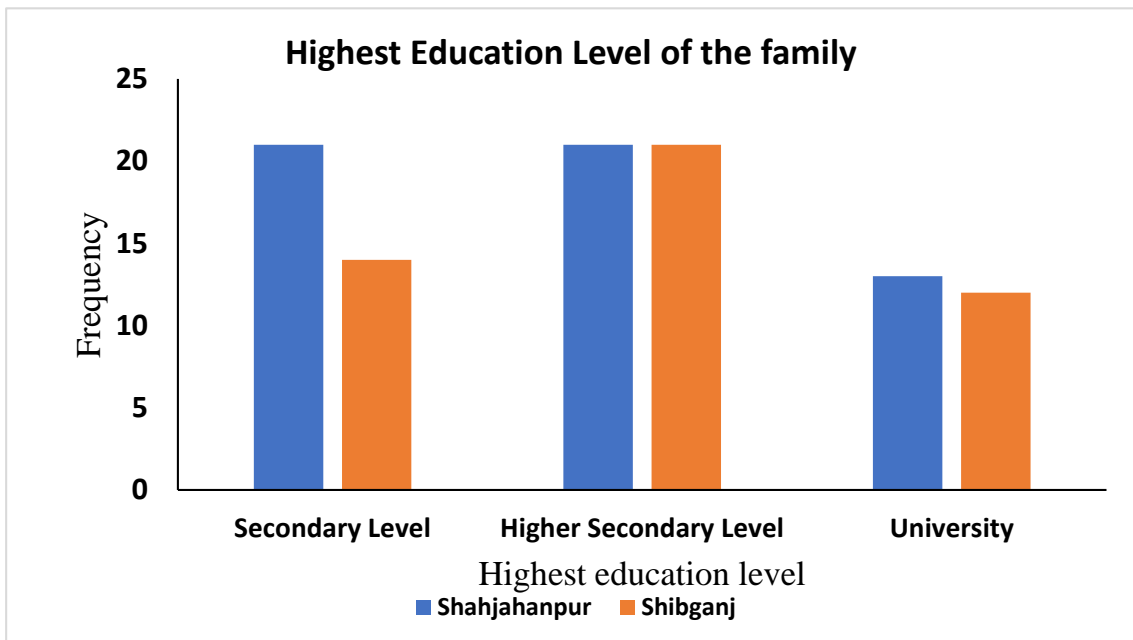
Source: Field survey, 2022

**Figure 4.2:** Education Level of the Farmer by Study Area



### 4.1.3 Highest Education Level of the Family

Figure (4.3) showed that, in Shibganj upazila, about 14 were found the family's highest education level to have secondary level, about 21 were found the family's highest education level to have higher secondary level and 12 people were found the family's highest education level to have university level. In Shahjahanpur upazila, about 13 were found the family's highest education level to have secondary level, about 21 were found the family's highest education level to have higher secondary level and 8 people were found the family's highest education level to have university level. Sarker M. M. R. (2011) first used highest education of the family members as a socioeconomic character and found significant. And overall, we can see from this number that the family's highest education level 35% have a secondary level, 41% have a higher secondary level and 25% have a university level in the study area. In this figure, we saw most of the family's highest education level is secondary level in every upazila.

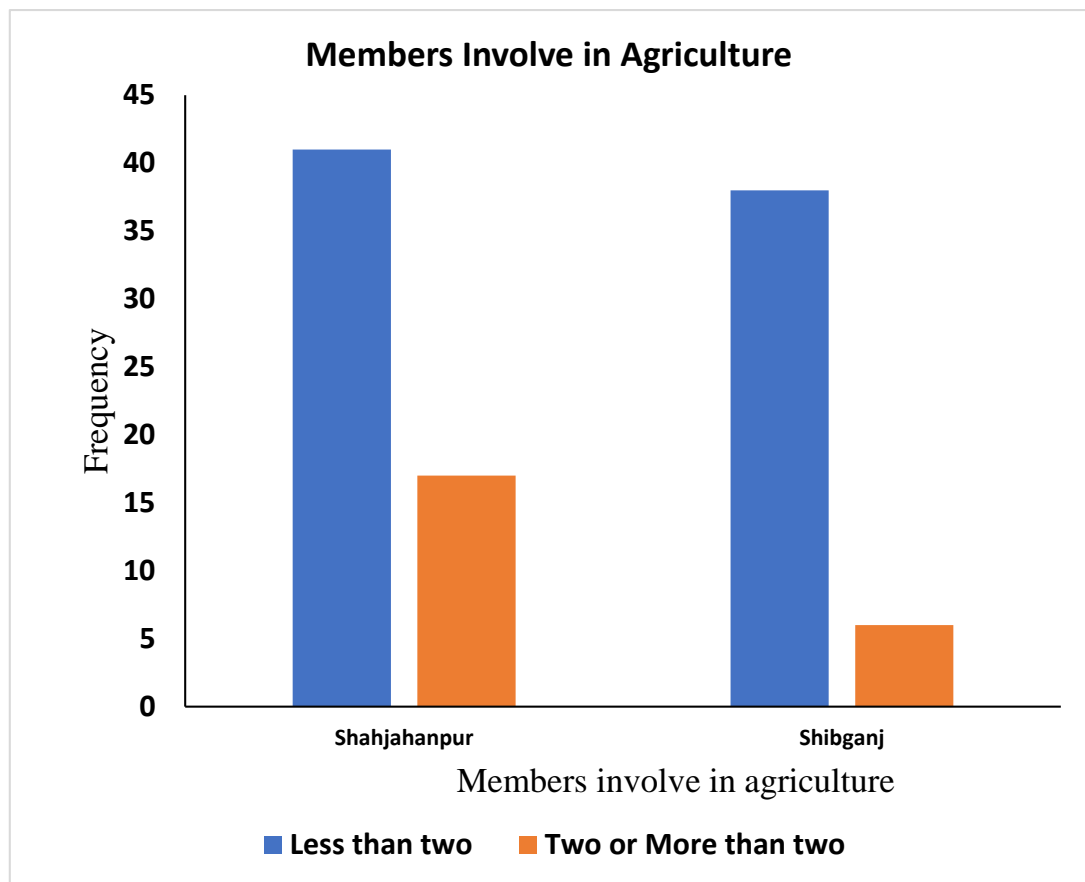


Source: Field survey, 2022

**Figure 4.3:** Highest education level of the family by study Area

#### 4.1.4 Members Involve in Agriculture

Samples were taken from two upazilas called Shibganj and Shahjahanpur 45 and 57 respectively to reflect the whole population. As shown in the diagram, Shahjahanpur has a higher percentage of its population engaged in agriculture.

