CARP POLYCULTURE FARMERS' KNOWLEDGE ON GOOD AQUACULTURE PRACTICES

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CERTIFICATE

This is to certify that the thesis entitled, ***"CARP POLYCULTURE FARMERS' KNOWLEDGE ON GOOD AQUACULTURE PRACTICES"*** *submitted to thefaculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***Master of Science (MS) in Agricultural Extension,*** *embodies the result of a piece of bona fide research work carried out by* ***NOOR-E-SHOGGHA****, Registration* ***No. 18-09308****, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that any help or sources of information, as has been availed of during the course of investigation have been duly acknowledged.

Dated: December, 2020
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DEDICATION

DEDICATED TO

THIS THESIS IS LOVINGLY DEDICATED TO MY PARENTS

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ABBREVIATIONS

GDP	Gross Domestic Product
BBS	Bangladesh Bureau of Statistics
NGOs	Non-Government Organizations
GOs	Government Organizations
DoF	Department of Fisheries
FAO	Food and Agriculture Organization
PUFAs	Poly Unsaturated Fatty Acid
SAU	Sher-e-Bangla Agricultural University
GAP	Good Aquaculture Practices
RDRS	Rangpur Dinajpur Rural Service
BRRI	Bangladesh Rice Research Institute
IPM	Integrated Pest Management
FFS	Farmers Field School
SPSS	Statistical Package for Social Sciences
VEOs	Village Extension Officer's
SD	Standard Deviation
Ag. Ext. Ed.	Agricultural Extension Education
Ag. Ext. and Info. Sys.	Agricultural Extension and Information System
B	Multiple regression
MoYS	Ministry of Youth and Sports
AIS	Agriculture Information Service
et. al	All Others

CARP POLYCULTURE FARMERS' KNOWLEDGE ON GOOD AQUACULTURE PRACTICES

NOOR-E-SHOGGHA

ABSTRACT

The objectives of this study were to describe the socioeconomic characteristics of the respondents; to determine the extent of knowledge on good aquaculture practices and to find out the contribution of selected characteristics of the farmers to their knowledge on good aquaculture practices.The study was conducted with randomly selected 120 carpfish farmers in six villages from three unions under sadar upazila of Natore district. An interview schedule was used to collect data from the farmers during 24thDecember, 2020 to 23thJanuary, 2021. Farmers' knowledge on good aquaculture practices was the dependent variable and its was measured on the basis of knowledge scores. Farmers'11 selected characteristics of the respondents contributed the independent variables of the study.Multiple regression was used to examine the contribution of the selected characteristics of the carp poly culture farmers.The highest 19.17 percent of the farmers had high knowledge on good aquaculture practices, 26.66 percent had low knowledge and 54.17 percent had medium knowledge on good aquaculture practices. Five characteristics of the respondent's viz. extension contact for fish farming information, education, age, cosmopoliteness and training exposure had significant positive contribution with their knowledge on good aquaculture practices.It indicates that fish farming information, education, age, cosmopoliteness and training exposure effect on good aquaculture practices in villages.For sustaining and better quality of carp fish cultivation, farmers' need to provide with basic education for better understanding, basic training of good aquaculture practices, forming group with the good practices of carp polyculture farmers for better communication, providing information through media contact as a result farmers can understand the importance of biosafety during culture period for creating future export channel.

CHAPTER I
INTRODUCTION

1.1 Background of the Study

In Bangladesh, fisheries sector play a central role in dietary patterns, livelihoods, and culture. Fish is the most commonly consumed animal-source food across all population groups. Fish is an important diet staple, providing a rich source of micronutrients and accounting for 60% of animal protein intake and now people intake 62.58 gram per head (DoF, 2018). Research shows that increasing fish consumption and dietary diversity can affect significant developmental changes. On the other hand, fat composition of fish is unique in respect of other animal food sources due to presence of poly unsaturated fatty acid (PUFAs) (Kawarazuka, 2010). Those PUFAs reduce the risk of heart disease. Both capture fisheries and aquaculture play substantial roles in fish production and consumption in Bangladesh. Aquaculture currently produces more than 2 million metric tons per year, while small-scale fisheries production is around 1.54 million metric tons. There is great potential to substantially scale-up production with innovations such as community-based fisheries management, sustainable feeds, and low carbon production systems.

Bangladesh's fisheries sector has proved that poverty reduction and rural development are possible without significant development plans and infrastructure projects. Creative initiatives of small farmers, government's supportive policy, and the innovation of scientists are key reasons behind the success of the fisheries sector. In 2018, Bangladesh was the fifth-biggest aquaculture producer in the world, according to the Food and Agriculture Organization (FAO) of the United Nations report "The State of World Fisheries and Aquaculture 2018." In 2019, the FAO had recognized Bangladesh as the eighth top fish producing country in the world. However, this year Bangladesh has broken all its previous records in producing freshwater fish, bagging the second position among the highest fish producing rate countries in the world(Daily sun,20 july-2020). According to the latest report titled 'The State of World Fisheries and Aquaculture-2020', Bangladesh ranks fifth in fish cultivation in the world while China and India are in the first and second place, respectively. According to the report, at present, the growth rate of fish in the country is nine percent. Indonesia is at the top position, with a growth rate of 12 percent.

The fisheries sector in Bangladesh is broadly divided into four sub-sectors- inland capture, inland culture, mariculture (artisanal fisheries), and marine industrial fisheries.

Bangladesh is one of the world's leading inland fisheries producers. It has a vast water resource all over the country in the form of small ponds, ditches, lakes, canals, small and large rivers, and estuaries covering about 4.34 million hectares.Freshwater aquaculture involves pond aquaculture, especially the polyculture of native and exotic species. The country also has a coastal area of 2.30 million hectares and a coastline of 714 kilometres along the Bay of Bengal, which supports large artisanal and coastal fisheries (DoF, 2018). Hence, productivity as well efficiency of culture fisheries is much higher than capture fisheries whereas production of open water bodies showed decreasing trend and availability of some species have greatly reduced but still there is a rampant scope to increase the fish production level by using modern aquaculture technology. Low fish production in the State can be attributed to several reasons. However, knowledge of the fish farmers on scientific fish culture is the single largest known factor responsible for low fish production. Knowledge on scientific fish culture plays a very important role to improve fish production by assisting farmers to make appropriate decision upon adoption of innovations. Knowledge is a component of the behavior of an individual. To improve the present status of aquaculture practice in this country, it is necessary to assess the knowledge of the fish farmers.This would form a base for the future extension efforts. Keeping these facts in view, the present investigation was carried out to 1) determine the extent of knowledge on aquaculture practices, 2) bring out the relationship between selected socio demographic characteristics of respondents and their knowledge on aquaculture practices.

The fisheries sector represents one of the most productive and dynamic sectors in Bangladesh. This sector is playing an increasingly significant role in the economy for the last few decades. This sector is playing a very significant role in the socio-economic development and deserves potential for future growth in the agrarian economy of Bangladesh. However, the fisheries sector of Bangladesh faces several challenges, such as over-fishing, fisheries resources degradation. Several factors are responsible for fisheries resource degradation, which are the construction of roads and embankments, together with drainage, flood control, and natural siltation, the use of pesticides and fertilizers, pollution, upstream damming in major river systems. The massive infrastructure of roads and embankments, urbanisation, and housing projects has blocked many water bodies. This condition has adversely affected the breeding and spawning of

many indigenous fish species. Therefore, many water areas, previously rich in fisheries, now fish became scanty. Fishing communities are mostly also affected because of these reasons.

Good Aquaculture Practices (GAP) are specific methods which, when applied to aquaculture, create food for consumers or further processing that is safe and wholesome. Good Aquaculture Practices (GAP) during on-farm production and post-production processes resulting in safe fisheries products is of immense importance for ensuring a safe food supply. GAP, as defined by FAO, are a "collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food fisheries products, while taking into account economic, social and environmental sustainability"(FAO, 2003). Many importing countries as well as domestic buyers, especially organized retailers, are requiring producers to implement GAP as a prerequisite for procurement to ensure the quality and safety of their produce. In addition, implementing GAP also helps promote sustainable aquaculture and contributes to meeting national and international environmental and social developmental objectives. It has been documented that implementation of GAP encourages promotion of the optimum and right use of resources such as antibiotics, fertilizers,feed quality and recirculatory system of water, and eco-friendly aquaculture.Its social dimension would be to protect the fisheries workers' health from improper use of antibiotics and feed. Farmers are not easily adopting any new technology and their education level is maximum time very low. So, farmers knowledge on good aquaculture practice is also very low. So, increasing knowledge of carp fattening farmers on Good Aquaculture Practice (GAP) is very important issue nowadays. So they require proper incentives. The incentives for farmers to adopt GAPs include economic incentives such as increasing and/or stabilising revenue, reducing average costs, improved market access, increased capital valuation of farm assets, reduced vulnerability to poor aquaculture practices of other farmers; regulatory or legal incentives including changes in ownership rights or tax burdens, liability rules, subsidies; and human capital etc. Disincentives for farmers to adopt GAPs include economic disincentives such as: increased production costs, investment in assets that are specific to one buyer or cannot be recovered if the buyer-seller relationship breaks down; institutional constraints, weak or corrupt public institutions for overseeing GAPs and human capital constraints etc.

The purpose of this study is to set out Good Aquaculture Practices to be implemented to the carp polyculture farmers to improve the safety and quality of their products. This standard specifies the requirements of GAP with respect to all types of fish species covering activities such as production, harvesting and post-harvest handling of farm produce and pack house operations for produce either for sale for direct human consumption or to be used for further processing by the food industry. The fundamental objective of laying down this standard is to strengthen Good aquaculture Practices (GAP) for fisheries in countries. The challenges currently being faced by most countries include the absence of standards for good practices in the farming sector. Most of the food safety standards are focused on end products, whether mandatory technical standards or voluntary standard. So, to face the future challenges we need to improve the awareness level and carp polyculture farmers' knowledge on good aquaculture practices (GAP) of sadar upazila under Natore district.

