DETERMINANTS OF PESTICIDE USE AND RISK PROTECTIVE BEHAVIOUR IN CAULIFLOWER PRODUCTION

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DETERMINANTS OF PESTICIDE USE AND RISK PROTECTIVE BEHAVIOUR IN CAULIFLOWER PRODUCTION

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CERTIFICATE

This is to certify that thesis entitled, ***"DETERMINANTS OF PESTICIDE USE AND RISK PROTECTIVE BEHAVIOUR IN CAULIFLOWER 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. ABDUR RAHMAN MITOO****, Registration No.* ***19-10314*** *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
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DEDICATED

TO

MY BELOVED PARENTS

ABSTRACT

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. The study was conducted to examine the determinants of pesticide use and risk protective behaviour in cauliflower production in some selected areas of Bogura district in Bangladesh. Besides, attempt had given to describe the socio-economic characteristics of the cauliflower farmers, to identify the factors that significantly influence farmers use of pesticides in cauliflower production, to compare the use of pesticides among cauliflower farmers and investigate the comparison of risk protective behaviour among cauliflower farmers. Two upazilas called Shibganj and Shahjahanpur under the Bogura districts was selected purposively for the study on the basis of extensive cauliflower production. Simple sampling procedure was used to select a sample of 99 respondents. Data were analyzed using descriptive statistics, Multiple linear regression coefficients of contributing determinants related to the determinants of pesticide use in cauliflower. 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 (54) 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 (58) did not know about pesticide toxicity. Findings from the Multiple linear regression coefficients model estimation indicated that use of NPK and Highest education level of family are significant at 5% level and plot size is significant at 1% 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 measure, safety training programs and suitable extension services. In terms of public policy, developing and executing targeted interventions aiming at the limit of detrimental consequences of excessive pesticide use on human health and the environment.

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Md. Abdur Rahman Mitoo

CONTENTS

CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

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

Agriculture has been playing a pioneering role in the growth and stability of the national economy of Bangladesh (Sharmin et al., 2018). The main agricultural commodities of our country are rice, wheat, pulse, jute, and different vegetables. Vegetables are considered one of the most important food crops due to their high nutritive value, relatively higher yield, and higher return (Sharmin, 2015). Apart from nutritional importance, it helps to employment generation, increases income, and reduces poverty in developing countries like Bangladesh (SOFA team et al., 2011). Vegetable production has experienced tremendous growth in the last 40 years in Bangladesh. Vegetable contributes an important share of the total agricultural export in Bangladesh. The vegetables and crops sub-sector also contributes an important share to the agricultural GDP which is near about 9.71 % (MoF, 2018). Vegetables are generally labor-intensive crops and thus offer a considerable promise for generating increased rural employment opportunities (S Akter et al., 2011). Homestead crop production systems especially the production of horticultural crops can to a considerable extent, help to ensure food and nutrition security in addition to self-employment, poverty alleviation, and income generation of the farmers. Vegetables can be identified as a significant one for this economy for their noteworthy contribution to raising the foreign exchange earnings and occupying an important position among the items exported from Bangladesh. Among more than 90 types of vegetables, Cauliflower is grown mainly as a Rabi crop during winter. The production of vegetables including cauliflower is increasing day by day in Bangladesh. Among all the vegetables produced in the country, cauliflower dominates a major share in terms of total cropping area and production. Bangladesh is one of the most densely populated and

intensive agricultural countries, covers roughly 9.1 million hectares, which is 70% of the country's land area, to feed its more than 170 million inhabitants, of which more than 15 million are farming households, produced 38 million tons (MT) cereals, 0.4 MT pulses, 1.0 MT oilseed, 0.5 MT vegetables, 2.5 MT spices and condiments and GDP contribution from agriculture is 13.3% in 2018–2019 (BBS, 2020). Pesticide application has increased manifold from 758 metric tons in 1960 and 3028 metric tons in 1980 to over 19,000 metric tons in 2000. The number of pesticides applied in fields across the country rose to 48,690 metric tons in 2008 (Islam et al., 2016; Miah et al., 2014) and over 47% of farmers overusing pesticides in Bangladesh (Dasgupta et al., 2005). Pesticides are essential to agricultural development to protect crops from pests and to assure higher crop yields (Damalas and Eleftherohorinos, 2011). 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 (https://www.marketsandmarkets.com). According to FAO, global pesticide use almost doubled between 1990 and 2018, increasing from 2.3 to 4.1 million tones (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, such as increased consumption of meat and dairy products and greater use of cereals in feeding livestock. The availability of additional agricultural land is limited (Popp el 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. The substantial increase in pesticide consumption is due to the dependency of agricultural crops and their productivity on synthetic pesticides. Pesticides are the dominant control tactic for managing agricultural pests in Bangladesh and there was a 5-fold increase in the use of all agricultural pesticides (insecticides, herbicides, and fungicides) between 1990 and 2020. Insecticide use in Bangladesh is very particularly high in vegetables, especially in Cauliflower. Cauliflower is low in fat, high in dietary fiber, contains water and vitamin C, possessing a very high nutritional density. The warm and humid climatic condition of the country, increase in the use of modern high-yielding varieties of crops and more use of chemical fertilizers are highly favorable for the development and multiplication of pests and diseases. In the Bangladesh context, cauliflower growers have been using pesticides frequently to have a higher yield.

1.2 Production of Cauliflower in Bangladesh

Cauliflower is grown mainly as rabi crop during winter. The production of vegetables including cauliflower is increasing day by day in Bangladesh. Among all the vegetables produced in the country, cauliflower dominates a major share in terms of total cropping area and production. It grows in all the districts of Bangladesh but plenty of cauliflower are produced in the region of Bogura, Jessore, Rajshahi, Rangpur, Tangail and Kustia.

Table 1.1: Total cauliflower production area and total production

Division	**Total Area (Acre)**	**Total Production (MT)**
Dhaka	9008.75	52106.26
Chattogram	6735	30620
Rajshahi	8485	21064
Khulna	10071.95	51197.85
Mymensingh	6515	39842
Rangpur	10942	75699
Sylhet	2743.39	20040
Barishal	1528	4115

Source: BBS 2021

1.3 Production of cauliflower in Bogura

Cauliflower 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. Cauliflower grows best on a neutral or slightly acid soil (pH 6.0 to 6.5). According to Agricultural statistics yearbook-2021 in Bogura total area of cauliflower cultivation is 1112 acre and total production is 5233 MT. (BBS 2021).

1.4 Scope of the Study

Cauliflower 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 consumers preference for blemish-free and high-quality cauliflowers. To respond to the expanding market demand and consumer preferences, cauliflower 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 cauliflower farmers on pesticide use, there is little knowledge about determinants of the level of pesticide usage among cauliflower farmers. Hence, it is on the foregoing that this study was geared towards filling these knowledge gaps among cauliflower 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 cauliflower.

1.5 Objectives of the study

In light of the aforementioned issue, the following particular goals were devised to provide the research with correct direction:

i. To explore the socioeconomic characteristics of those Cauliflower farmers.
ii. To identify the factors that significantly influence farmers use of pesticides in cauliflower
iii. To compare the use of pesticides among Shibganj and Shahjahanpur farmers.
iv. To identify 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 cauliflower 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 behaviours, determinants of the level of pesticide usage as well as the role of risk protective behaviour and socio-economic characters among cauliflower 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 cauliflower 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

In this chapter, an attempt has been made to review of pertinent literature keeping in view the problem entitled, "**Determinants of Pesticide Use and Risk Protective Behaviour in Cauliflower Production**". Again, some of these studies may not entirely relevant to the present study, but their findings, methodology of analysis and suggestions have a great influence on the present study. Review of some research works relevant to the present studies, which have been conducted in the recent past, are discussed below.