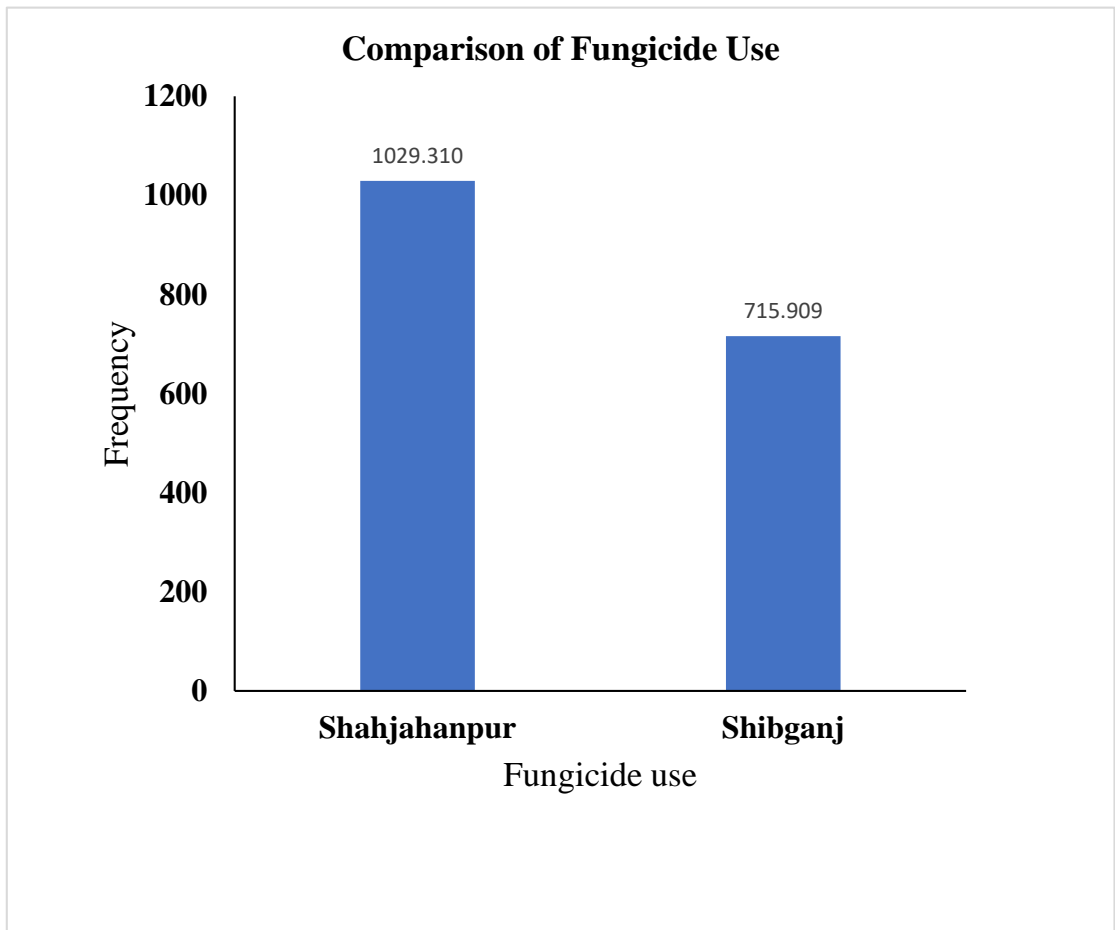


Source: Field survey, 2022

**Figure 4.4:** Members involve in agriculture by study area

#### 4.1.5 Comparison of Fungicide Use in between Shahjahanpu and Shibganj

In that figure (4.5), we distinguish between the application of fungicide in the two upazilla known as Shahjahanpur and Shibganj. The average amount of fungicide used by farmers in Shibganj is 715.909 ml, but it is 1029.310 ml for farmers in Shahjahanpur. So that we may say that farmers in Shibganj use less fungicide than farmers in Shahjahanpur.