But now people are becoming interested in carpfish farming and establishing large or small-scale carpfish farm commercially. On these considerations, the present researcher felt the necessity to conduct this research on "Carp polyculture farmers' knowledge on good aquaculture practices".

1.2 Statement of the Problem

Carpfish culture in different region of Bangladesh is increasing in north Bengal day by day. Carp fish culture become very profitable for its higher consumer demand, higher market price,exporting in European countries and middle east countries. But there are also some factors which affect the carpfish culture and cause fish farmer's economic losses and rejection from exporting of carpfish. The development of a carpfish farm has been influenced by production inputs, availability of water,culture method, fish diseases treatment method,application of antibiotics and farmer's knowledge on carpfish culture (Ahmed *et al.,* 2007). Considering the nature of study the researcher sought information regarding following research questions:

1. What is the knowledge of farmers about goood aquaculture practices in carp polyculture?
2. What are characteristics of the carp polyculture farmers?

3. What are the relationships among the farmers with the knowledge of good aquaculture practices in carp polyculture?

1.3 Specific Objectives

The specific objectives of the study:

1. To determine farmers' knowledge on good aquaculture practices
2. To describe the socio-economic characteristics of the carp polyculture farmers:
    - Age
    - Education
    - Experience in carp poly culture
    - Dependency ratio
    - Area under fish culture
    - Annual Family income
    - Annual income from carp polyculture
    - Organizational participation
    - Cosmopoliteness
    - Training exposure
    - Extension contact
3. To explore the contribution of the selected characteristics of the farmers to their knowledge on good aquaculture practices

1.4 Justification of the Study

There are a number of studies have been conducted on farmers knowledge on carp poly culture. Many of them based on pond fish farming/aquaculture knowledge and practices in different culture species.As Bangladesh is becoming a developing country day by day so it is very important to know the good aquaculture practices for carp fish farmers.For exporting carp fishes in foreign countries, it is bound to obey the rules of good aquaculture practices.Aquaculture knowledge is not enough for exporting.There is a need to conduct study on farmers' knowledge on good aquaculture practices for carp fish production. So, this is an urgent need to undertake a study on this perspective. The investigator believes that the findings are likely to be helpful to find out the gap of Carp polyculture farmers' knowledge on good aquaculture Practices (gap) of Natore sadar upazila under Natore

district for the environment friendly aquaculture research and extension system of the country.

1.5 Scope of the Study

The present study was designed to have an understanding of Carp polyculture farmers' knowledge on good aquaculture Practices (GAP) of Natore sadar upazila under Natore district and the characteristics that influence farmer's knowledge. The findings of the study will fit to the areas of Bangladesh where physical, socioeconomic, cultural and geographic condition do not differ much from those of the study area. Thus, the findings are expected to be useful to students, researchers, extension workers, and particularly for planners in formulating and designing the procedures for maintaining the natural balance. The findings may also be helpful to the field workers of different nation building departments to improve strategies of action to conform environment friendly sustainable production to the rural people. Lastly, the researcher believes that the findings and recommendations of this study will definitely lead to the right way of culture of carp fish and simultaneously reduce the risk of environmental damages.

1.6 Assumptions of the Study

An assumption has been defined as "the supposition that an apparent fact or principle is true in light of the available evidence" (Goode, 1945). An assumption is taken as a fact or belief to be true without proof. So, the following assumptions were in mind of the researcher while carrying out this study:

The respondents included in the sample were capable of furnishing proper responses to the questions of the interview schedule.

- Views and opinions furnished by the respondents were the representative views and opinions of the whole population of the study.
- The responses furnished by the respondents were reliable and they truly expressed their opinions on farmers' knowledge on carp polyculture.
- The data collected by the researcher were free from bias.
- The researcher who acted as the interviewer was well adjusted to the social and cultural environment of the study area. Hence, the respondents furnished their correct opinions without any hesitation.

- ❖ The respondents had almost similar background and seemed to be homogenous to a great extent.
- ❖ The information sought by the researcher revealed the real situation to satisfy the objectives of the study.
- ❖ The findings were useful in choosing the clients as well as for planning execution and evaluation the extension programme.

1.7 Limitations of the Study

The present study was undertaken to have an understanding of the carp polyculture farmers' knowledge on good aquaculture practices and to determine the contribution factors with selected characteristics of the farmers. Considering the time, money and other necessary resources available to the researcher and to make the study manageable and meaningful from the point of view of research, it becomes necessary to impose certain limitations. The limitations were as follows:

- ❖ The study was confined in three union of natore Sadar upazila Under natore district.
- ❖ The study was restricted within the carp polyculture farmers who had some culturable pond under their own aquaculture.
- ❖ The population for the study was kept confined to the heads of the family who regularly cultured their pond.
- ❖ There were many characteristics of the farmers but in the study only 11 of them were selected for investigation.
- ❖ For information about the study, the researcher depended on the data furnished by the selected respondents during their interview with her.
- ❖ Major information, facts and figures supplied by the respondents were applicable to the situation prevailing in the locality during the year 2020.

1.8 Definition of Terms

A researcher needs to know the meaning and contents of every term that he uses. It should clarify the issue as well as explain the fact to the investigator and readers. However, for clarity of understanding, a number of key concepts/terms frequently used throughout the study defined are interpreted as follows:

Age: Age was defined as the period of a respondent from her birth to the time of interview. It was measured in terms of years.

Education: Empirically it was defined to the development of desirable changes in knowledge, skill and attitudes in an individual through reading, writing, walking, observation and other selected activities. It was measured on the basis of classes a respondent has passed from a formal educational institution.

Experience in carp fish culture: Experience as a general concept comprises knowledge of or skill of some thing or some event gained through involvement in or exposure to that thing or event. Experience in Carpfish Culture is the knowledge and skill that is gained through time spent doing carpfish culture.

Dependency ratio: The dependency ratio is an age-population ratio of those typically not in the labor force (the dependent part ages 0 to 14 and 65+) and those typically in the labor force (the productive part 9 ages 15 to 64). It is used to measure the pressure on the productive population. Consideration of the dependency ratio is essential for governments, economists, bankers, business, industry, universities and all other major economic segments which can benefit from understanding the impacts of changes in population structure. A low dependency ratio means that there are sufficient people working who can support the dependent population(Simon *et al.* 2012). It is normally expressed as a percentage:

$$\text{Dependency Ratio} = 100 * \left\{ \frac{(\text{No. of people aged 0 to 14}) + (\text{No. of people aged 65 and above})}{\text{Number of people aged 15 to 64}} \right\}$$

Area under fish culture: It refers to the area owned by the farmer on which he cultured carpfish during the season of collection of data for this study.

Annual family income: The term annual family income referred to the total earning of the respondent himself/herself from agriculture, livestock, fisheries and other accessible

sources (business, service, daily labor etc.) during a year. It was expressed in Thousand Taka.

Annual income from carp fish culture: It referred to the earning of the respondent from selling of carpfish and carpfish fry and it was expressed in Thousand Taka.

Organizational participation: Organization participation of an individual refers to his participation in various organizations as ordinary member, executive committee member or executive officer within a specified period of time.

Cosmopoliteness: Cosmopoliteness referred to the degree to which an individual was oriented external to his own social system.

Extension contact for fish farming information: It referred to an individual's (farmer) exposure to or contact with different extension services, source and personalities being used for dissemination of new technologies.

Training exposure: It was used to refer to the completion of an activity by the fish farmers which were offered by the government, semi-govt. or non-government organization (s) to improve the knowledge & skills of farmers for better performing an agricultural job. It was measured by the number of days of training received by the respondent.

Knowledge: It referred to the extent of basic understanding of the farmers in different aspects of bio-safety in fish cultures i.e. species, pond preparation, predatory fish, food availability, food preparation,food safety, diseases, bio-safety, fish harvesting, marketing etc. It referred to the amount of understood information possessed by the farmer on various aspects of good aquaculture practices in carp fish culture.

CHAPTER II
REVIEW OF LITERATURE

This chapter deals with the review of past researches related to this investigation. The reviews are conveniently presented based on the major objectives of the study. In spite of sincere effort, adequate numbers of directly related literature were not readily available for this study. However, the literatures of available studies have been briefly discussed in this chapter.

2.1 Concept of Knowledge

Knowledge can be defined as the 'understanding obtained through the process of experience or appropriate study'. Knowledge can also be an accumulation of facts, procedural rules, or heuristics. Here-

1. A fact is generally a statement representing truth about a subject matter or domain.
2. A procedural rule is a rule that describes a sequence of actions
3. A heuristic is a rule of thumb based on years of experience.

Knowledge is the result of some activity such as generation, storage, dissemination and utilization of something that entails either information or data. It is usually based on learning, thinking, and proper understanding of the problem area. It is not information and information are not data. Knowledge is derived from information in the same way information is derived from data when processed or patterned in human mind. It can be considered as the integration of human mind. It can be considered as the integration of human perceptive processes that helps them to draw meaningful conclusions.So, when a pattern relation exists among the data and information, the pattern has the potential to represent knowledge. It only becomes knowledge, however, when one is able to realize and understand the patterns and their implications.

2.2 Farmers' Knowledge in good aquaculture practices

Knowledge recalls or recognizes information, ideas and principles in the approximate form, which were learned previously (Huitt, W. 2004).

Bhuiyan (2012) indicated that "knowledge may be defined as the scientific fact of an idea which is experimentally or empirically verified."