Sarker, A. *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) observed 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.

Talukdar, N. *et. al.* (2021) investigated that cauliflower is low in fat, high in dietary fiber, contains water and vitamin C, possessing a very high nutritional density. The warm and humid climatic condition of the country, increase use of modern high yielding varieties of crops and more use of chemical fertilizers are highly favorable for development and multiplication of pests and diseases. In Indian context, the cauliflower growers have been using the pesticides frequently to have the higher yield. Pesticide is widely used in the cultivation of cauliflowers in Assam. But the overdoses of pesticides make the residue problem, which might pollute our food and be harmful for our health. Finally, the method was applied to the determination of these pesticides in commercial samples collected from the cultivators. Therefore, the purpose of this study was to develop an analysis scheme for determination of some pesticides in cauliflower. And this method provides good results for a specific pesticide present in cauliflower. Quantification of protein in the samples were also done and compared and it showed the presence of almost equal amount of protein in both the samples.

Barau, A. *et. al.* (2020) found that the knowledge on pesticide use in vegetable production in Narsingdi District, Bangladesh 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 cauliflower, bean, brinjal, 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 cauliflower, tomato, brinjal, country bean and bitter gourd. 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 (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 M. S. *et. al.* (2018) Found that the samples of the cauliflowers were analyzed to assess the residue level of insecticides. Out of analyzed 75 collected samples of cauliflower 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 cauliflowers may be due to its irrational and repeated use before harvest.

Nguyen T. M. *et. al.* (2018) observed that the pesticide use in vegetable production: A survey of Vietnamese farmers' knowledge. Plant protect 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 & Naha (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. (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 S. J. *et. al.* (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 & Nazneen (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. Attempt made to ensure that their applications were correct and safe and result in no residues in food beyond codex developed maximum residue limits. Method used permitted the determination of these pesticides in cauliflower 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 cauliflower 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 cauluflower production.

CHAPTER 3
METHODOLOGY

3.1. Introduction

The quality of statistical research is determined by the study's approach. The use of proper technique is a must for excellent research. Any survey's design is largely defined by the study's nature, goals, and objectives. It is also contingent on the availability of the required resources, supplies, and time. Data for statistical research may be collected in a variety of ways. A statistical research normally entails gathering information from individual farmers; data collection for statistical analysis necessitates the analyst's judgment in selecting data collecting techniques within the constraints imposed by the work's resources.

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

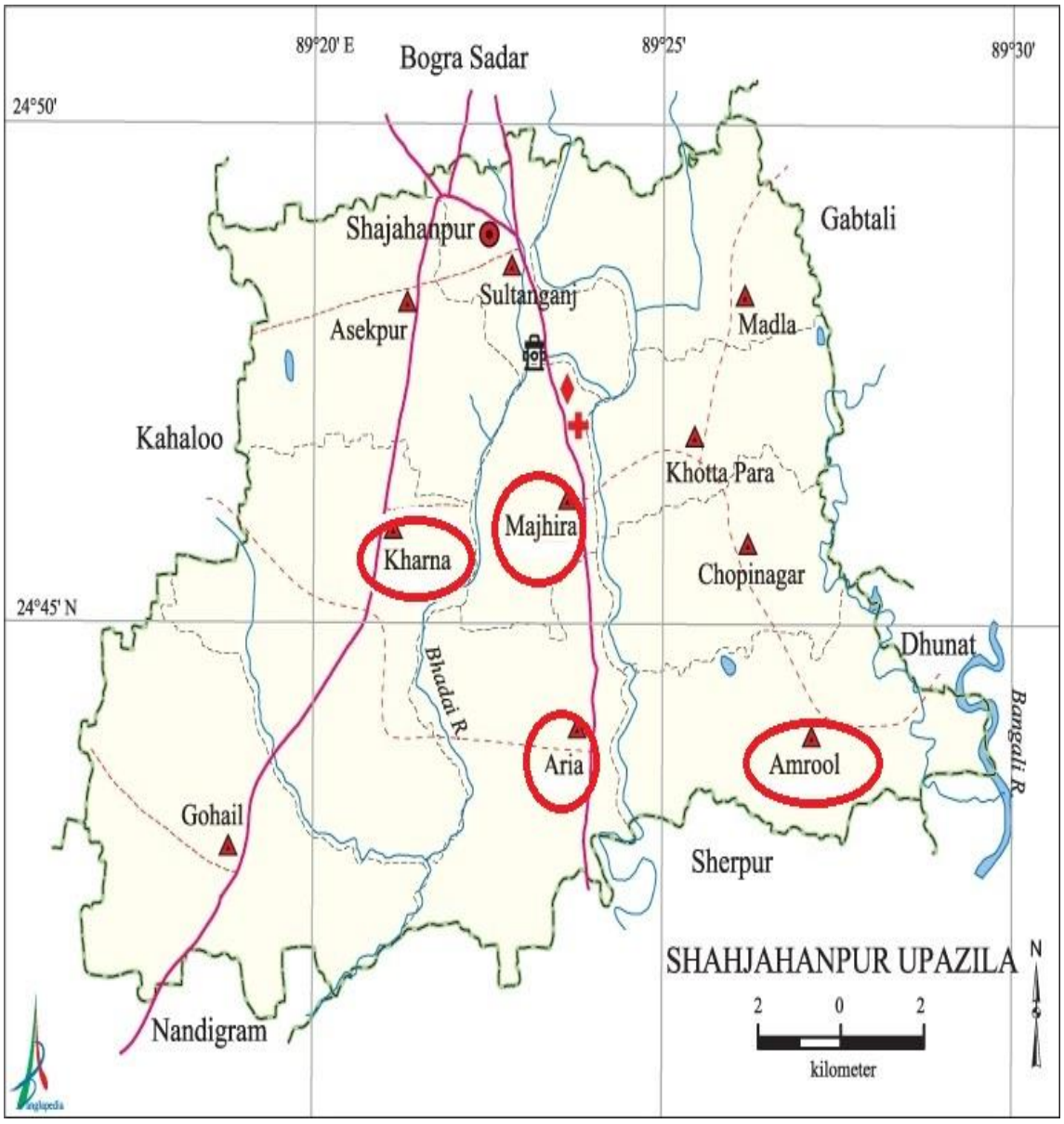
i. The survey allows for rapid study of a large number of instances and
ii. The findings are more widely applicable.