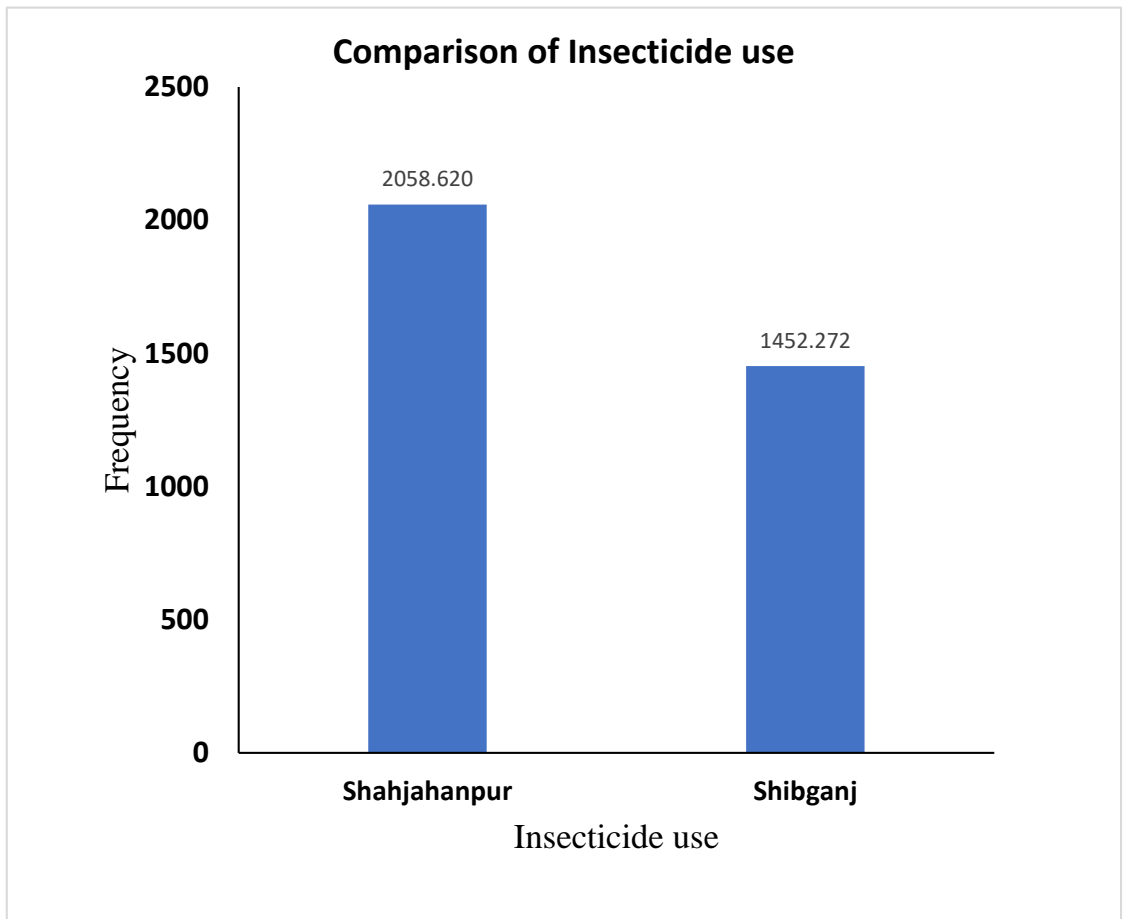


Source: Field survey, 2022

**Figure 4.5:** Comparison of fungicide use in between Shahjahanpur and Shibganj

#### 4.1.6 Comparison of Insecticide Use in between Shahjahanpu and Shibganj

According to figure (4.6) we differentiate the use of insecticide in two upazilla called shahjahanpur and Shibgaj. By following the average use of insecticide in Shahjahanpur farmers is 2058.62 ml. and the average use of insecticide in Shibganj farmers is 1452.272 ml. So that we can the farmers of Shahjahanpur use more insecticide than farmers of Shibganj.

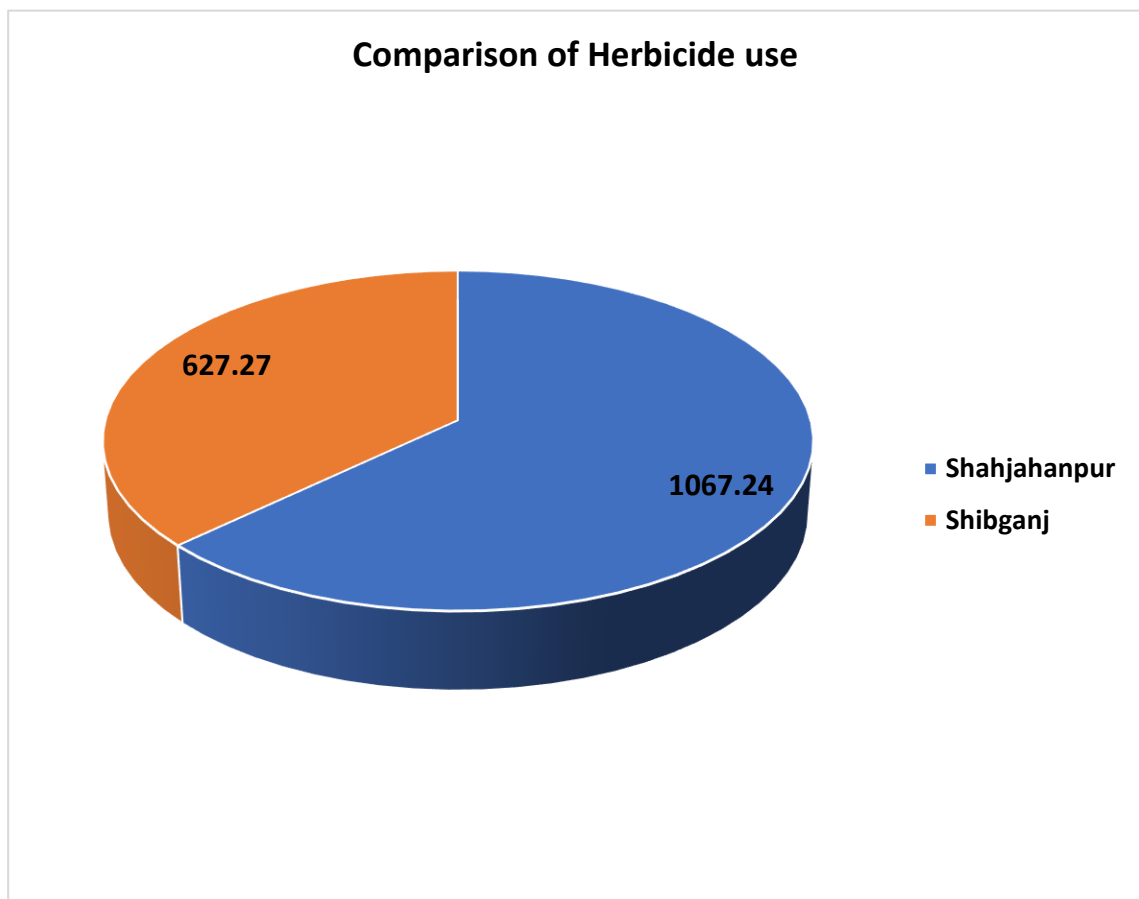


Source: Field survey, 2022

**Figure 4.6:** Comparison of insecticide use in between Shahjahanpu and Shibganj

#### 4.1.7 Comparison of Herbicide Use in between Shahjahanpu and Shibganj

In that figure (4.7) we differentiate the use of herbicide in two upazilla called shahjahanpur and Shibgaj. By following the average use of herbicide in Shahjahanpur farmers is 1067.24 ml. and the average use of herbicide in Shibganj farmers is 627.27 ml. So that we can say the farmers of Shahjahanpur use more herbicide than farmers of Shibganj.



Source: Field survey, 2022

**Figure 4.7:** Comparison of herbicide use in between Shahjahanpu and Shibganj

## 4.2 Determinants of Pesticide Use in Brinjal Production

Multiple linear regression analysis was performed to determinants of pesticide use in brinjal production, as shown in Table 4.1.

**Table 4.1:** Multiple linear regression coefficients of contributing determinants related to the determinants of pesticide use in brinjal.