Boudreau (1995) indicated “human faculty resulting from interpreted information; understanding that germinates from combination of data, information, experience, and individual interpretation. Variously defined as, Things that are held to be true in a given context and that drive us to action if there were no impediments."

Islam (2007) studied on famers‟ knowledge on ecological practices and found that majority (68 percent) of the farmers possessed medium knowledge compared to 23 percent had high knowledge and only 9 percent low knowledge on ecological agriculture.

Nurzaman (2000) conducted a study on knowledge, attitude and practices of FFS and non-FFS farmers in respect of IPM. His study at sadarupazilla under Mymensingh district revealed that the FFS farmers had a significant higher knowledge on IPM than the non-FFS farmers.

Mandal (2016) found that, majority (64.3 %) of the farmers possessed ‘medium knowledge’ while 20.7 and 15.0 percent of the farmers possessed ‘low’ to ‘high knowledge’ respectively in watermelon cultivation.

Mondal (2014) found that, Majority (54 percent) of the farmers possessed medium knowledge while 27.4 and 14.6 percent of the farmers possessed low and high knowledge respectively on strawberry cultivation.

Hossain (2003) found in his study on farmers’ knowledge and adoption of modern sugarcane cultivation practices found that highest proportion (84 percent) of the farmers possessed medium knowledge, 13 percent high knowledge and lowest proportion (3 percent) possessed low knowledge.

Saha (2001) conducted a study to determine farmers’ knowledge in improved practices of pineapple cultivation and found that the majority (62 percent) of the farmers possessed good knowledge, 33 percent poor knowledge and only 5 percent possessed excellent knowledge.

Parvene (1995) in her study found that 58 percent of the farm women had moderate knowledge while 35 percent had high and 7 percent had poor knowledge on the use of fertilizer, pesticides and irrigation water.

Abolagba (2006) showed that a higher percentage of the farmers (42.1% and 36.8%) were hobby and part time farmers and the average age of the farmers was 47 years. About 94.7% of the farmers feed their fish using locally available feed ingredients; 89.5% and 26.3% of the farmers use poultry dropping and single super phosphate fertilizers, respectively to fertilize their ponds while 63.2% do not lime their ponds. The pond management practices were and can be generally considered as fair.

Akankali*et al.* (2011)showed in their articles reviews the fish pond management processes, stocking of ponds, feeding of fish, types of culture, fish farming combined with other branches of agriculture, rearing of fish for purposes other than food, other fish culture, types of fish used for fish culture in central east Africa, general biology of the species of 13 value in fish culture and suitable combinations of fish for stocking to reawaken the minds of individuals, companies and government on the need to develop pond fish culture in Nigeria.

2.3 Literatures Related to Relationships between Selected Characteristics of the Farmers and Knowledge

2.3.1 Age and knowledge

Islam *et al.* (2019) concluded that age of the farmers had no significant relationship with their knowledge on climate change effects in agriculture.

Rahman (2006) found in his study that age of the farmers had a significant and negative relationship with their knowledge on prawn culture. Similar results were observed by Sarker (2002), Kashem (1987), Hansara and Chopra (1986) in their respective studies.

Roy (2005) found in his study that age of the farmers had no significant relationship with their knowledge on boro rice cultivation. Similar results were observed by Khan (2005), Islam (2005) and Rahman (2004) in their respective studies.

Akhter (2003) found in his study that the age of the farmers had no significant relationship with their knowledge on agricultural activities.

Saha (2003) found no relationship between poultry farmers' age and their knowledge on poultry production.

Sana (2003) found in his study there was no relationship of age with their knowledge in shrimp farming.

Sarker (2002) conducted a study on farmer's knowledge of and attitude towards BRRI dhan 29 variety of rice and found that the age of the farmers was not related to farmer's knowledge on BRRI dhan 29.

Saha (2001) made an attempt on farmer's knowledge on improved practices of pineapple cultivation and found that the age of the farmers had no significant relationship with their knowledge on improved practices of pineapple cultivation.

Rahman (2001) conducted a study to determine the knowledge, attitude and adoption of the farmers regarding Alok 6201 hybrid rice. He found that age of the farmers was not related to farmer's knowledge on Alok 6201 hybrid rice.

Hossain (2000) in his study found that age of the farmer's had no significant relationship with their knowledge on Binadhan-6 technology.

Rayaparaddy and Jayaranaiah (1989) worked on Village Extensions Officer's (VEOs) knowledge of rice production technology, and found that age of the VEOs showed negative relationship with the knowledge level of VEOs.

Chandargi (1980) found that there was significant association between age and knowledge gain as a result of training. Mundhua and Patel (1987) found that the farmer's age and their level of knowledge had a significant relationship.

2.3.2 Education and knowledge

Islam *et al.* (2019) concluded that education of the farmers had no significant relationship with their knowledge on climate change effects in agriculture.

Nasrin *et al.* (2019) concluded that education of the farmers had positive significant relationship with their knowledge on pesticide application in vegetable cultivation.

Rahman (2006) observed in his study that education level of the farmers had significant and positive relationship with their knowledge on prawn culture.

Roy (2005) in his study found that education level of the farmers had significant and positive relationship with their knowledge on boro rice cultivation.

Islam (2005) in his study explored that education level of the farmers had significant positive relationship with their knowledge on IPM in crop production.

Rahman (2004) in a study found that level of education of the farmers had significant and positive relationship with their knowledge on boro rice cultivation.

Hossain (2003) found that with increased level of education of the farmers, there was a corresponding increase in the knowledge level of modern Boro rice farmers.

Akhter (2003) found in his study that level of education of the farmers had a significant and positive relationship with their knowledge on agricultural activities.

Saha (2003) found among the six independent variables, only education was positively and significantly related at 0.01 level of probability with poultry farming knowledge.

Sana (2003) found that education of the shrimp farmers were found to be significantly related with the knowledge of shrimp culture.

Sarker (2002) conducted a research on farmer's knowledge of and attitude towards BRRI Dhan 29 variety of rice and found that education of the respondents had positively relationship with their knowledge of BRRI Dhan29.

Saha (2001) found that the education of the farmers had a positive significant relationship with their knowledge on improved practices of pineapple cultivation.
Hossain (2000) found that the education of the respondents had significant positive relationship with their knowledge on Binadhan-6.

2.3.3 Experience and knowledge

Islam (2008) found that vegetable cultivation experience had a positive and substantial significant relationship with knowledge on vegetables production activities by woman members in homestead area under world vision project.

Mandal (2016) in his study concluded that watermelon cultivation experience of the farmers had no significant relationship with their knowledge on watermelon cultivation.

Azad (2014) in his study concluded that vegetable cultivation experience of the farmers had significant relationship with their knowledge on post harvest practices of vegetables.

Tanushree (2015) observed in her study that strawberry cultivation experience of farmers had positive significant relationship with knowledge on strawberry cultivation. In their different study, Rayaparaddy and Jayaranaiah (1989) and Setty (1973) found that experience of the farmers had no relationship with their knowledge.

Habib (2000) reported that experience of the farmers had a positive significant relationship with their attitude.

Sarker (2002) reported that experience of the farmers had a positive significant relationship with their attitude.

2.3.4 Dependency ratio and knowledge

A high dependency ratio can cause serious problems for a country if a large proportion of a government's expenditure is on health, social security & education, which are most used by the youngest and the oldest in a population. The fewer people of working age, the fewer the people who can support schools, retirement pensions, disability pensions and other assistances to the youngest and oldest members of a population, often considered the most vulnerable members of society. Dependency ratio is a value comes from family size. So, literature related to family size and effectiveness are mentioned below:

Rahman (2004) found in his study that family size of the farmers had no significant relationship with their knowledge on boro rice cultivation practices.

Hossain (2003) found that family size of the farmers was not significantly related to farmers' knowledge on modern Boro rice cultivation practices.

Farhad (2003) found that family size of rural women farmer had no significant relationship with their knowledge in using IPM in vegetable cultivation.

Sana (2003) revealed that family size of the farmers was not related to their knowledge of shrimp culture.

Sutradhar (2002) found that family size of the respondents had a significant positive relationship with their awareness on environmental degradation.

Hanif (2000) found that in his study there was a positive insignificant relationship between family size of the respondents and their awareness on environmental pollution.

Hossain (2000) found that family size of the farmers had significant positive relationship with their knowledge on Binadhan-6.

Parveen (1995) revealed that family size of the farm women had a positive significant relationship with their knowledge on the use of fertilizer, pesticides and irrigation water.

Kashem (1987) in his study, however, did not find any significant relationship between family size and agricultural knowledge of the farmers.

Shidhu (1980) found that family size was not associated with the level of knowledge toward dairying.

2.3.5 Area under Fish culture and knowledge

Tanushree (2015) observed in her study that strawberry cultivation area of farmers had positive significant relationship with knowledge on strawberry cultivation.

Rahman (2015) also observed in his that BRRI dhan 47 cultivation area of rice farmers had positive significant relationship with knowledge on BRRI dhan 47 cultivation.

Vegetable cultivation area had a positive and substantial significant relationship with knowledge on vegetables production activities by women members in homestead area under world vision project. The result found by (Islam, 2004)

2.3.6 Income and knowledge

Ali (1984) also found that income of the contact and non-contact farmers differed significantly. He also found that income of the contact and non-contact farmers had significant positive contribution to both of their agricultural knowledge and adoption of innovations.

Hossain (2003) found that income of the rural women farmers had negative relationships with their knowledge of modern Boro rice cultivation.

Nurzzaman (2000) found that incomes of the rural women farmers had no relationships with their knowledge of the FFS and non-FFS farmers.