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

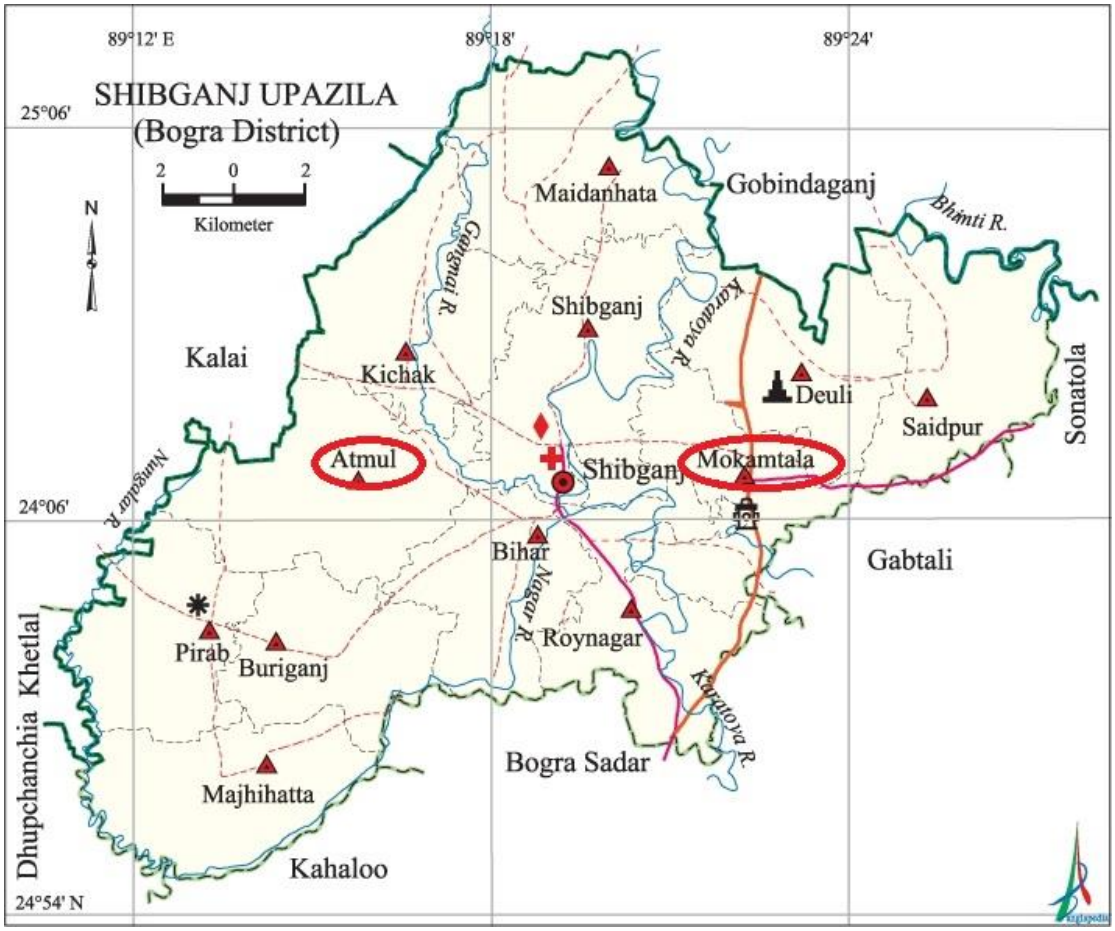
The selection of the study area is a crucial stage in any statistical research. The location chosen was appropriate for the study's specific goal as well as the possibility of farmer collaboration. Bogura district was selected purposively as a study area because this district is one of the leading cauliflower producing area of Bangladesh. The districts of Bangladesh are divided into sub-districts called Upazilas (Sarker, M. M. R. 2010). The upazila is the second lowest tier of administrative government in Bangladesh. Spatial variation of different household characteristics was found in the different studies in Bangladesh (Sarker, M. M. R. 2012). Shajahanpur and Shibgonj upazila ware selected randomly as the study area. A preliminary survey was conducted in some villages of those upazila under bogura district to gather primary knowledge about the pesticide use in cauliflower production, and risk protective behaviour of farmers. After preliminary visit some village's namely Darigasi, Amtoli, Mohasthangor and Amrul were selected randomly as study area. Most of the farmers in these villages used to produce high yielding varieties of cauliflower and use different type of pesticide in cauliflower.

Although cauliflower is produced across Bangladesh, under the Bogura district Shibganj and Shahjahanpur are the most significant area where it is grown widely.



Source:www.google.com

Figure 3.1: The study area showing the villages.



Source: www.google.com

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

Agriculture is the major economic activity in this region. Cauliflower, tomato, maize, beans, wheat, carrots, peas, onions, and other fruits are some of the main crops grown in the area. Some of the livestock bred kept in the area include; cattle, poultry, goats, well as sheep **Figure (3.1 and 3.2)** represents a map of the study area. As a result of the larger amount of cauliflower production, two upazilas in bogura district, namely Shibganj and Shahjahanpur, were purposefully chosen for the research. The following were the primary factors in deciding on the research area:

a) The research region contained a big number of cauliflower farmers.
b) These villages had certain similar physical features for growing cauliflower, 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 99 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 99 Cauliflower vegetable cultivating farmers were selected randomly for a face-to-face interview. 46 from Shibganj Upazila and 53 from Shahjahanpur Upazila. Thus, a total of 99 farmers were interviewed from the selected areas of the Bogura district.

3.4 Data Collection

Data collection is an important step and the result of any study depends on the accuracy and reliability of data. The accuracy and reliability of data mostly depend on the method of collection. The study was mainly based on a set of field level primary data collected from the selected members by using pretested interview schedules. Field level primary data were collected from the selected respondents through direct interview conducted by the researcher himself. After preparing the schedule, each selected respondents was interviewed separately. Before beginning the actual interview, each respondent was given a brief introduction about the nature and purpose of the study. Then the questions were asked sequentially in a simple manner. The responses were recorded directly on the interview schedules. Usually the respondents at grass root level do not keep written record of their different activities, so the researcher had to depend on bare memory of the respondents. During interview, the researcher asked questions systematically and explained whenever necessary. After completion of each interview, the schedule was checked and verified to be sure that the answer had been properly recorded. In order to minimize time and for easy understanding, data were collected in local units.

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 a strong data collecting instrument that uses multi-dimensional questions to acquire information. A questionnaire without a defined objective and purpose would always ignore crucial topics and waste the time of enumerators and respondents by asking and responding to irrelevant questions. All of these issues were considered to the best of our ability in order to construct 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, I picked some of the farmers 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 was entered into a computer and analyses were 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 of contributing determinants of pesticides use in Cauliflower. The following is the model for this study:

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

Where,

Y_i = Amount of Pesticide use (ml/ha)

β_0 = Intercept

ε_i = Random Error

β_1 = Co-efficient of age	X_1 = Age
β_2 = Co-efficient of education	X_2 =Education
β_3 = Co-efficient of highest educational level of the family	X_3 =Highest education
β_4 = Co-efficient of experience	X_4 =Experience
β_5 = Co-efficient of family size	X_5 =Family size
β_6 = Co-efficient of members involve in agriculture	X_6 =Members involve in agriculture
β_7 = Co-efficient of plot size	X_7 =Plot size
β_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 (ha.)	Continuous	Total cultivated area by the farmers
NPK (kg/ha.)	Continuous	Amount (kg) 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 cauliflower 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, NPK.

3.8.3 Measurement of Dependent Variable

Amount of pesticide use in cauliflower 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 cauliflower 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 score 1 for 1 years of schooling otherwise it is 0.

3.8.4.3 Highest Education Level of family

Highest Education The family level 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. For 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 cauliflower 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, cauliflower, brinjal etc.