Dependent variable	Independent variable	Parameter	Coefficient	P-value
Amount of pesticide use (ml/ha.)	Constant	$\beta_0$	-2508.1	0.000
	Age years ( $X_1$ )	$\beta_1$	-7.557	0.580
	Education ( $X_2$ )	$\beta_2$	-27.80	0.134
	Highest Education ( $X_3$ )	$\beta_3$	-85.17*	0.013
	Experience ( $X_4$ )	$\beta_4$	- 47.49*	0.042
	Family Size ( $X_5$ )	$\beta_5$	136.5*	0.018
	Members involves in Agriculture ( $X_6$ )	$\beta_6$	114.0	0.447
	Plot Size (ha.) ( $X_7$ )	$\beta_7$	29564.2**	0.000
	NPK (kg/ha) ( $X_8$ )	$\beta_8$	1.947**	0.000

\*\*Indicates 1% level of significance

\* Indicates statistical significance at 5%

$R^2 = 0.7819$

N=102

The study tried to investigate the determinants of pesticide use in brinjal production and their impact. In this model, the descriptive factors were age, education, highest education level of family, experience, family size, members involve in agriculture, plot size, NPK.

**Age years ( $X_1$ ):** The estimated regression coefficients for age of the respondent was found to be negative. The coefficient of the age was -7.557 and statistically insignificant. so, further illustration is avoided.

**Education ( $X_2$ ):** The estimated regression coefficients for education of the respondent was found to be negative. The coefficient of the education was 27.80 and statistically insignificant. so, further illustration is avoided.

**Highest Education ( $X_3$ ):** The estimated regression coefficients for highest education of the respondent was -85.17 and statistically significant at 5% level of confidence. It implies that keeping other things constant, if highest education level increased by 1 year then amount of pesticide use decreased by 85.17 (ml/ha.) in brinjal production.

**Experience ( $X_4$ ):** The estimated regression coefficients for experience of the respondent was -47.49 and statistically significant at 5% level of confidence. It indicates that keeping other things constant, if experience level increased by 1 year then amount of pesticide use decreased by -47.49 (ml/ha.) in brinjal production.

**Family Size ( $X_5$ ):** The estimated regression coefficients for family size of the respondent was 136.5 and statistically significant at 5% level of confidence. It implies that keeping other things constant, if family size increased by one- member then amount of pesticide use increased by 136.5 (ml/ha.) in brinjal production.

**Members Involves in Agriculture ( $X_6$ ):** The estimated regression coefficients for members involves in agriculture of the respondent was found to be positive. The coefficient of the members involves in agriculture was 114.0 and statistically insignificant. so, further illustration is avoided.

**Plot Size (ha.) (X<sub>7</sub>):** The estimated regression coefficients for plot size of the respondent was 29564.2 and statistically significant at 1% level of confidence. It implies that keeping other things constant, if plot size increased by 1 unit then amount of pesticide use increased by 29564.2 (ml/ha.) in brinjal production.

**NPK (kg/ha) (X<sub>8</sub>):** The estimated regression coefficients for NPK use of the respondent was 1.947 and statistically significant at 1% level of confidence. It indicates that keeping other things constant, if NPK use increased by 1 unit then amount of pesticide use increased by 1.947 (ml/ha.) in brinjal production.

**Value of R<sup>2</sup>:** Regression analysis shows that the independent variables explained 78.19% ( $R^2 = 0.7819$ ) of the total variation of the respondents amount of pesticide use in brinjal production.

### **4.3 Risk Protective Behaviour in Brinjal Production**

#### **4.3.1 .Wearing mask when spraying pesticide**

Farmers of brinjal were observed using masks while applying pesticides, and the findings are displayed in the table below. Due to their low levels of education, expensive costs, and lack of availability, the majority of farmers (40) did not utilize masks. Table 4.2 compares the use of masks by farmers in Shahjahanpur and Shibganj. Farmers utilize masks in Shibganj (69.56%) and Shahjahanpur (53.57%).



### **4.3.2 Wearing gloves when spraying pesticide**

When pesticides were sprayed, the actions of brinjal farmers were observed, and the results are displayed in Table 4.2 Findings. Due to their low levels of education, expensive costs, and lack of availability, the majority of farmers (96) did not utilize gloves. The table 4.2 compares the use of gloves by farmers in Shibganj and Shahjahanpur. Farmers utilize gloves in Shibganj (6.52%) and Shahjahanpur (5.35%).

### **4.3.3 Changing cloths after spraying pesticide**

The results of the observation of brinjal farmers during pesticide applications are displayed in Table Findings. Due to their low levels of education and lack of awareness, the majority of farmers (81) did not change their clothes. Table 4.2 compares how farmers in Shibganj and Shahjahanpur change their clothes. Farmers change their clothes in Shibganj (23.91%) and Shahjahanpur (17.85%).

**Table 4.2:** Risk protective behaviour in Brinjal production by the study area

<b>Determinants of Risk protective behaviour</b>	<b>Shahjahanpur</b>				<b>Shibganj</b>			
	N = 56 (total farmer)				N = 46 (total farmer)			
	Total		Percentage		Total		Percentage	
	yes	no	yes	no	yes	no	yes	no
1.Wearing mask when spraying pesticide	30	26	53.57	46.43	32	14	69.56	30.44
	Total		No	40	Total		Yes	62
2. Wearing gloves when spraying pesticide	3	53	5.35	94.65	3	43	6.52	93.48
	Total		No	96	Total		Yes	6
3.Changing cloths after spraying pesticide	10	46	17.85	82.15	11	35	23.91	76.09
	Total		No	81	Total		Yes	21
4.Showering immediately after spraying pesticide	7	49	12.5	87.5	3	43	6.52	93.48
	Total		No	92	Total		Yes	10
5.Never discarding empty pesticide containers in the field	27	29	48.21	51.79	26	20	56.52	43.48
	Total		No	49	Total		Yes	53
6.Carefully reading the instruction on the pesticide labels	30	26	53.57	46.43	11	35	23.91	76.09
	Total		No	61	Total		Yes	41
7.Knowledge about pesticide toxicity	38	18	67.85	32.15	29	17	63.04	36.96
	Total		No	35	Total		Yes	67
8. Knowledge about pesticide effect on the body	52	4	92.85	7.15	43	3	93.47	6.53
	Total		No	7	Total		Yes	95

Source: Field Survey 2022

#### **4.3.4 Showering immediately after spraying pesticide**

The results of the observation of brinjal farmers during the application of pesticides are displayed in Table 4.2 Findings. Due to their low levels of education, high costs, and lack of access, the majority of farmers (92) did not shower immediately. The table compares how farmers in Shibganj and Shahjahanpur show their showering activity. Farmers shower immediately after using pesticide at Shibganj (6.52%) and Shahjahanpur (12.5%).