Sharma and Sonoria (1983) found that both the contact and non-contact farmers were different in their size of operational holdings. However, they found no significant differences in knowledge of both the contact and non-contact farmers with the size of their operational holdings.

Islam (1996) found that there was significant and negative relationship between the farm size of the farmers and their extent of use of indigenous technical knowledge.

Alam (1997) studied the use of improved farm practices farm in rice cultivation by the farmers. The findings of the study showed that the farm size had a significant relationship with their use of improved farm practices in rice cultivation. Similar results were found by Verma and Kumar (1991).

Amin (2001) found that farm size of PETRRA and non-PETRRA beneficiaries had no relationship with knowledge on organic cocoon and skills on production, procession and storing of rice seed.

Hossain (2003) reported that farm size of the farmers had significant relationship with modern Boro rice cultivation.

2.3.7 Income from carp polyculture and knowledge

Income from vegetable cultivation had a positive and substantial significant relationship with knowledge on vegetables production activities by women members in homestead area under world vision project. The result found by (Islam, 2002).

Income from vegetable cultivation had a positive and no significant relationship with knowledge on postharvest practices of vegetables (Azad, 2013).

2.3.8 Organizational participation and knowledge

Islam *et al.* (2019) concluded that organizational participation of the farmers had positive significant relationship with their Knowledge on climate change effects in agriculture.

Nasrin *et al.* (2019) concluded that organizational participation of the farmers had no significant relationship with their knowledge on pesticide application in vegetable cultivation.

Ahmad (1974) concluded that there is a relationship between organizational participation of farmers and their agricultural knowledge.

Alam (1997) fond that organizational participation of the rice farmers had no significant relationship with their use of improved farm practices in rice cultivation.

Ali (1984) found that organizational participation of contact and non-contact farmers had significant positive contribution to their agricultural knowledge.

Hamid (1995) found a positive significant relationship between organizational participation of the farmers and their awareness on environmental pollution.

Hoque (1984) concluded that organizational participation of the farmers had a significant relationship with the adoption of improved practices in sugarcane cultivation.

Hossain (1991) reported that organizational participation had a significant and positive relation with the adoption of improved farm practices in wheat cultivation.

2.3.9 Cosmopoliteness and knowledge

Islam et al. (2019) concluded that cosmopoliteness of the farmers had positive significant relationship with their knowledge on climate change effects in agriculture.

Hossain (2000) concluded that cosmopoliteness of the farmers had no significant relationship with their knowledge and perception of Binadhan-6 in the boro season.

Hussen (2001) concluded that cosmopoliteness of the farmers had positive significant relationship with their knowledge and adoption of modern sugarcane cultivation practices.

2.3.10 Training Exposure and knowledge

Islam *et al.* (2019) concluded that training received of the farmers had positive significant relationship with their Knowledge on climate change effects in agriculture.

Nasrin *et al.* (2019) concluded that training received of the farmers had positive significant relationship with their knowledge on pesticide application in vegetable cultivation.

Sana (2003) found that training received of the farmers had a positive significant relationship with their knowledge in shrimp culture.

Hossain (2001) found that the length of the training of the respondents had positive relationship with their knowledge of crop cultivation.

2.3.11 Extension contact and knowledge

Sana (2003), Sarker (2002) and Rahman (2001) found in their study that media exposure of farmers were highly positive significant relationships with their knowledge.

Abdullah (2013) in his study concluded that extension contact of the farmers had no significant relationship with their knowledge on pond fish culture.

Hossain (2000) concluded that media exposure of the farmers had a significant relationship with their knowledge.

Rahman (1995) study on farmers' knowledge on improved practices of potato cultivation by the farmers of Kajipurupazilla of Sirajgonj district. The study indicated a significant relationship between extension contact of farmers and their knowledge on improved practices of potato cultivation.

Hossain (1991) in his study found that extension media contact of the farmers was significantly related to farmer's knowledge of crop cultivation.

Rayaparaddy and Jayaramaish's (1989) working on Village Extension Officer's (VE0s) knowledge on rice production technology revealed that training had significant positive relationship with the knowledge levelof VEOs.

Kaur (1988) found that extension contact and mass media exposure had significant influence upon opinion and level of knowledge of selected programme of rural women.

Ali (1984) found that contact and non-contact farmers differed significantly in respect of their media exposure. He observed that media exposure of the contact and non-contact

farmers had significant contribution towards their agricultural knowledge.

The findings of the study of Manjunatha (1980) revealed that the trained farmers had higher knowledge level and adopting behaviour compared to untrained farmers.

Venugopal (1977) found that there was a significant association between the overall knowledge of agricultural extension officers in respect of rice cultivation and type of training received by them.

Ahmed (1974) found that here was a significant positive relationship between extension contact of the farmers and their agricultural knowledge.

2.4 Conceptual Framework of the Study

In scientific research, selection and measurement of variables constitute on important task. The hypothesis of a research while constructed properly contains at least two important elements i.e. a dependent variable and an independent variable. A dependent variable in that factor which appears, disappears or varies on the researcher introduces, removes or varies as the independent variables. An independent variable is that factor which is manipulated by the researcher in this attempt to ascertain its relationship to an observed phenomenon. A simple conceptual framework for the study is shown in Figure 2.1.

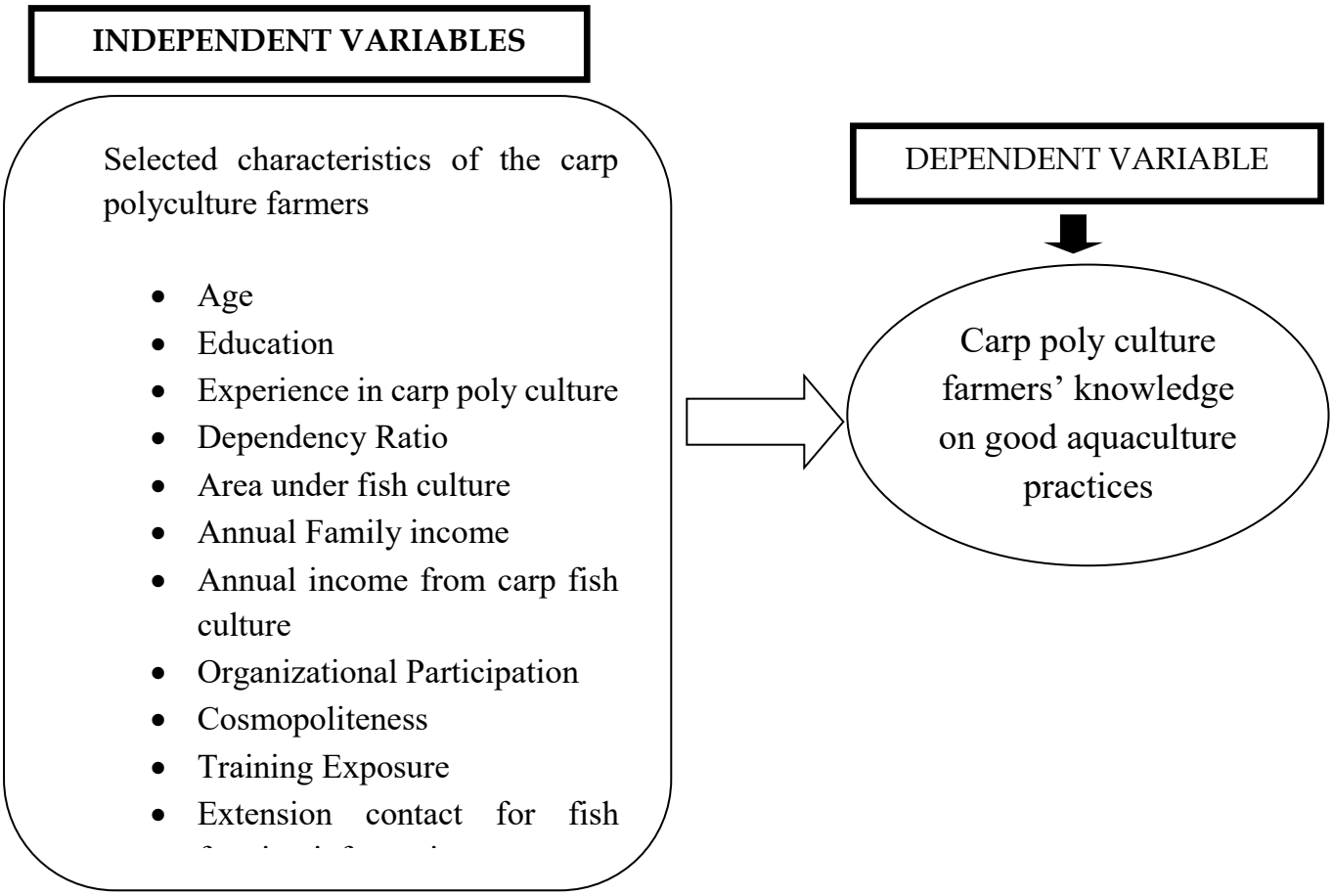

Figure 2.1: The conceptual framework of the study

CHAPTER III
METHODOLOGY

Methods play an important role in a scientific research. To fulfill the objectives of the study, a researcher should be very careful while formulating methods and procedures in conducting the research. According to Mingers (2001), research method is a structured set of guidelines or activities to generate valid and reliable research results. This chapter of the thesis illustrates the research methods and procedures used to collect and analyze the data for answering the research questions and attaining the purposes. The methods and operational procedures followed in conducting the study e.g. selection of study area, sampling procedures, instrumentation, categorization of variables, collection of data, measurement of the variables and statistical measurements. A chronological description of the methodology followed in conducting this research work has been presented in this chapter.