3.8.4.8 NPK

Fertilizer are used in production of cauliflower 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 cauliflower 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

As illustrated in 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 farmers 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.

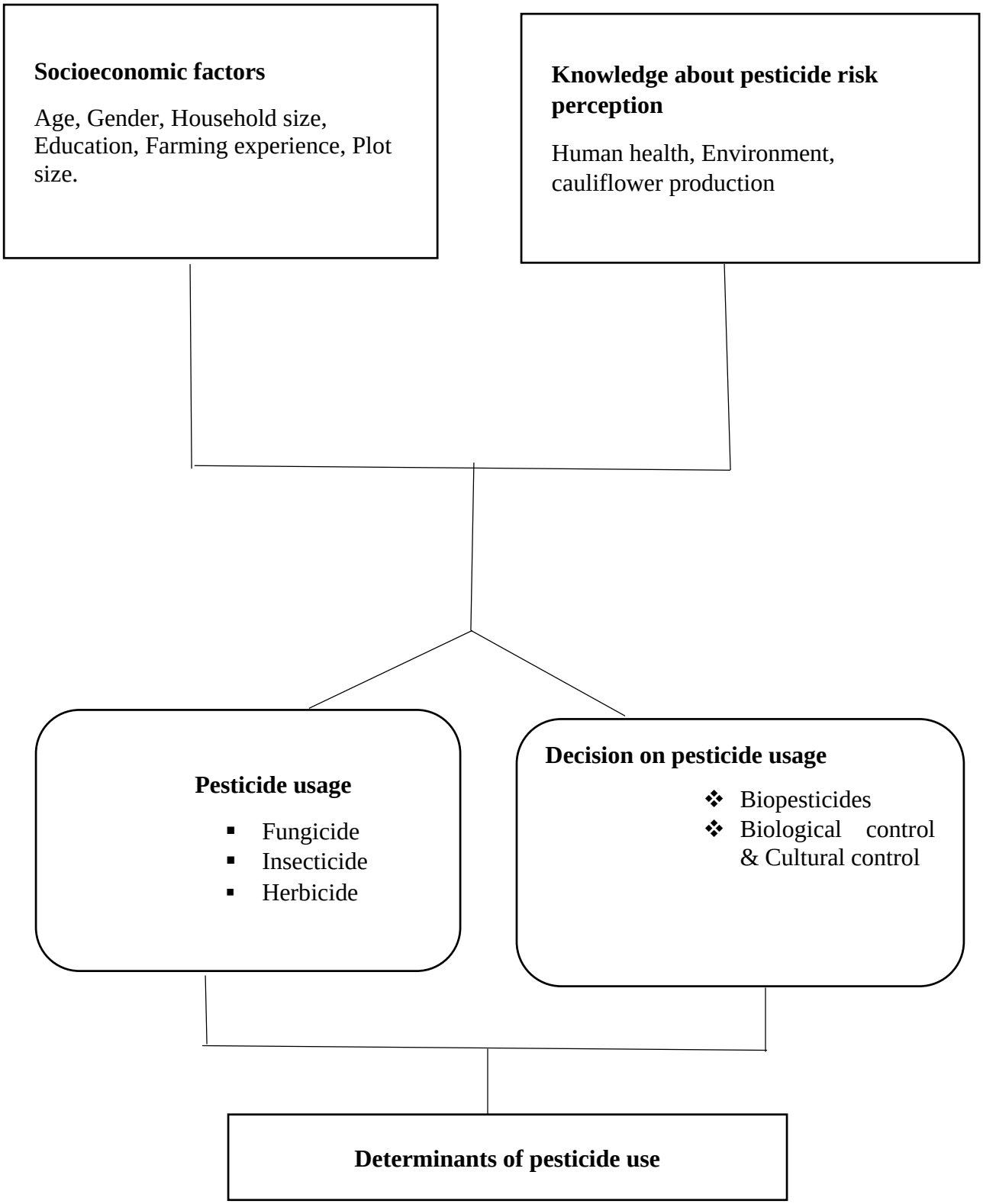


Figure 3.3: Conceptual framework on determinants of pesticide usage.

CHAPTER 4
RESULTS AND DISCUSSION

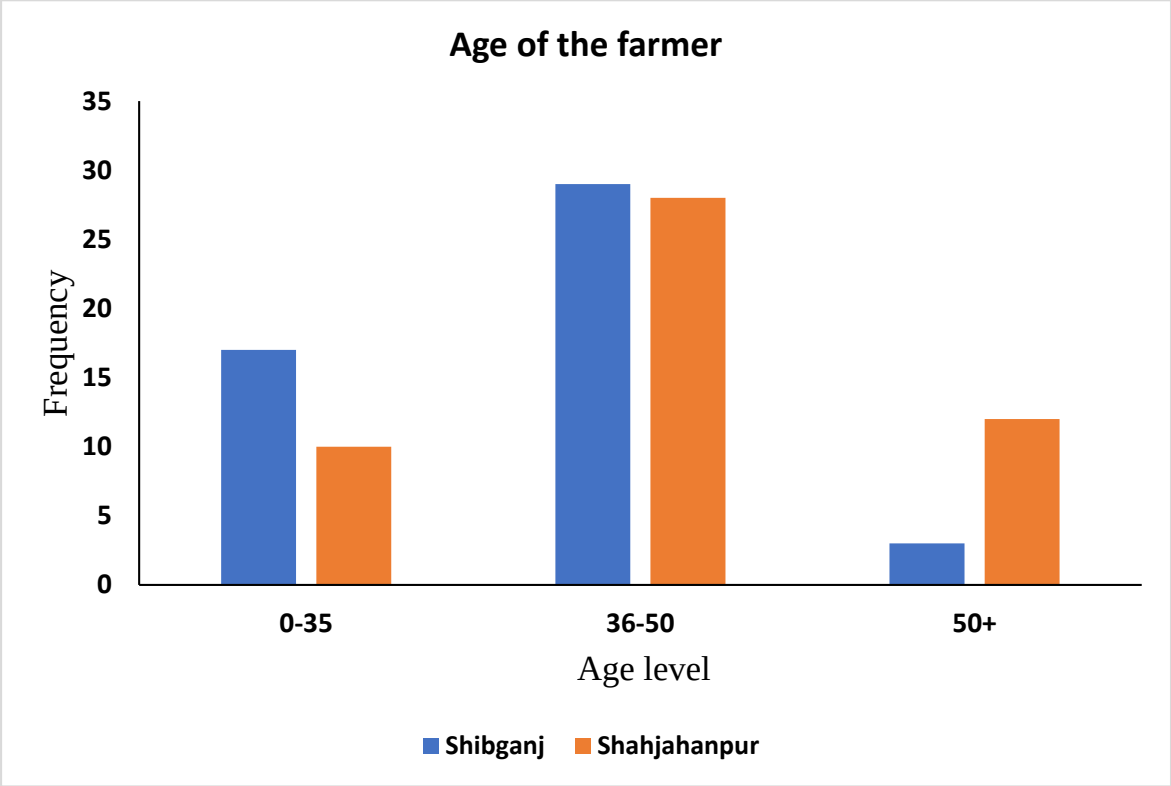
This Chapter presents a conclusive and extensive explanation of the scientific research study's conclusions. This part provides the findings and discussion of the study. Descriptive statistics of cauliflower farmers household characteristics and precautionary risk behaviour in pesticide use were presented 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 cauliflower 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

Samples (99) were taken from two upazilas called Shibganj (49) and Shahjahanpur (50) respectively to reflect the whole population. In Shibganj upazila contains 17 of samples were up to 35 years old, 39 were 36-50 years old, and 3 were above 50 years old. In shahjahanpur upazila, 10 of samples were up to 35 years old, 28 were 36-50 years old, and 12 were above 50 years old. (Figure 4.1) and overall 27% were up to 35 years old, 57% were 36-50 years old and 16% were above 50 years old in the study area. In each upazila, the majority of persons were between the ages of 36 and 50.