#### **4.3.5 Never discarding empty pesticide containers in the field**

A small number of farmers were unsafely discarding rinses and empty containers. As an illustration 4.2 some farmers said they reused empty containers, while maximum said they washed knapsack sprayers in rivers or streams. This might have increased the likelihood of experiencing illness as well as contributed to water pollution. From immemorial times till now, people have been concerned about protecting the environment and minimizing the ways of environmental pollution. Air, water and land are non-renewable resources that are the subjects of pollution (Mahmuda Akter et al.). Contextualizing the Impacts of COVID-19 in Bangladesh: An Evidence from Social and Environmental perspective. By this table we can see that 48.21% Shahjahanpur and 56.92% of Shibganj farmers never discarding empty pesticide containers in the field.

#### **4.3.6 Carefully reading the instruction on the pesticide labels**

The actions of brinjal farmers were observed as they prepared pesticides, and the results are shown in Table 4.2 Findings. The majority of the farmers (61) did not read and adhere to the pesticide product label's instructions, which may have led to pesticide misuse. The intricacy of the

instruction language, the small print size, and the inability to read and comprehend the instructions possibly as a result of low education levels could all be blamed for this. According to reports, a sizable portion of farmers in Pakistan (73%) apparently neglected to read the information on the pesticide product label (Damalas and Khan, 2016).

#### **4.3.7 Knowledge about pesticide toxicity**

The results of the observation of brinjal farmers during the application of pesticides are displayed in Table 4.2 Findings. The majority of farmers (34.31%) did not know about pesticide toxicity. The table 4.2 compares the knowledge on pesticide toxicity among farmers in Shibganj and Shahjahanpur. The farmers knowledge about pesticide toxicity in Shibganj (63.04%) and Shahjahanpur (67.85%). According to Sarker, M.M.R. *et. al.* (2012) the average arsenic concentration level of a district varied from 0 to 366 µg/L. The percentage of awareness varied from 98.50 to 30.80 percent.

#### **4.3.8 Knowledge about pesticide effect on the body**

The findings from watching brinjal growers when pesticides were administered are shown in Table 4.2 Findings. 95 of farmers were aware of how pesticides affected the human body. The farming practices in Shibganj and Shahjahanpur are contrasted in the table. Farmers in Shahjahanpur (7.5%) and Shibganj (6.53%) are aware of the effects of pesticides on the human body.

## **CHAPTER 5**

### **SUMMARY, CONCLUSIONS AND RECOMMENDATIONS**

This chapter presents the summary of findings, conclusions and recommendations of the study.

#### **5.1 Summary of Findings**

The major findings of the study are summarized below:

##### **5.1.1 Social profile of the respondents**

###### **Age**

The highest portion (72%) of the farmers were 36-50 years old where 19% were up to 35 years old and 11% year above 50 years old.

###### **Education**

The majority of respondents (50%) have a secondary education, followed by 33% with a primary education and 20% with a higher secondary education.

###### **Highest Education level of the family**

The highest portion (35%) of the respondent's family's highest education level have a secondary level where 41% have a higher secondary level and 25% have a university level

###### **Members involve in Agriculture**

Shahjahanpur has the greater percentage of members involve in agriculture where Shahjahanpur contains the 57% and Shibganj contains the 45%.

### **Comparison of Fungicide Use**

The average amount of fungicide used by farmers in Shibganj is 715.909 ml, whereas the average amount used by farmers in Shahjahanpur is 1029.310 ml. In order to say that Shahjahanpur farmers use more fungicide than Shibganj farmers.

### **Comparison of Insecticide Use**

Farmers in Shibganj use 1452.272 ml of insecticide on average each crop, compared to 2058.620 ml in Shahjahanpur. In order for us to claim that Shibganj farmers use less insecticide than Shahjahanpurj farmers.

### **Comparison of Herbicide Use**

Shahjahanpur farmers use 1067.24 ml of herbicide on average, while Shibganj farmers use 627.27 ml on average. In order to claim that farmers in Shibganj use less herbicide than those in Shahjahanpur.

### **Mortgage:**

The land that is taken in return for funds provided by the mortgagee to the land owner for a certain period of time with the understanding that the land will be freed following the owner's repayment of the funds to the mortgagee is referred to as the land under mortgage.

### **Lease:**

Land is said to be under lease when it is obtained by the cultivator from the owner in exchange for a set sum of money for a year or for any other length of time for the purpose of cultivating a crop. According to this standard, land will be automatically removed from the cultivator's occupation after a predetermined amount of time.

### **5.1.2 2 Risk Protective Behaviour in Brinjal Production**

All of the farmers in the study area have faced the major health issue of using mask, gloves, changing cloth after spraying pesticide. showering immediately after spraying pesticide. Most of them have a little knowledge on pesticide toxicity (67.75%), effect on body (88.25%).

## **5.2 Conclusions**

The following conclusions were based on the four objectives;

- 1.** The determinants of pesticide use in brinjal were age, education, highest education level of the family, experience, use of NPK, use of pesticide, fungicide and herbicide and risk protective behaviour.
- 2.** Majority of the farmers were overusing insecticide, fungicide while underusing herbicide during pest control. The findings further showed that the likelihood of higher level of pesticide usage was positively influenced by plot size, amount of NPK, highest education level of family, experience, family size used by the farmer. On the other hand age, education, and members involve in agriculture not influenced the level of pesticide usage. This observation offers a wide range of interventions to promote safe pesticide use.
- 3.** Safety behavior in pesticide use were limited particularly in the use of personal protective equipment such as mask, hand gloves and synthetic cloths. Factors such as the high cost of purchase and discomfort were associated with limited use of protective measures.
- 4.** The determinants of comparison among the use of fungicide, insecticide and herbicide in brinjal production were age, family size, educational level, members involve in agriculture.

### **5.3 Recommendations**

On the basis of observation and conclusions drawn from the findings of the study following Recommendation are made.

1. The DAE and other related organization should take necessary steps regarding give knowledge about determinants of pesticide use among the farmers.
2. Related officials should organize more training about using of pesticide in route level. So, that every farmer can get information.
3. Use of NPK fertilizer had significant positive contribution to the determinants of pesticide use in brinjal. Therefore, it may be recommended that, which fields needed more NPK its also need more pesticide.
4. To the pesticide companies and the government sensitization of the dangers of pesticide misuse on human health and environment should be carried out through farmer groups, pesticide dealers with other relevant stakeholders to facilitate change in behavior, attitude, and practices and promote safety behaviours in pesticide use. For instance, the use of experience groups with a mentor could be influential in sharing experiences among farmers. Moreover, farmers should be encouraged to join farmer groups and other social networks to facilitate the exchange of new ideas, information, increase their bargaining power, access vital production inputs and protective measures.
5. To the implementation of a farmer to farmer extension provision services with a strong focus on promoting safe pesticide use and use of alternative crop protection methods to misuse of pesticide use behaviour in the fields.