3.1 Locale of the study

Natore Sadar is a suitable place for fish culture for it's water quality and culture technique of farmers.So carp polyculture is famous in farmers level now-a-days.The study was conducted of six villages from three union in sadar upazila under Natore district. The researcher properly selected three unions from the upazila namely Borohorishpur, Satni and Dighapotia. The selected study areas are much improved in carpfish culture. The map of the study area is shown in figure 3.1 & 3.2.

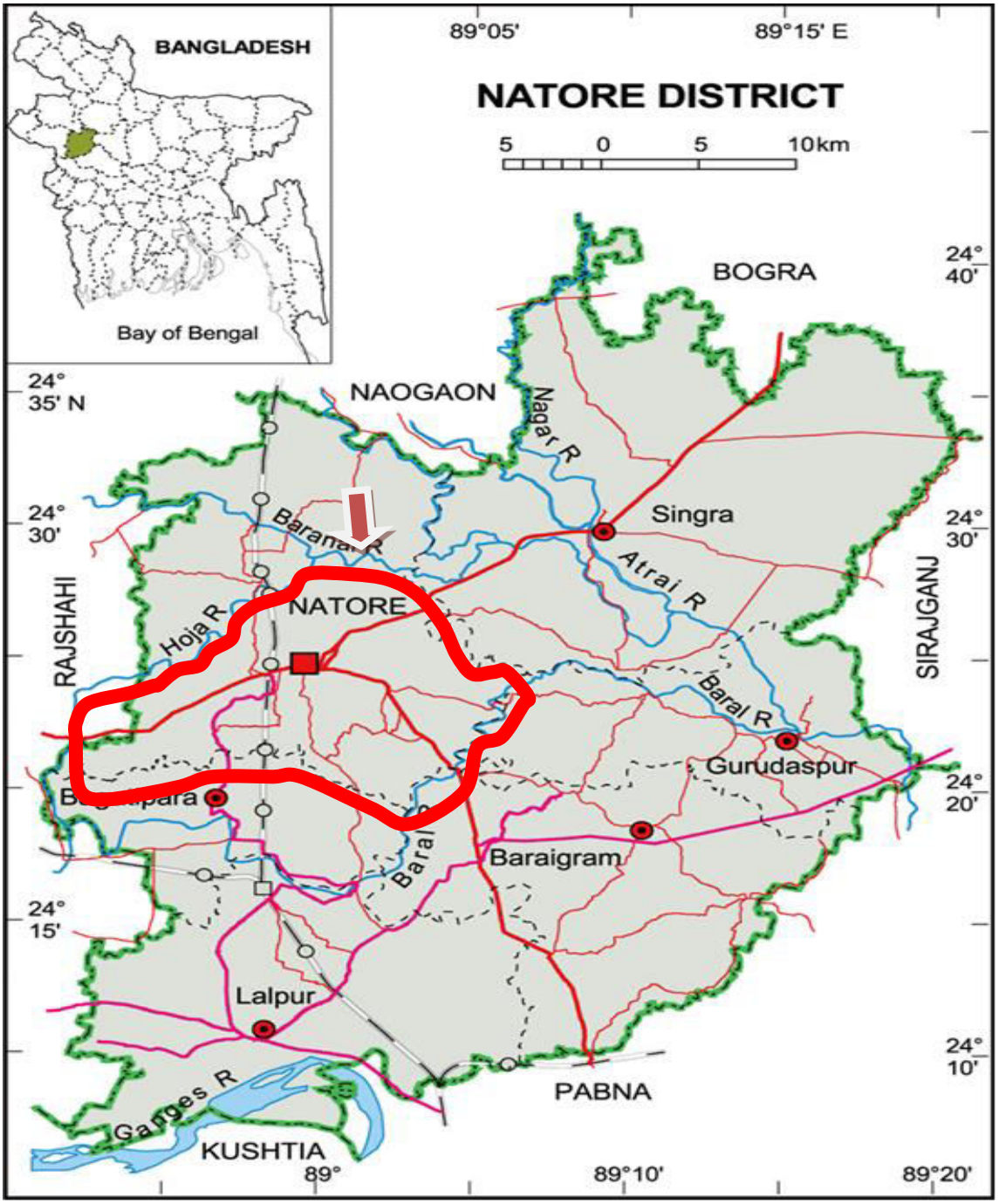

Figure3.1 Map of Natore district showing the study area

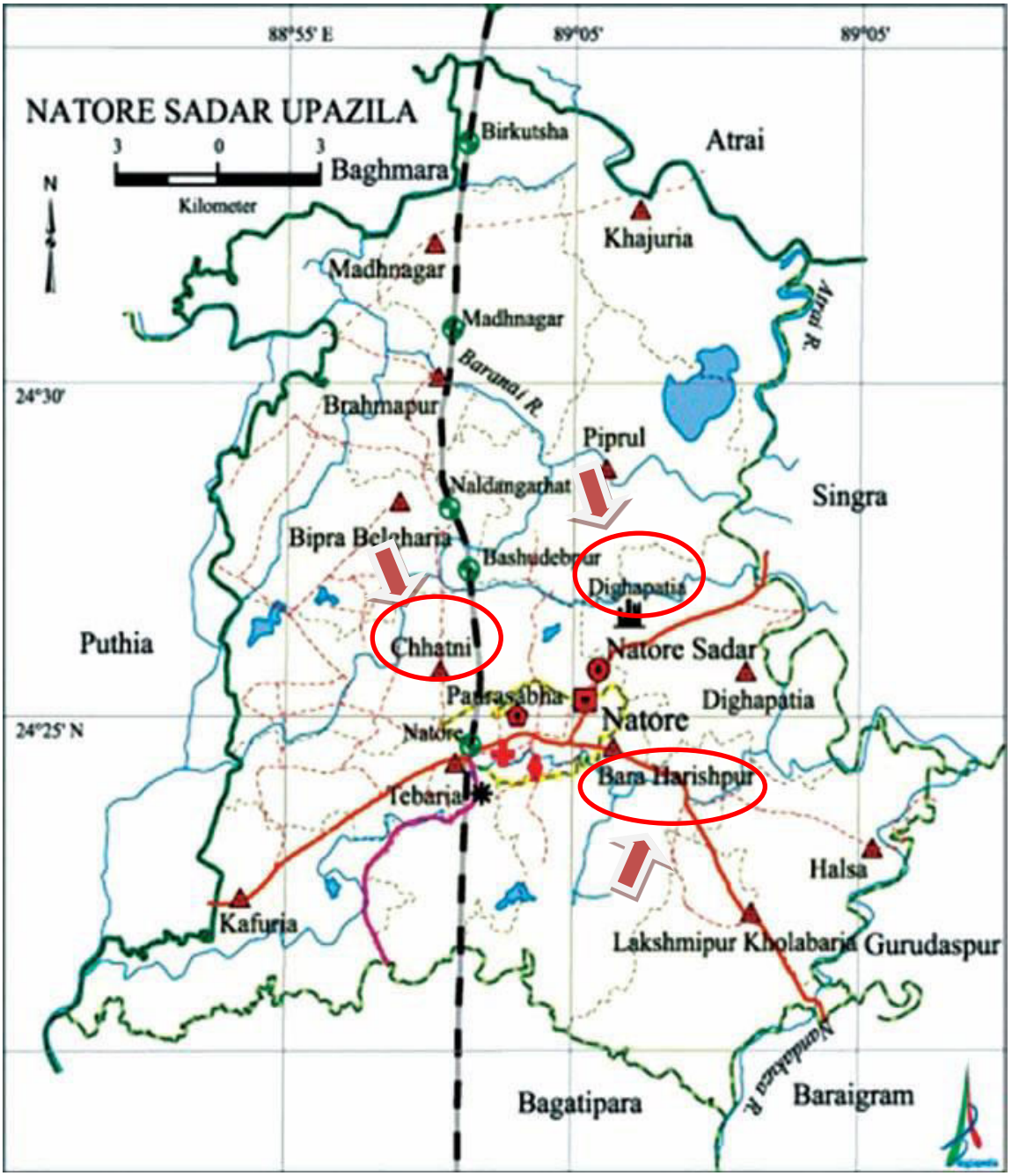

Figure 3.2: Map of Union in Sadar Upazila of Natore district showing the study area

3.2 Population and Sampling Design

All the farmers who permanently reside in the selected villages of Borohorishpur, Satni and Dighapotia union of nature Sadar upazila and culture carp fishes were constituted the active population of this study. The fish farmers who culture carp fishes of Horishpur, Dholat of Borohorishpur union, Agdhigha, Majdhigha of satni union and vaturia, Dhighapotia of Dighapotia union of nature Sadar upazila under Natore district were the population of the study. However, representative sample from the population were taken for collection of data following random sampling technique. One farmer (who mainly operated the carp fish culture) from each of the families was considered as the respondent. Updated lists of all the fish farmers of the selected villages were prepared with the help of field level workers and local leaders. A purposive sampling procedure was followed to select one district from the whole of Bangladesh, and the same method was used to select the area of the district as well as the villages as the study group. The total number of carp fish culture farmers of the selected villages were 241; where 41 farmers from Dholat, 20 farmers from Horishpur of Borohorishpur union, 58 farmers from Agdhigha, 30 farmers from Majdhigha of Satni union and 69 farmers from vaturiya, 23 farmers from Dighapotia of Dhighapotia union which constituted the population of the study. Thus, 241 farmers constituted the population of the study which is shown in the following Table 3.1

3.2.1 Determination of sample size

The population for the study was 241. As the population size is small, therefore the researcher followed percentage method rather than standard statistics formula. The fifty percent (50%) of the population size was considered as sample of the study. So, the sample size (n) was = 120.