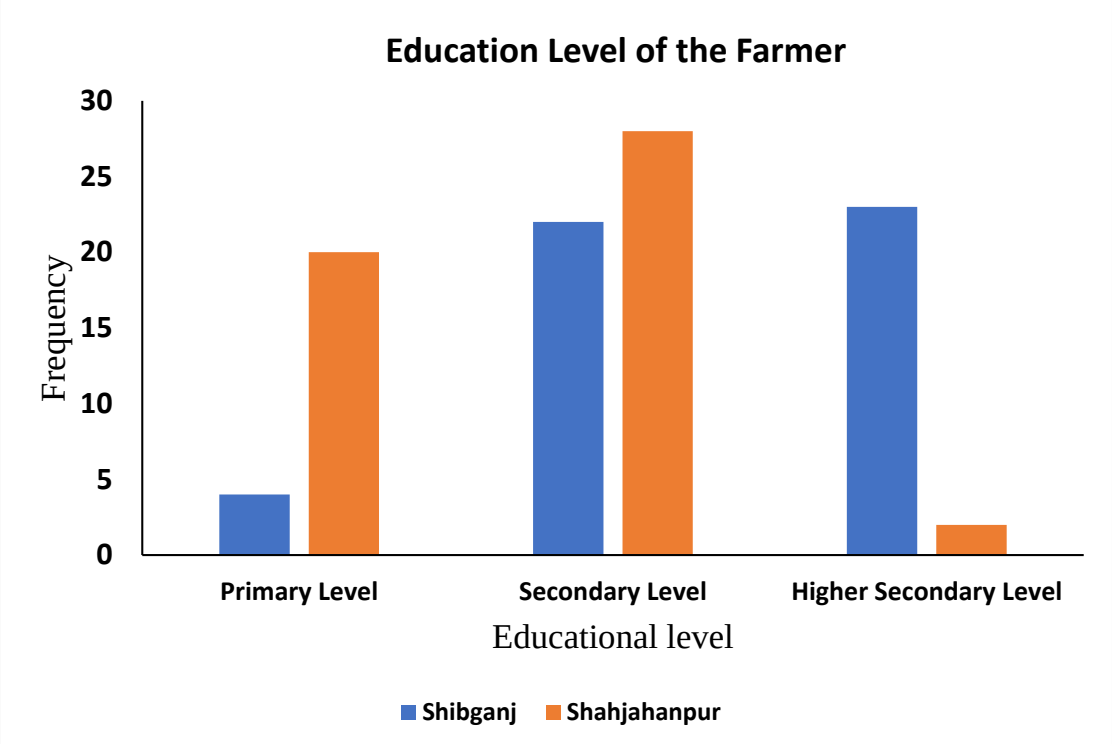


Source: Field survey, 2022

Figure 4.1: Age of the respondent by Study Area

4.1.2 Education

According to figure (4.2), around 4 of individuals have a primary level of education, approximately 22 have a secondary level of education, and 23 have a higher secondary level of education in Shibganj upazila. Around 20 of individuals have a primary level of education, 28 have a secondary level of education, and 2 have a higher secondary level of education in Shahjahanpur Upazila. And overall, we can see from this number that 24% have a primary level of education, 50% have a secondary level of education and 25% 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.

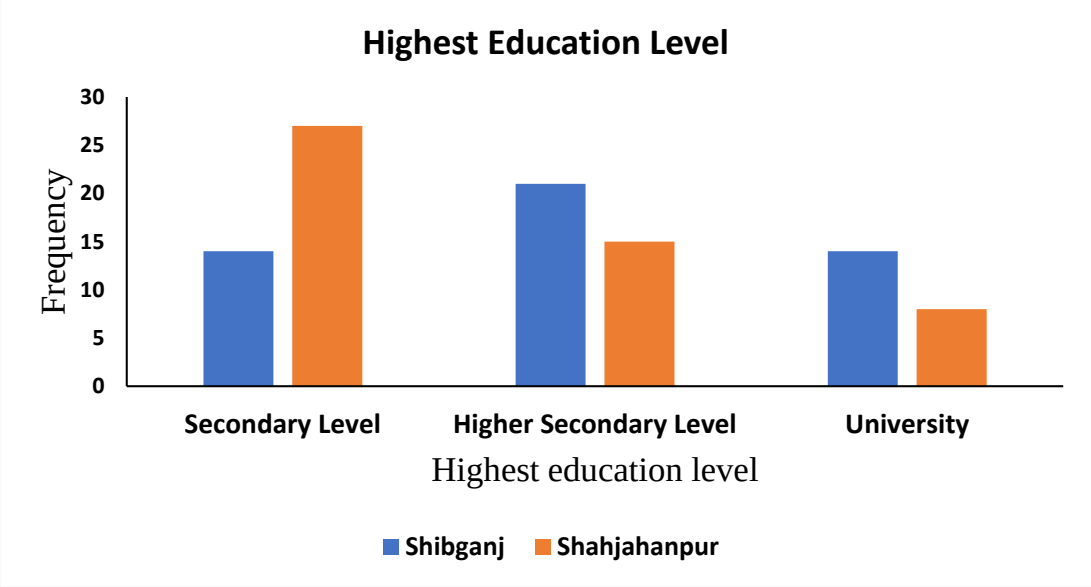


Source: Field survey, 2022

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 10 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 14 people were found the family's highest education level to have university level. In Shahjahanpur upazila, about 27 were found the family's highest education level to have secondary level, about 15 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 41% have a secondary level, 36% have a higher secondary level and 23% 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.