Finally, the study did not assess the determinants of pesticide-related disease incidences experienced by farmers which could provide numerous interventions to minimize pesticide poisoning and to improve human health. The study look at consumers risk protective behaviour of chemical pesticide use in brinjal production related to food security and health concern.

## REFERENCES

- Ahmed, M. S., Sardar, M. M. A., Ahmad, M., & Kabir, K. H. (2018). Qualitative analysis of insecticide residue in brinjal samples collected from different regions of Bangladesh
- Alam, SN. Insect pest management for quality horticultural crop production in Bangladesh. *HORTEX NEWSLETTER*, 2011, 11(2)
- Bangladesh Bureau of Statistics (BBS), 2020. Gross domestic product of Bangladesh at current prices, 2015–16 to 2018–19. Bangladesh Bureau of Statistics, Ministry of Planning, Government of Bangladesh, Dhaka.
- Bannwarth, M. A., Grovermann, C., Schreinemachers, P., Ingwersen, J., Lamers, M., Berger, T., & Streck, T. (2016). Non-hazardous pesticide concentrations in surface waters: An integrated approach simulating application thresholds and resulting farm income effects. *Journal of environmental management*, 165, 298-312.
- Barau, A. A., Naznin, M., Haque, M. E., Zakaria, M., & Afrad, M. S. L. (2020). Extent of adoption and knowledge on pesticide use in vegetable production in Narsingdi district, Bangladesh.
- Begum, S., Sultana, S., Ahmed, M. S., & Azad, M. A. K. (2019). Pesticide Residue Analysis from Winter Vegetables Collected from Six Markets of Rajshahi Bangladesh. *Journal of Environmental Science and Natural Resources*, 12(1-2), 43-50.

- Bhandari, L. R. (2019). Increasing Trend of Pesticides' Use in Vegetable Farming and Its Impact for Human Health: A case study of Bharatpur Metropolitan City, Nepal. *Nepal Journal of Multidisciplinary Research*, 2(3), 50-67.
- C. Antonini *et al.*, Productivity and environmental costs from intensification of farming. A panel data analysis across EU regions. *Journal of clean production* (2017)
- Calliera, M., Berta, F., Galassi, T., Mazzini, F., Rossi, R., Bassi, R., Meriggi, P., Bernard, A., Marchis, A., Di Guardo, A., Capri, E., 2013. Enhance knowledge on sustainable use of plant protection products within the framework of the Sustainable Use Directive. *Pest Manag. Sci.* 69, 883–888. <https://doi.org/10.1002/ps.3579>.
- Chowdhury, M. G. F., Rahman, M. A., Miaruddin, M., Khan, M. H. H., & Rahman, M. M. (2019). Assessment of pesticides and ripening chemicals used in selected vegetables at different locations of Bangladesh. *Bangladesh Journal of Agricultural Research*, 44(2), 261-279.
- Damalas, C.A., Eleftherohorinos, I.G., 2011. Pesticide exposure, safety issues, and risk assessment indicators. *Int. J. Environ. Res.*
- Damalas, C. A., & Hashemi, S. M. (2010). Pesticide risk perception and use of personal protective equipment among young and old cotton growers in northern Greece. *Agrociencia*, 44(3), 363-371.
- Dasgupta, S., Meisner, C., Haq, M., 2005. Health effects and pesticide perception as determinants of pesticide use: evidence from Bangladesh. *World Bank Policy Research Working Paper*. p. 3776  
November 2005.

[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=872759](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=872759).

Elshobary, M. E., Abo-Shady, A. M., Khairy, H. M., Essa, D., Zabed, H. M., Qi, X., & Abomohra, A. E. F. (2019). Influence of nutrient supplementation and starvation conditions on the biomass and lipid productivities of *Micractinium reisseri* grown in wastewater for biodiesel production. *Journal of environmental management*, 250, 109529.

EU (European Union). 2021. The use of pesticides in developing countries and their impact on health and the right to food. <https://www.europarl.europa.eu/cmsdata/219887/Pesticides%20health%20and%20food.pdf>

Ezekiel, M., & Fox, K. A. (1959). *Methods of correlation and regression analysis: linear and curvilinear*.

FAO (Food and Agriculture Organization). 2021. Pest and Pesticide Management. Online publication. <http://www.fao.org/pest-and-pesticide-management/about/understanding-the-context/en/>

Hashemi, S. M., & Damalas, C. A. (2010). Farmers' perceptions of pesticide efficacy: reflections on the importance of pest management practices adoption. *Journal of Sustainable Agriculture*, 35(1), 69-85

Ibrahim, S. A. (2016). *An Assessment of Pesticide Use, Contamination and Impact on the Environment and the Health of People in Sierra Leone*. Kinuthia, C. W. (2019). *Determinants of pesticide use and uptake of alternative pest control methods among small scale tomato farmers in Nakuru County, Kenya* .

- Islam, S.M., Shah, A.M., Uddin, N.M., Zabir, A.A., Islam, S.M., Haque, A.K., Islam, S.M.A., Hossain, S.A.A.M., 2016. Farm level pesticides use in Patuakhali and Comilla region of Bangladesh and associated health risk. *J. Health and Environ. Res.* 2, 20–26. <https://doi.org/10.11648/j.jher.20160204.11>.
- Islam, M. S., Alam, M. S., Uddin, M. N., Zabir, A. A., Islam, M. S., Haque, K. A., ... & Hossain, S. A. A. M. (2016). Farm level pesticides use in Patuakhali and Comilla region of Bangladesh and associated health risk. *Journal of Health and Environmental Research*, 2(4), 20-26.
- Karunamoorthi, K., Mohammed, M., & Wassie, F. (2012). Knowledge and practices of farmers with reference to pesticide management: implications on human health. *Archives of Environmental & Occupational Health*, 67(2), 109-116.
- Khan, M. (2016). Farmers' attitudes towards pesticide labels: implications for personal and environmental safety. *International Journal of Pest Management*, 62(4), 319-325.
- Kinuthia, C. W. (2019). *Determinants of pesticide use and uptake of alternative pest control methods among small scale tomato farmers in Nakuru County, Kenya* (Doctoral dissertation, Egerton University).
- Mannan, S.A. (2001). An analysis of agro-economic potentials of jute production in Bangladesh, Ph. D. thesis, Bangladesh Agricultural University. Mymensingh.
- Marchis, A., Di Guardo, A., Capri, E., 2013. Enhance knowledge on sustainable use of plant protection products within the framework of the Sustainable Use Directive. *Pest Manag. Sci.* 69, 883–888. <https://doi.org/10.1002/ps.3579>