3.2.2 Distribution of the population, sample size and reserve list

According to taken a representative percentage of population, the respondents comprised of 120 farmers. A reserve list of 12 carpfish farmers (ten percent of the sample size) were also prepared so that the farmers of this list could be used for interview if the farmers included in the original sample were not available at the time of conduction of interview. The carpfish culture farmers of the selected villages were measured according to the proportionate of the total sample size. The distribution of the

population, the number of sample size and number of respondents along with the reserve list are given in the following Table 3.1.

Table 3.1 Distribution of the carpfish culture farmers according to population and reserve list

Selected upazila	Selected union	Selected villages	Population	Sample size	Reserve list
Natore Sadar	Borohorishpur	Dholat	41	20	2
		Horishpur	20	19	2
	Satni	Majdigha	58	19	2
		Agdhigha	30	21	2
	Dighapotia	Vaturiya	69	19	2
		Dighapotia	23	22	2
			241	120	12

3.3 Data collection tools

Structured interview schedules were prepared to reach the objectives of the study. The schedule was prepared containing open and closed form of questions. The open questions allowed for the respondents to give answers using their own language and categories (Casley and Kumar, 1998). The questions in this schedule were formulated in a simple and unambiguous way and arranged in a logical order to make it more attractive and comprehensive. The instruments were first developed in English and then translated into Bengali. The survey tools were initially constructed based on an extensive literature reviews and pre-tested. The schedule was pretested with 20 randomly selected carp fish culture farmers in the study area. The pre-test was helpful in identifying faulty questions and statements in the draft schedule. Thus, necessary additions, deletions, modifications and adjustments were made in the schedule on the basis of experiences gained from pre-test. The questionnaires were al-so checked for validity by supervisor and educational experts at Sher-e-Bangla Agricultural University (SAU). Finally, based on background information, an expert appraisal and the pre-test, the interview schedule was finalized. Data was gathered by the researcher personally. During data collection, necessary cooperation was obtained from field staff of different GOs and NGOs and local leader. The primary data were collected from 2 December to 6 December, 2020. Books, journals, reports and internet documents were used as secondary sources of data supporting or supplementing the empirical findings of the study. The final data collection was started from 24 December and completed in 23 January, 2021.

3.4 Variables and their measurement techniques

The variable is a characteristic, which can assume varying, or different values in successive individual cases. A research work usually contains at least two important variables viz. independent and dependent variables. An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variable (Townsend, 1953). In the scientific research, the selection and measurement of variable constitute a significant task. Following this conception, the researcher reviewed literature to widen this understanding about the natures and scopes of the variables relevant to this research. At last, he had selected 11 independent variables and one dependent variable. The independent variables were: age, education, experience in carpfish culture, dependency ratio, area under fish culture, annual family income, annual income from carpfish culture, organizational participation, cosmopoliteness, training exposure and extension contact for fish farming information. The dependent variable of this study was the 'carp polyculture farmers' knowledge on good aquaculture practices in Natore sadar under nature district'. The methods and procedures in measuring the variables of this study are presented below:

3.4.1 Measurement of independent variables

The 11 characteristics of the carp polyculture farmers mentioned above constitute the independent variables of this study. The following procedures were followed for measuring the independent variables.

3.4.1.1 Age

Age of the farmers was measured in terms of actual years from their birth to the time of the interview, which was found on the basis of the verbal response of the rural people (MoYS, 2012). A score of one (1) was assigned for each year of one's age. This variable appears in item number 1 in the interview schedule as presented in Appendix-I.

3.4.1.2 Education

Education was measured by assigning score against successful years of schooling by a farmer. One score was given for passing each level in an educational institution (Rashid, 2014). For example, if a farmer passed the final examination of class five or equivalent examination, his/her education score has given five (5). Each farmer of can't read and write has given a score of zero (0). A person not knowing reading or writing but being able to sign only has given a score of 0.5. If a farmer did not go to school but took non-formal education, his educational status was determined as the equivalent to a formal school student. This variable appears in item number 2 in the interview schedule as presented in Appendix-I.

3.4.1.3 Experience in carpfish culture

Experience in carpfish culture of the farmer was determined by the total number of years involved in carpfish culture. A score of one (1) was assigned for each year carpfish culture. This variable appears in item number 3 in the interview schedule as presented in Appendix-I.

3.4.1.4 Dependency ratio

The dependency ratio is a measure of the number of dependents aged zero (0) to 14 and over the age of 65, compared with the total population aged 15 to 64. The scoring was made by the actual number of family members expressed by the farmers. For example, if a farmer had five members in his/her family, his/her score was given as 5. This variable appears in item number 4 in the interview schedule as presented in Appendix-I.

3.4.1.5 Area under fish culture

Area under fish culture of a farmer referred to the total area of land on which his/her family carried out the fish culture, the area being in terms of full benefit to the family. The data was first recorded in terms of measurement unit i.e.hectare. This variable appears in item number 5 in the interview schedule as presented in Appendix-I.

3.4.1.6 Annual family income

Annual family income of a fish farmer was measured in Thousand Taka. The total yearly earning from agricultural (field crops, vegetables, fruits, spices, livestock and

fisheries) and nonagricultural sources (service, business, and others) by the respondent himself and other members of his family was determined. Thus, yearly earning from agricultural and nonagricultural sources were added together to obtain annual family income of a fish farmer. A score of one was given for each Tk. 1,0000 to compute the annual income scores of the respondents. This variable appears in item number 6 in the interview schedule as presented in Appendix-I.

3.4.1.7 Annual income from carpfish culture

Annual income from carpfish culture was measured in Thousand Taka. It refers to the earning of the respondent from selling of carpfish and catfish fry. A score of one was given for each Tk. 1,0000 to compute the annual income scores of the respondents. This variable appears in item number 7 in the interview schedule as presented in Appendix-I.

3.4.1.8 Organizational participation

Organizational participation of a respondent was measured on the basis of the nature of his involvement in different organizations found operating in the study area. Organizational participation scores were assigned in the following manner for activities of individual respondents in each group or organization. Score of one (1) was assigned for ordinary member, score of two (2) was assigned for executive committee member, Score of three (3) was assigned for executive committee officer. The researcher identified 4 organizations in the study area as shown in item number 8 in the interview schedule as presented in Appendix-I.

3.4.1.9 Cosmopoliteness

Cosmopoliteness of a respondent was measured in terms of his nature of visits to the eight different places external to his own social system and as shown in item number 9 in the interview schedule. The respondents indicated whether they visited those places frequently, occasionally, rarely and not at all. Weights assigned to these visits were 3, 2, 1 and 0 respectively. A respondent's cosmopoliteness score was obtained by adding the weights for his visits to all the places listed in the instrument. The cosmopoliteness score of the respondents could range from 0 to 24, where 0 indicating no cosmopoliteness and 24 indicating high cosmopoliteness.

3.4.1.10 Training exposure

Training exposure of farmers was determined by the total number of training relative to carpfish culture received in his/her life regarding carpfish culture activities. A score of one (1) was assigned for each type of training attended. This variable appears in item number 10 in the interview schedule as presented in Appendix-I.

3.4.1.11 Extension contact for fish farming information

This variable was measured by computing a extension contact for fish farming information score on the basis of a respondent's extent of contact with 5 selected media as obtained in response to item number 11 of the interview schedule as presented in Appendix-I. Each respondent was asked to indicate the frequency of his contact with each of the selected media. With four alternative responses as 'regularly', 'occasionally', 'rarely' and 'not at all' basis and weights were assigned as 3, 2, 1 and 0 respectively. The extension contact score of a respondent was determined by summing up his/her scores for contact with all the selected media. Thus, possible extension contact score could vary from zero (0) to 15, where Zero indicated no extension contact and 15 indicated the highest level of extension contact.

3.4.2 Measurement of dependent variable

Knowledge refers to the ability of a respondent to recall or recognize items of information related to anything. Knowledge on good aquaculture practices in carp fish production was the dependent variable of the study. It was measured based on Knowledge good aquaculture practices in carp fish production. The knowledge on good aquaculture practices in carp fish production was determined by computing a knowledge score based on the responses against 23 questions good aquaculture practices in carp fish production. These questions were developed under the concept of Blooms Taxonomy to define and distinguish different levels cognition of respondents. The Bloom's Taxonomy helped the researcher to distinguish between Higher Order Thinking Skills (HOTS) and Lower order Thinking Skills(LOTS) of the respondents. At the lowest level respondents just remembered the information, then understanding, then applications, then analysis, Evaluation and at highest level it is creation of knowledge. This helped the researcher in forming strategies for delivering the 23 content. From each components of Blooms Taxonomy, a pair of question were developed. Each of the question carried a full weight of 2 (two). For correct answer

respondents was given full marks. If respondents are unable to provide the answer than he or she got zero marks. Thus, knowledge score of a farmer could range from 0 to 46, where '0' indicated very low knowledge and 46 indicated highest level of knowledge on good aquaculture practices in carp fish production.

3.5 Hypothesis of the study

According to Kerlinger (1973) a hypothesis is a conjectural statement of the relation between two or more variables. Hypothesis are always in declarative sentence form and they are related, either generally or specifically from variables to variables. In broad sense hypotheses are divided into two categories: (a) Research hypothesis and (b) Null hypothesis.

3.5.1 Research hypothesis

Based on review of literature and development of conceptual framework, the following research hypothesis was formulated: "Each of the 11 selected characteristics (age, education, experience in carpfish culture, dependency ratio, area under fish culture, annual family income, annual income from carpfish culture, organizational participation, cosmopoliteness, training exposure and extension contact for fish farming information)of the farmers has significant contribution to their knowledge on good aquaculture practices." However, when a researcher tries to perform statistical tests, then it becomes necessary to formulate null hypothesis.