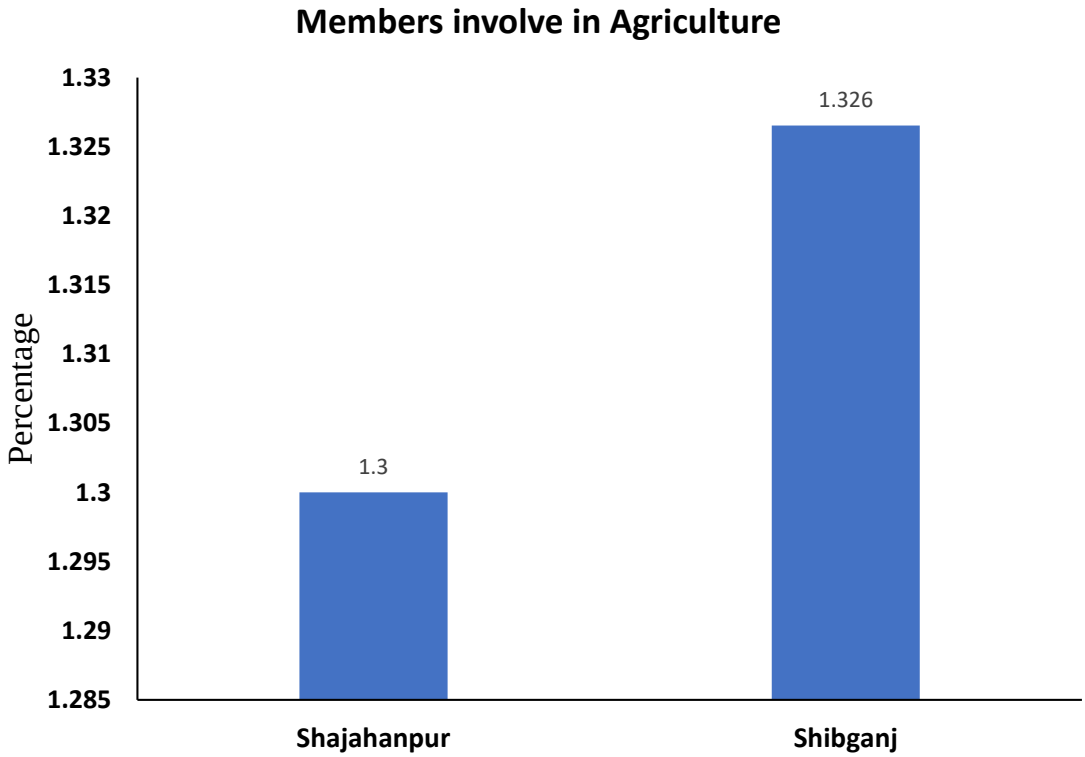


Source: Field survey, 2022

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 49 and 50 respectively to reflect the whole population. By the diagram we can see that Shibganj has the greater percentage of members involve in agriculture where Shibganj contains the value 1.326 and Shahjahanpur contains the value 1.3.

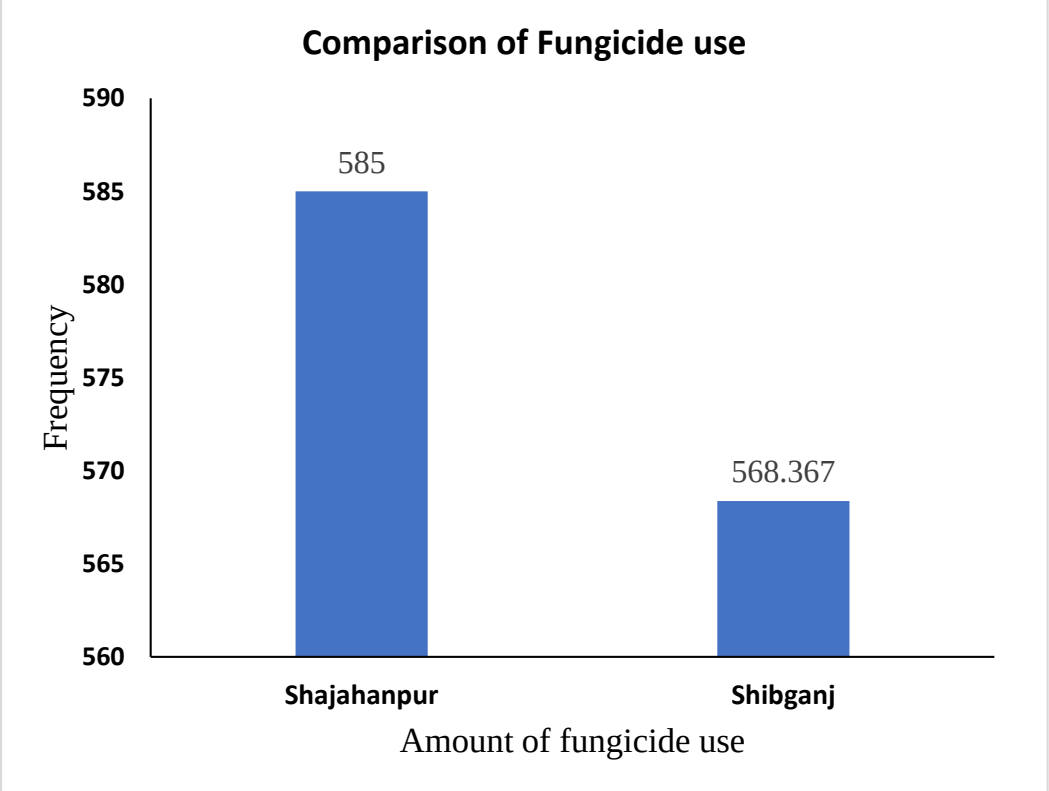


Source: Field survey, 2022

Figure 4.4: Members involve in agriculture

4.1.5 Comparison of Fungicide use in between Shahjahanpu and Shibganj

In that figure (4.4) we differentiate the use of fungicide in two upazilla called shahjahanpur and Shibganj. By following the average use of fungicide in Shahjahanpur farmers is 585 ml. and the average use of fungicide in Shibganj farmers is 568.367 ml. So that we can say the farmers of Shahjahanpur use more fungicide than farmers of Shibganj.

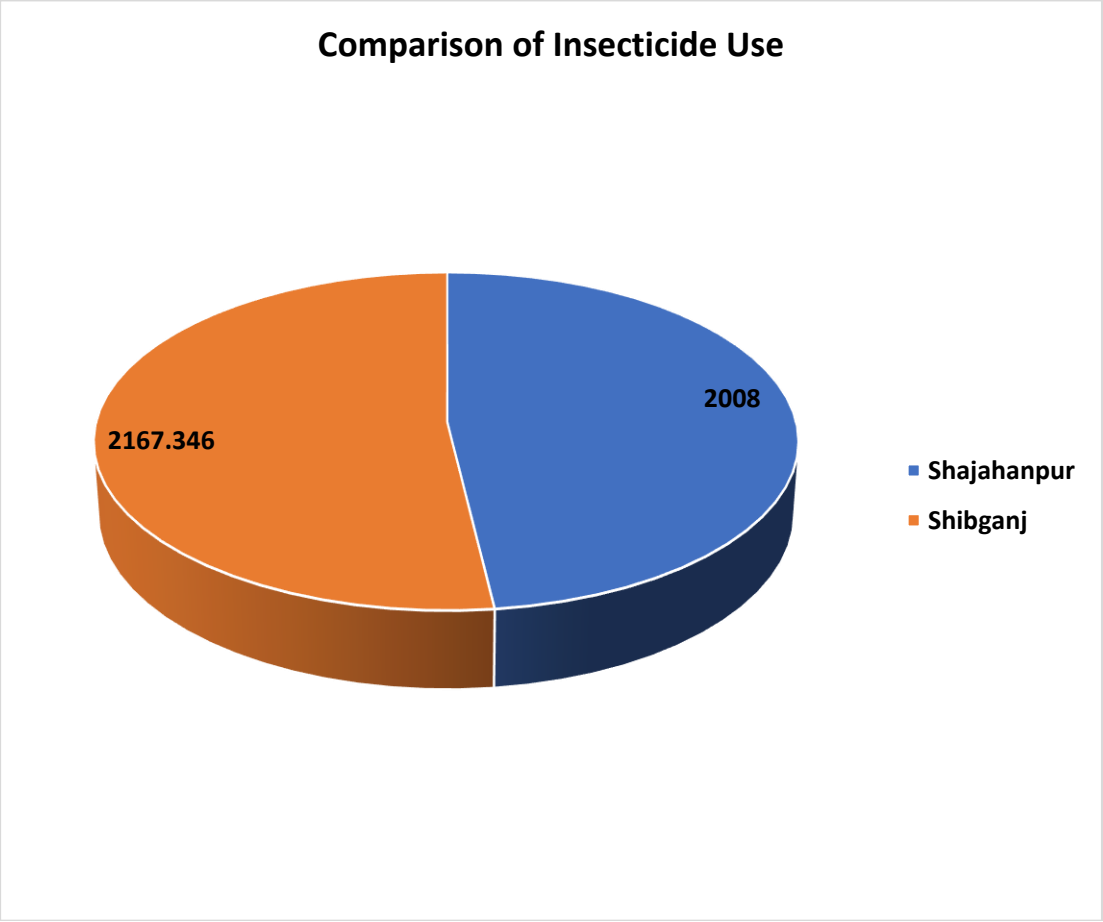


Source: Field survey, 2022

Figure 4.5 : Comparison of Fungicide use in between Shahjahanpur and Shibganj.