- Miah, S.J., Hoque, A., Paul, A. and Rahman, A. 2014. Unsafe use of pesticide and its impact on health of farmers: a case study in Burichong Upazila, Bangladesh. *IOSR J. Environ. Sci. Toxicol. Food Technol.* 8, 57–67.
- Miah, S. J., Hoque, A., Paul, A., & Rahman, A. (2014). Unsafe use of pesticide and its impact on health of farmers: a case study in Burichong Upazila, Bangladesh. *Cancer* , 21(3), 22-30
- MoF (2018). Bangladesh Economic Review, Economic Advisory Section, Department of Finance, Ministry of Finance, Bangladesh.
- Nguyen, T. M., Le, N. T. T., HaVukaiNeN, J., & HaNNaway, D. B. (2018). Pesticide use in vegetable production: A survey of Vietnamese farmers' knowledge. *Plant Protection Science*, 54(4), 203-214.
- Nisha, U. S., Khan, M. S. I., Prodhan, M. D. H., Meftaul, I. M., Begum, N., Parven, A., & Hakim, M. A. (2021). Quantification of pesticide residues in fresh vegetables available in local markets for human consumption and the associated health risks. *Agronomy*, 11(9), 1804.
- Oerke, E-C. "Crop losses to pests." *The Journal of Agricultural Science* 144.1 (2006): 31-43.
- Popp, J., Pető, K. & Nagy, J. 2013. Pesticide productivity and food security. A review. *Agron. Sustain. Dev.* 33, 243–255. <https://doi.org/10.1007/s13593-012-0105-x>.
- Rahman, M.Z. (2000), Effect of spacing on the growth, yield and storability of some garlic germplasm, M.S. in Horticulture thesis, Bangladesh Agricultural University, Mymensingh.

- Rashid, M. T. (2014). *Adaptability of Horticultural Crops with Respect to Climate Change: A Case Study in Fakirhat Upazila of Bagerhat District* (Doctoral dissertation, dept. of horticulture).
- Raza, M. S., Rahman, M. A., Rahaman, K. M. M., Juliana, F. M., Hossain, S., Rahman, A., & Asaduzzaman, M. (2018). Present status of insecticides use for the cultivation of brinjal in Kushtia region, Bangladesh. *International Journal of Engineering Science Invention*, 7(1), 44-51.
- Sankoh, A. I. (2016). *An assessment of pesticide use, contamination and impact on the environment and the health of people in Sierra Leone*.
- Sarker, S., Gil, J. D. B., Keeley, J., & Jansen, K. (2021). *The use of pesticides in developing countries and their impact on health and the right to food*. European Union.
- Sarker, A., Nandi, R., Kim, J. E., & Islam, T. (2021). Remediation of chemical pesticides from contaminated sites through potential microorganisms and their functional enzymes: Prospects and challenges. *Environmental Technology & Innovation*, 23, 101777.
- Sarker, M. M. R., Khan, M., Parvin, M. M., Jury, F. H., & Fagun, A. N. (2022). Determinants of Adoption of Climate-Smart Agriculture Technologies in Rice Production in Bangladesh. *American Journal of Environmental Protection*, 11(4), 97-102.
- Sarker, M. M. R., & Fagun, A. N. (2021). COVID-19, Food Security, Food Prices and Urban-rural Interrelationship for Sustainable Food and Nutritional Security: A Study on Dhaka City. *International Journal of Agricultural Economics*, 6(1), 47-58.

- Sarker M. M. R. Akter, M. & Nishat, N. I. (2021). Contextualizing the Impacts of COVID-19 in Bangladesh: An Evidence from Social and Environmental Perspective. *Journal of Health and Environmental Research*, 7(4), 198-205.
- Sarker, M. M. R. (2011). *Implications, perception, arsenicosis health status, averting behavior and willingness to pay for arsenic free water: order logit and spatial analysis.*
- Sarker, M. M. R. (2010). Determinants of arsenicosis patients' perception and social implications of arsenic poisoning through groundwater in Bangladesh. *International journal of environmental research and public health*, 7(10), 3644-3656.
- Sarker M. M. R, Alam MS, Akthar N. (2002). Pesticides use in modern rice production: The issue of farmers' health and environment, in m. feroze ahmed, saleh, a. tanveer and abm badurzzaman (eds.), Bangladesh environment pp: 571- 583.
- Sharmin, S., Rashid, M. H. Ar., Begum, R., & Hoque, S.S. (2018). Relative profitability of farming systems research and development (FSRD) project farmers and non-project farmers of integrated farming systems in Tangail district of Bangladesh. *Journal of Bangladesh Agricultural University*, 16(1), 117–122. <https://doi.org/10.3329/jbau.v16i1.36492>
- Sharmin, S. (2015). Relative profitability and resource use efficiency of participatory and non-participatory farmers of integrated FSRD project in Tangail district. M.S. Thesis. Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.



- Sheheli, I., Nazneen, A., Hossain, M. S., Nilufar, N., Mohammad, M., & Mamun, M. I. (2009). Analysis of some pesticide residues in cauliflower by high performance liquid chromatography. *American journal of environmental sciences*, 5(3), 325-329
- Talukdar, N., Ahmed, M. U., Barman, I., & Kalita, P. P. Extraction of pesticide residues from cauliflower collected from cultivators and its nutraceutical analysis.
- Team, S.O.F.A., & Doss, C. (2011). The role of women in agriculture. Agricultural development economics division. Food and Agricultural Organisation of the United Nations. working paper 11: 02.
- USITC (United States International Trade Commission). 2020. Global Economic Impact of Missing and Low Pesticide Maximum Residue Levels, Vol. 1. <https://www.usitc.gov/publications/332/pub5071.pdf>
- Weinberger, K., & Genova II, C.A. (2005). Vegetable production in Bangladesh: commercialization and rural livelihoods. AVRDC-World Vegetable Center.
- Yeasmin, F., Yasmin, S., & Nahar, K. (2018). Factors influencing farmers practices in using pesticide for vegetable cultivation at sadar upazila of Gazipur district in Bangladesh. *Progressive Agriculture*, 29(3), 259-266.
- Zabed, H. M., Akter, S., Yun, J., Zhang, G., Awad, F. N., Qi, X., & Sahu, J. N. (2019). Recent advances in biological pretreatment of microalgae and lignocellulosic biomass for biofuel production. *Renewable and Sustainable Energy Reviews*, 105, 105-128.