3.5.2 Null hypothesis

A null hypothesis states that there is no contribution between the concerned variables. The following null hypothesis was formulated to explore the contribution of the selected characteristics to knowledge on good aquaculture practices. Hence, in order to conduct tests, the earlier research hypothesis was converted into null form as follows: "There is no contribution of the selected characteristics (age, education, experience in catfish culture, dependency ratio, area under fish culture, annual family income, annual income from catfish culture, organizational participation, cosmopoliteness, training exposure and extension contact for fish farming information of carpfish farmers to their knowledge on good aquaculture practices."

3.6 Data processing and analysis methods

Bogdan and Biklen (2006) insist that data analysis is an on-going part of data collection. Initially, all collected data were carefully entered in Access, exported to Microsoft Excel. Exported data were checked randomly against original completed interview schedule. Errors were detected and necessary corrections were made accordingly after exporting. Further consultation with research assistants and in some cases with the community people were required. Finally, data were exported from the program Microsoft Excel to SPSS/windows version 22.0, which offered statistical tools applied to social sciences. Qualitative data were converted into quantitative numbers, if required, after processing, scaling and indexing of the necessary and relevant variables to perform subsequent statistical analysis for drawing inferences. As outlined earlier, there are many different forms and methods that can be used to analyze both quantitative and qualitative data in accordance with the objectives of the study. Both descriptive and analytical methods were employed in order to analyze the data. Descriptive techniques have been used to illustrate current situations, describe different variables separately and construct tables and graphs presented in results. These included: frequency distribution, percentage, range, mean, median, standard deviation and coefficient of variance. In most cases the opinions of respondents were grouped in broader categories. Analytical techniques have been utilized to investigate the contribution of the selected characteristics of the farmers to their problems in catfish culture. Statistical test like regression was used in this study. Each statistical technique is used under specific conditions and depends on the measurement scale of different variables.

3.7 Statistical analysis

Regression analysis was used to identify the linear combination between independent variables used collectively to predict the dependent variables (Miles and Shevlin, 2001). Regression analysis helps us understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. Ordinary Least Squares (OLS) is used most extensively for estimation of regression functions. In short, the method chooses a regression where the sum of residuals, ΣUi is as small as possible (Gujarati, 1995). The factors that contribute to the knowledge of the farmers in carpfish culture are analyzed using a regression model. The overall quality of fit of the model has been tested by

ANOVA specifically F and R^2 test. The data were analyzed in accordance with the objectives of the proposed research work. The factors that contribute to the knowledge of the farmers in carpfish culture are analyzed using a regression model, multiple regression analysis (B) was used. Throughout the study, five (0.05) percent and one (0.01) percent level of significance were used as the basis for rejecting any null hypothesis. If the computed value of (B) was equal to or greater than the designated level of significance (p), the null hypothesis was rejected and it was concluded that there was a significant contribution between the concerned variable. Whenever the computed value of (B) was found to be smaller at the designated level of significance (p), the null hypothesis could not be rejected. It was concluded that there was no contribution of the concerned variables.

The model used for this analysis can be explained as follows:

$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11} + e$

Y= is the knowledge of the farmers in carpfish culture; Of the independent variables,

x_1 is the age of farmer,

x_2 is education,

x_3 is experience in carpfish culture,

x_4 is dependency ratio,

x_5 is area under fish culture,

x_6 is annual family income,

x_7 is annual income from carpfish culture,

x_8 is organizational participation,

x_9 is cosmopoliteness,

x_{10} is training exposure and

x_{11} is extension contact for fish farming information.

On the other hand, b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9, b_{10}, and b_{11} are regression coefficients of the corresponding independent variables, and e is random error, which is normally and independently distributed with zero mean and constant variance.

CHAPTER IV
RESULT AND DISCUSSION

Recorded observations were presented with the objective of the study and discussed with justifiable and relevant comments under this chapter. The results of the study and their interpretation have been presented in this chapter. These are presented in three sections according to the objective of the study. The first section deals with farmers' knowledge on good aquaculture practices, while the second section describes the selected characteristics of the farmers. The third section describes the Contribution of the selected characteristics of the respondents to their knowledge on good aquaculture practices.

4.1 Farmers' knowledge on good aquaculture practices

Farmers' knowledge on good aquaculture practices scores of the farmers ranged from 8 to 46 against possible score of 0 to 46. The average score and standard deviation were 31.24 and 8.53, respectively. Based on the knowledge on good aquaculture practices scores, the farmers were classified into three categories (Mean ± Standard Deviation) namely low, medium and high knowledge on good aquaculture practices. The distribution of the farmers according to their knowledge on good aquaculture practices is presented in Table 4.1

Table 4.1 Distribution of the farmer according to their knowledge

Categories	**Farmers**		Mean	SD
	Number	Percent		
Low knowledge (up to 23)	32	26.66	31.24	8.53
Medium knowledge (24-39)	65	54.17		
High knowledge (>39)	23	19.17		
Total	**120**	**100**		

Data presented in the table 4.1 revealed that 19.17 percent of the farmers had high knowledge on good aquaculture practices, 26.66 percent had low knowledge and 54.17 percent had medium knowledge on good aquaculture practices. Thus, an overwhelming majority (73.34 percent) of the farmers had medium to high knowledge on good aquaculture practices.This led to understanding that knowledge on carp poly culture would reflect more by the medium knowledge on production farmers' group in the present study. Knowledge on good aquaculture practices is definitely affected by the

education of the carp poly culture farmers because education helps to enhance the eagerness to be acquainted with new variety or technology. In addition, Knowledge on good aquaculture practices of the farmer is definitely affected by the media exposure because with the increase of the communication exposure new thing can be taught. Knowledge on good aquaculture practices is very important, aspected for creating positive attitude towards carp poly culture. Hence, good aquaculture practices farmers must require skill and modern knowledge to bring more yield and profit to ensure creating favorable attitude towards good aquaculture practices. This might be logical because the education facilities at the study area were more available as well as the training provided by the different GOs and NGOs were also satisfactory.

4.2 Selected Characteristics of the Farmers

Eleven characteristics of the farmers were selected for this research. The characteristics include: age, education, experience in carp polyculture, dependency ratio, area under fish culture, annual family income, annual income from carp polyculture, organizational participation, cosmopoliteness, training exposure and extension contact for fish farming information. Some descriptive statistics of these features are given in Table 4.2 . However, for ready reference, separate Tables are provided while presenting categorizations, discussing and /or interpreting results concerning each of the characteristics in this chapter.

Table 4.2 The salient features of the selected characteristics of the farmers

Categories	Measuring Unit	Range		Mean	S D
		possible	observed		
Age	Years	-	24-69	44.21	11.99
Education	Year of schooling	-	0-18	9.96	5.71
Experience in carp polyculture	Score	-	1-23	6.35	5.21
Dependency ratio	Score	-	0-300	87.81	73.09
Area under fish culture	Hectare		0.11-4.05	.65	.49
Annual family income	"0000" Tk.	-	9.50-310	50.48	37.77
Annual income from carp polyculture	"0000" Tk.	-	2.55-202.42	47.99	41.44
Organizational participation	Score	-	0-6	1.52	1.43
Cosmopoliteness	Score	0-24	0-15	7.55	3.72
Training exposure	Days	-	0-11	2.09	1.85
extension contact for fish farming information		0-15	0-15	6.20	3.33

4.2.1 Age

Age of the farmers ranged from 24 to 69 years, the average being 44.21 years and the standard deviation, 11.99. All the variables were categorized on the basis of their possible scores except age was categorized based on the classification provided by the Ministry of Youth and Sports, Government of the People's Republic of Bangladesh. The distribution of the farmers according to their age is shown in Table 4.3.

Table 4.3 Distribution of the farmers according to their age

Categories	Farmers		Mean	SD
	Number	Percent		
Young aged (up to 35)	34	28.33	44.21	11.99
Middle-aged (36-50)	48	40.00		
Old (>50)	38	31.67		
Total	**120**	**100**		

Table 4.3 showed that the highest proportion 40.00 percent of the farmers was "middle aged" category, while 31.67 percent of them was "old aged" category and 28.33 percent of the farmers was "young aged" category. The findings indicate that a large proportion

(71.67) of the farmers were middle to old aged usually culture carp fishes as they have better experiences to perform GAP in their culture system.

4.2.2 Education

The education scores of the farmers ranged from 0 to 18. The average was 9.96 and the standard deviation was 5.71. On the basis of their educational scores, the farmers were classified into four categories, namely "illiterate (0-0.5), primary (1-5), secondary (6-10) and above secondary (above 10). This distribution was supported by Hoque (2016) and Masud, (2007) and shown in the Table 4.4.

Table 4.4 Distribution of the farmers according to their education

Categories	Farmers		Mean	SD
	Number	Percent		
Illiterate (0)	23	19.17		
Primary level (1-5)	4	3.33		
Secondary level (6-10)	33	27.50	9.96	5.71
Above secondary level (>10)	60	50.00		
Total	**120**	**100**		

Similar result was observed by Nasreen *et al*. (2013) where highest numbers of respondents were completed up to above secondary education level. Table 4.4 indicated that the majority (50.00 percent) of the farmers had above secondary level of education compared to 27.50 percent of them having secondary level of education. About 19.17 percent of the farmers were illiterate, while only 3.33 percent had primary level of education. The findings indicate that better education creates better chances to gain knowledge about good aquaculture practices.

4.2.3 Experience in carp polyculture

Score of experience in carp polyculture fish farmers could range from 1 to 23 with mean and standard deviation of 6.35 and 5.21, respectively. On the basis of experience scores, the fish farmers were classified into three categories (Mean ± Standard Deviation) namely ‘low, ‘medium’ and ‘high’ experience in carp polyculture. The distribution of the fish farmers according to their experience in carp polyculture is given in Table 4.5.