4.1.6 Comparison of Insecticide use in between Shahjahanpu and Shibganj

In that 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 2008ml. and the average use of insecticide in Shibganj farmers is 2167.346ml. So that we can say the farmers of Shibganj use more insecticide than farmers of Shahjahanpur.

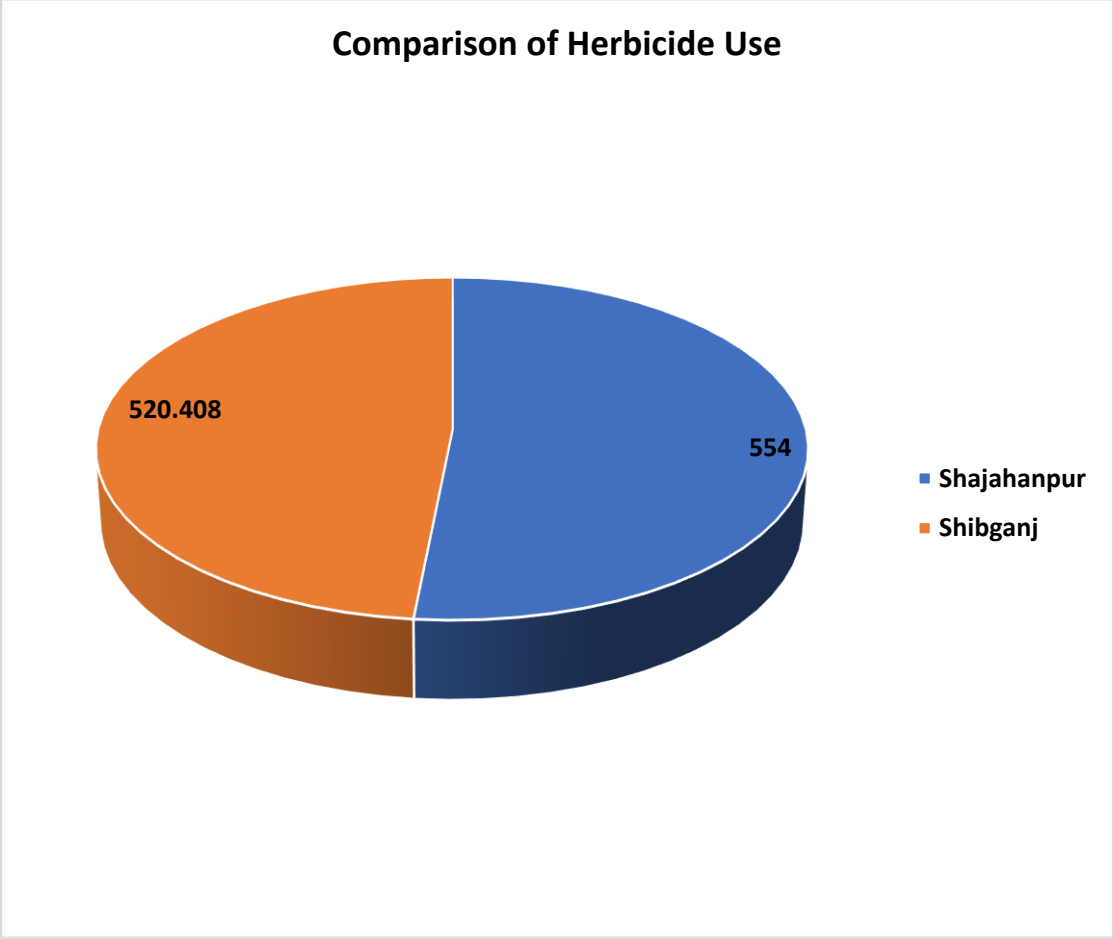


Source: Field survey, 2022

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 554 ml. and the average use of herbicide in Shibganj farmers is 520.408 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 Cauliflower Production

Multiple linear regression analysis was performed to determinants of pesticide use in cauliflower 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 cauliflower.

Dependent variable	Independent variable	Parameter	Coefficient	P-value
Amount of pesticide use (ml/ha.)	Constant	β_0	-1372.7	0.029
	Age years (X_1)	β_1	-2.729	0.810
	Education (X_2)	β_2	-13.07	0.505
	Highest Education (X_3)	β_3	-48.89*	0.041
	Experience (X_4)	β_4	-9.695	0.732
	Family Size (X_5)	β_5	72.64	0.202
	Members involves in Agriculture (X_6)	β_6	71.42	0.580
	Plot Size (ha.) (X_7)	β_7	21847.8**	0.000
	NPK (kg/ha) (X_8)	β_8	0.454*	0.029

**Indicates 1% level of significance
* Indicates statistical significance at 5%

R^2 = 0. 7445

N = 99

The study tried to investigate the determinants of pesticide use in cauliflower 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 and NPK used by the farmer.

Age years (X_1): The estimated regression coefficients for age of the respondent was found to be negetive. The coefficient of the age was -2.729 and statistically insignificant. so, further illustration is avoided.

Education (X_2): The estimated regression coefficients for education of the respondent was found to be negetive. The coefficient of the education was -13.07 and statistically insignificant. so, further illustration is avoided.

Highest Education (X_3): The estimated regression coefficients for Highest Education level of the family was -48.89 and statistically significant at 5% level of confidence. It indicates that keeping other things constant, highest education level of the family increased by 1 year then amount of pesticide use decreased by -48.89 (ml/ha.) in cauliflower production.

Experience (X_4): The estimated regression coefficients for experience of the respondent was found to be negetive. The coefficient of the experience was -9.695 and statistically insignificant. so, further illustration is avoided.

Family Size (X_5): The estimated regression coefficients for family size of the respondent was found to be positive. The coefficient of the family size was 72.64 and statistically insignificant. so, further illustration is avoided.

Members involves in Agriculture (X_6): The estimated regression coefficients for age of the respondent was found to be negetive. The coefficient of the age was -71.42 and statistically insignificant. so, further illustration is avoided.

Plot Size (X_7): The estimated regression coefficients for plot size of the respondent was 21847.8 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 21847.8 (ml/ha.) or 21.847 (L/ha.) in cauliflower production.