## APPENDIX

### A questionnaire for a research study on the "Determinants of pesticide use and risk protective behaviour in brinjal production."

Name of Enumerator: .....

Date: -----/-----/-----.

#### Identification of Respondent:

Name: \_\_\_\_\_ Village: \_\_\_\_\_

Upazilla/Thana: \_\_\_\_\_ District: \_\_\_\_\_

Cell No: \_\_\_\_\_

#### 1. Socio-economic Characteristics of Respondent:

##### A. General Information:

Age (Years)	
Main Occupation	
Others Occupation	
Experience in Cultivation of Brinjal & (Years)	
Educational Qualification (Year of Schooling)	

Educational code: 0= Illiterate, 1= Just literate, 2= Primary level passed, 3= High school level passed, 4= Graduate, 5= Postgraduate, 6= Child (bellow 6 years)

##### B. Family Structure:

Number Family Member	Children (bellow 18)	Adult (18 & more)
Male		
Female		
Members involved in agriculture		

Gender code: 1= male, 2= female

## 2. Land holding and tenancy:

Category of land	Area (decimals)
a) Homestead	
b) Own land	
c) Land under sharecropping	
d) Leased out land	
e) Leased in land	
f) Mortgage	
g) Contract Farming	
h) Total Brinjal/ cultivated area	
i) Others (specify):	

1 katha= -----decimals, 1 bigha= -----decimals, 1 kani= -----  
-----decimals,

1 hactare= -----decimals, 1 acre= -----decimals, 1 paki= -----  
-----decimals.

## 3. Information about annual income:

Items		Total income (Tk.)
a) Crop	Rice	
	Brinjal	
	Potato	
	Others	
b) Livestock		
c) Poultry		
d) Fisheries		
e) Others (specify):		

#### 4. Inputs use patterns of Brinjal cultivation:

##### A) Labor cost:

Size of plot= -----decimals

Sl. No.	Items	Family labor (man-days)	Hired labor (man-days)	Labor wage (Tk./man-days)	Total cost (Tk.)
01	Labor for land preparation				
02	Labor for uprooting and transplanting				
03	Labor for fertilizer application				
04	For carrying farmyard manure and application				
05	Labor for weeding				
06	Labor for irrigation				
07	Labor for pesticide and herbicide application				
08	Labor for harvesting and carrying (Inc. Marketing Cost)				
<b>Total</b>					

##### B) Cost of land preparation:

Items	Medium (put tick mark)	Owned	Hired	Cost
No. of ploughing	Plough/power tiller/tractor			
No. of laddering	Plough/power tiller/tractor			
Contract land preparation				

**C) Irrigation cost:**

Items	Medium or ways (put tick mark)	Cost (Tk./plot)	Total cost (Tk.)
No. of irrigation			
Types of irrigation	STW/ DTW/ Electricity operated/ Surface irrigation		
Cost of fuel/electricity in case of own machine			

**D) Fertilizer cost:**

<b>Organic fertilizers</b>		
Items	Amounts (Kg.)	Cost
a) Cow dung		
b) Excreta of chickens		
c) Ash		
d) Vermicompost		
e) Compost		
f) Others (specify):		
<b>Inorganic fertilizers</b>		
Items	Amounts (Kg.)	Cost
a) Urea		
b) MoP		
c) TSP		
d) DAP		
e) Gypsum		
f) Zinc sulphate		
g) Magnesium sulphate		
h) Boric acid/Boron		
i) Others (specify):		

- ❖ Fertilizer price (Tk./Kg): Urea-----, TSP-----, MoP-----, DAP-----, Gypsum-----, Zinc sulphate-----, Boric acid-----, Magnesium sulphate-----, Compost-----, Vermicompost-----, Farm yard manure-----.

**E) Pesticide Cost:**

Items	Amounts (kg.) or (ml)	Price (Tk/kg) or (Tk/ml)	Total cost (Tk)
Fungicide			
Insecticide			
Herbicides			
Plant Growth Regulator (PGR)			
Others			

**5. When You use pesticide? Before affected / During affected**

**6. Availability of cash capital for farming operation: Yes/ No**

**7. If loan is needed, institutional loan is available: Yes/ No**

**8. Primary disposal & selling pattern of Brinjal:**

Items	Quantity (mounds)	Unit Price
Sale before harvest		
Sale during harvest		
Sale after harvest		
Used for family consumption		
Use for seed		
Paid as kind (harvesting)		
Total		

**9. Perceptions of the consequences (PC) of pesticide use among groups of Farmers and Regions:**

Sl.	Items	Yes	No
1	It will be very detrimental to my health if I do not protect myself when spraying pesticides		
2	The current environment will be improved if I spray less pesticide		
3	Spraying less pesticide will reduce the production		
4	Spraying more pesticides will not lower product price		

### 10. Protective behavior (PB) in pesticide uses

Sl.	Items	Yes	No
1	Wearing Mask/ Globs and long/ Sleeved cloths when spraying pesticide		
2	Changing Cloths or showering immediately after spraying pesticide		
3	Carefully storing pesticide in a safe place after purchase		
4	Never discarding the empty pesticide containers in the filed after use		
5	Never applying pesticide more than prescribed by dept. of Agricultural extension (DAE) or the instruction manual		
6	Selecting new types of pesticide recommended by DAE		
7	Low toxicity is the main reason for selecting and purchasing pesticide		
8	Reading the instruction on the pesticide carefully before spraying		

### 11. Knowledge of pesticide use (KPU) among groups of farmers and regions:

Sl.	Items	Yes	No
1	Knowledge about pesticide toxicity		
2	Read and understand instruction manual & pesticide labels		
4	Pesticide is associated with current human illness		
5	The environment is affected by pesticide		
6	Know pesticide effect on the body		
7	Effect of pesticide on Soil		
8	Do you know the minimum time duration of harvesting after using pesticide		