NPK (X_8): The estimated regression coefficients for NPK use of the respondent was 0.454 and statistically significant at 5% level of confidence. It indicates that keeping other things constant, if NPK use increased by 1 unit then Amount of pesticide use increased by 0.454 (ml/ha.) in cauliflower

production.

Value of R^2 : Regression analysis shows that the independent variables explained 74.45% (R^2 = 0. 7445) of the total variation of the respondents amount of pesticide use in cauliflower production.

4.3 Risk Protective Behaviour in Cauliflower Production

4.3.1 Wearing mask when spraying pesticide

The actions of cauliflower farmers were observed as they use mask in the time of pesticide spraying, and the results are shown in Table Findings. The majority of the farmers (54) did not use mask as a result of low education levels, high cost, not availability could all be blamed for this.The table **4.2** shows the comparison among Shahjahanpur and Shibganj farmers of using mask. In Shahjahanpur 28% and in Shibganj 63.26% farmers are use mask.

4.3.2 Wearing gloves when spraying pesticide

When pesticides were sprayed, the actions of cauliflower 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 (97) did not utilize gloves. The table **4.2** compares the use of gloves by farmers in Shibganj and Shahjahanpur. Farmers utilize gloves in Shibganj (2) and Shahjahanpur (0).

4.3.3 Changing cloths after spraying pesticide

Farmers of cauliflower were observed as pesticides were applied, and the findings are shown in Table **4.2**. The majority of farmers (90) did not changing cloths because of their poor levels of education, and lack of awarness. The changing cloths by farmers in Shibganj and Shahjahanpur is compared in the table **4.2**. In Shibganj (4%) and Shahjahanpur (14.28%), farmers changing cloths.

Table 4.2 Risk protective behaviour in cauliflower production by the study area

Determinants of Risk protective behaviour	**Shahjahanpur**				**Shibganj**			
	N = 53 (total farmer)				N = 46 (total farmer)			
	Total		Percentage		Total		Percentage	
	yes	no	yes	no	yes	no	yes	no
1.Wearing mask when spraying pesticide	14	36	28	72	31	18	63.26	36.74
	Total		No	54	Total		Yes	45
2. Wearing gloves when spraying pesticide	0	50	0	100	2	47	4.08	95.92
	Total		No	97	Total		Yes	2
3.Changing cloths after spraying pesticide	2	48	4	96	7	42	14.28	85.72
	Total		No	90	Total		Yes	9
4.Showering immediately after spraying pesticide	1	49	2	98	3	46	6.12	93.88
	Total		No	95	Total		Yes	4
5.Never discarding empty pesticide containers in the field	22	28	44	56	28	21	57.14	42.86
	Total		No	49	Total		Yes	50
6.Carefully reading the instruction on the pesticide labels	21	29	42	58	15	34	30.61	69.39
	Total		No	63	Total		Yes	36
7.Knowledge about pesticide toxicity	16	34	32	68	25	24	51.02	48.98
	Total		No	58	Total		Yes	41
8. Knowledge about pesticide effect on the body	47	3	94	6	46	3	93.27	6.73
	Total		No	6	Total		Yes	93

Source : Field survey 2022

4.3.4 Showering immediately after spraying pesticide

The results of the observation of cauliflower 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 (95) did not shower immediately. The table compares how farmers in Shibganj and Shahjahanpur show their showering activity. Farmers shower emidiet after using pesticide at Shibganj (6.12%) and Shahjahanpur (2%).

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 44% farmers Shahjahanpur and 57.14% 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 cauliflower farmers were observed as they prepared pesticides, and the results are shown in Table **4.2** Findings. The majority of the farmers (63) 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 cauliflower 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 (58) 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 (25) and Shahjahanpur (16). 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

Table **4.2** Findings presents the findings from the observation of cauliflower producers as pesticides were applied. The majority of farmers (93) were aware of pesticide effect on the body. The table contrasts the practices of farmers in Shibganj and Shahjahanpur. Farmers at Shibganj (46%) and Shahjahanpur (47%) have knowledge about pesticde effect on body.

CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summery 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 (57%) of the farmers were 36-50 years old where 27% were up to 35 years old and 16% year above 50 years old.

Education

The highest portion (50%) of the respondents have a secondary level of education where 24.9% have a primary level of education and 25% have a higher secondary level of education.

Highest Education level of the family

The highest portion (41%) of the respondent's family's highest education level have a secondary level where 36% have a higher secondary level and 23% have a university level.

Members involve in agriculture

Shibganj has the greater percentage of members involve in agriculture where Shibganj contains the value 1.326 and Shahjahanpur contains the value 1.3.

Comparison of fungicide use

By following the average use of fungicide in Shahjahanpur farmers is 585ml. and the average use of fungicide in Shibganj farmers is 568.367ml. So that we can say the farmers of Shahjahanpur use more fungicide than farmers of Shibganj.

Comparison of insecticide use

The average use of insecticide in Shahjahanpur farmers is 2008ml. and the average use of insecticide in Shibganj farmers is 2167.346ml. So that we can say the farmers of Shibganj use more insecticide than farmers of Shahjahanpur.

Comparison of herbicide use

The average use of herbicide in Shahjahanpur farmers is 554 ml. and the average use of herbicide in Shibganj farmers is 520 ml. So that we can say the farmers of Shahjahanpur use more herbicide than farmers of Shibganj.

Mortgage:

The land which is taken in exchange of money paid by the mortgagee to the land owner for a fixed period of time under the condition that land would be released upon refunding the money to the mortgagee by the owner is considered as the land under mortgage.

Lease: The land which is taken by the cultivator from the owner in exchange of a certain amount of money for one year or for any period of time for the purpose of cultivating crop is treated as land under lease. Under this criterion, land will automatically be released from the occupancy of the cultivator after the certain period of time.

5.1.2 Risk protective behaviour in cauliflower production

All of the farmers in the study area have faced the major risk protective issue of using mask, gloves,changing cloth after spraying pesticide,. showering emidietly after spraying pesticide.Most of them have a little knowledge on pesticide toxicity(58.58%) , effect on body (93.93%).

5.2 Conclusions

The following conclusions were based on the objectives;

I. The determinants of pesticide use in cauliflower were age, education, highest education level of the family, experience, use of NPK(kg/ha.), use of Pesticide, fungicide and herbicide and risk protective behaviour.

II. 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 and amount of NPK (kg/ha.) usede by the farmer. On the other hand age, education, experience, highest education, family size, 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.

III. 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.

IV. The determinants of comparison among the use of fungicide, insecticide and herbicide in cauliflower production were age, family size, educational level, members invole 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 cauliflower. 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.. 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 cauliflower production related to food security and health concern.

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APPENDIX

A questionnaire for a research study on the "Determinants of pesticide use and risk protective behaviour in cauliflower 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 Cauliflower & (Years)	
Educational Qualification (Year of Schooling)	

Educational code level: 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) Contact Farming	
h) Total Cauliflower/ 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	
	Cauliflower	
	Potato	
	Others	
b) Livestock		
c) Poultry		
d) Fisheries		
e) Others (specify):		

4. Inputs use patterns of Cauliflower 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)				
Total					

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:

Organic fertilizers		
Items	**Amounts (Kg.)**	**Cost**
a) Cow dung		
b) Excreta of chickens		
c) Ash		
d) Vermicompost		
e) Compost		
f) Others (specify):		
Inorganic fertilizers		
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 Cauliflower**:

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		