Table 4.5 Distribution of the farmers according to their experience

Categories	Farmers		Mean	S D
	Number	Percent		
Low experience (up to 3)	17	14.17	6.35	3.21
Medium experience (4-9)	86	71.66		
High experience (above 9)	17	14.17		
Total	**120**	**100**		

Table 4.5 reveals that the majority (71.66 percent) of the fish farmers had medium experience in carp polyculture category, whereas only 14.17 percent had low experience category followed by 14.17 percent had high experience in carp polyculture category. The findings of the present study reveal that around 85.83 percent of the cultivators in the study area had medium to high experience in carp polyculture. Experience is very important that relates with education and age. So we can say that Good Aquaculture Practices(GAP) is interlinked with experience.

4.2.4 Dependency ratio

Dependency ratio of the farmers ranged from 0 to 300 with the mean and standard deviation of 87.81 and 73.09, respectively. According to dependency ratio of the farmers were classified into three categories (Mean ± Standard Deviation) viz. 'low', 'medium' and 'high' dependency. The distribution of the cultivators according to their dependency ratio are presented in Table 4.6.

Table 4.6 Distribution of the farmer according to their dependency ratio

Categories	Farmers		Mean	S D
	Number	Percent		
Low (up to 14)	25	20.83	87.81	73.09
Medium (15-160)	74	61.67		
High (above 160)	21	17.50		
Total	**120**	**100**		

Table 4.6 indicate that the medium dependency ratio constitutes the highest proportion (61.67 percent) followed by the low dependency ratio (20.83 percent). Only 17.50 percent of the farmers had high dependency ratio.

4.2.5 Area under fish culture

The area of the respondents varied from 0.11 to 4.05 hectares. The average farm size was 0.65 hectare with a standard deviation of 0.49. The respondents were classified into four categories based on their farm size as followed by DAE (DAE, 1999): "marginal farm" (upto 0.2 ha), "small farm" (0.21 – 1.0 ha), "medium farm" (1.0 -3.0 ha) “and large farm” (above 3.00 ha). The distribution of the farmers according to their farm size is shown in Table 4.7.

Table 4.7 Distribution of the farmer according to their area

Categories	Farmers		Mean	SD
	Number	Percent		
Marginal area (up to 0.2 ha)	47	39.17	.65	.49
Small area (0.21-1.0 ha)	59	49.17		
Medium area (1.01-3.0 ha)	11	9.17		
Large area (above 3 ha)	3	2.49		
Total	**120**	**100**		

Table 4.7 indicated that more than half (49.17 percent) of the farmers possessed small area compared to 9.19 percent of them having medium area and 39.17 percent marginal area and 2.49% of the farmers having large area. Thus, the overwhelming majority 88.34 percent of the farmers were the owners of marginal to small fish farms. Majority of the farmers were under small farmer’s category which is consistent with national scenario.

4.2.6 Annual family income

The score of annual family income of the cultivators ranged from 9.50 to 310 “0000” (BDT) with a mean and standard deviation of 50.48 and 37.77, respectively. On the basis observe range of income, the cultivators were classified into three categories namely ‘low’, ‘medium’ and ‘high’ annual family income. The distribution of the fish cultivators according to their annual income is presented in Table 4.8.

Table 4.8 Distribution of the farmer according to their annual income

Categories	Farmers		Mean	SD
	Number	**Percent**		
Low income (up to 13)	11	9.17	50.48	37.77
Medium income (14-87)	99	82.50		
High income (above 87)	10	8.33		
Total	**120**	**100**		

Data reveals that the fish cultivators having medium income constitute the highest proportion (82.50 percent), while the lowest proportion had high income (8.33 percent) followed by low income (9.17 percent). Over whelming majority (91.67 percent) of the cultivators had medium to low annual family income.

4.2.7 Annual income from carp poly culture

The score of annual income from carp poly culture of the cultivators ranged from 2.55 to 202.42 "0000" (BDT) with a mean and standard deviation of 47.99 and 41.44, respectively. On the basis observe range of income, the cultivators were classified into three categories namely 'low', 'medium' and 'high' annual income from carp poly culture. The distribution of the fish cultivators according to their annual income from carp poly culture is presented in Table 4.9.

Table 4.9 Distribution of the farmer according to their annual income from carp poly culture

Categories	Farmers		Mean	SD
	Number	Percent		
Low income (up to 6)	5	4.17	47.99	41.44
Medium income (7-88)	94	78.33		
High income (above 88)	21	17.50		
Total	**120**	**100**		

Data reveals that the fish cultivators having medium income constitute the highest proportion (78.33 percent), while the lowest proportion had low income from carp poly culture (4.17 percent) followed by high income from carp poly culture (17.50 percent). Overwhelming majority (95.83 percent) cultivators have medium to high annual income from carp poly culture.

4.2.8 Organizational participation

The observed organizational participation score of the respondents ranged from 0 to 6. The mean score was 1.52 with the standard deviation 1.43. On the basis of organizational participation scores, the respondents were classified into three categories namely, no, low organizational participation, medium organizational participation and high organizational participation, as shown in Table 4.10.

Table 4.10 Distribution of the respondents according to their participation

Categories (Scores)	Farmers		Mean	SD
	Number	Percent		
No (0)	27	22.50	1.52	1.43
Low (1-2)	67	55.83		
Medium (3-4)	21	17.50		
High (above 4)	5	4.17		
Total	**120**	**100**		

Data contained in the Table 4.10 revealed that the majority (55.83%) of the farmers had low organizational participation as compared to (22.50%) and (17.50%) having no and medium organizational participation respectively and only 4.17 percent of the farmers had high organizational participation.The majority (73.33%) of the respondents had medium to low organizational participation to develop better communication gathering latest infomation of carp ployculture.

4.2.9 Training exposure

Training exposure score of the farmers ranged from 0 to 11 with a mean and standard deviation of 2.09 and 1.85, respectively. Based on the training exposure score, the farmers were classified into three categories namely ‘no training’, ‘low’, ‘medium’ training and high training exposure. The distribution of the farmers according to their training exposure is presented in Table 4.11.

Table 4.11 Distribution of the respondents according to their training

Categories (Scores)	Farmers		Mean	SD
	Number	Percent		
No (0)	43	35.83	2.09	1.85
Low (up to 4)	65	54.17		
Medium (5-8)	9	7.50		
High (above 8)	3	2.50		
Total	**120**	**100**		

Table 4.11 indicates that the highest proportion (54.17 percent) of the farmers had low training exposure compared to 35.83 percent had no training exposure and 7.50 percent

of the farmers had medium training exposure category, respectively. Training makes the farmers skilled and helps them to acquire deep knowledge about the respected aspects. Trained farmers can face any kind of challenges about the adverse situation in their carp poly culture. So, they show favorable behavior toward positive attitude towards carp poly culture. This result might have due to the positive attitude towards carp poly culture.

4.2.10 Cosmopoliteness

Cosmopoliteness score of the farmers ranged from 0 to 15 against a possible range of 0 to 24 with a mean and standard deviation of 7.55 and 3.72, respectively. Based on the cosmopoliteness score, the farmers were classified into three categories namely 'low', 'medium' and high cosmopoliteness. The distribution of the farmers according to their cosmopoliteness is presented in Table 4.12.

Table 4.12 Distribution of the respondents according to their cosmopoliteness

Categories (Scores)	Farmers		Mean	SD
	Number	Percent		
Low (up to 4)	30	25.00	7.55	3.72
Medium (5-10)	62	51.67		
High (above 10)	28	23.33		
Total	**120**	**100**		

Data shows that the highest proportion (51.67 percent) of the farmers had medium cosmopoliteness and lowest cosmopoliteness had 23.33 percent of them having high cosmopoliteness and 25.00 percent of the farmers had low cosmopoliteness. The result indicates better cosmopoliteness performs better understanding with experienced farmers with new farmers or rural farmers. In our rural farmers usually in traditional features,they don't interest in contact with union parishad, upazila office etc. As a result the data of this research indicate low to medium cosmopoliteness.

4.2.11 Extension contact for fish farming

The observed score of extension exposure of the farmers ranged from 0 to 15 against a possible range of 0 to 15. The average score of the farmers' media exposure was 6.20 with a standard deviation 3.33 (Table 4.13). The farmers were classified into three categories on the basis of their exposure to farming information through communication

exposure scores and distribution of the three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' media exposure of the farmers. The distribution of the farmers according to their media exposure is presented in Table 4.13.

Table 4.13 Distribution of the respondents according to their contact

Categories	**Farmers**		Mean	SD
	Number	Percent		
Low contact (up to 3)	25	20.95	6.20	3.33
Medium contact (4-9)	82	68.55		
High contact (>9)	13	10.50		
Total	**120**	**100**		

Data shows that the highest proportion (68.55 percent) of the farmers had medium extension exposure and lowest extension exposure was 20.95 percent of them having low extension exposure and 10.50 percent of the farmers had high extension exposure. From this Table, it might be concluded that majority of the farmers had medium extension exposure. It could be concluded that different extension services of the study area were available to the farmers. The finding was interesting but logical because in general the farmers in the rural areas of Bangladesh are less cosmopolite in nature and less exposed to different information sources. Finding revealed that 20.95 percent of the farmers had low extension exposure which demands for strengthening and improving the communication strategy. Low extension exposure might be the reason that some respondent may think that they have enough knowledge about carp poly culture, they do not want to break the traditional culture pattern. Better culture practice means Good Aquaculture Practices(GAP) what is only possible after better extension contact.

4.3 The Contribution of the selected characteristics of the respondents to their knowledge on good aquaculture practices

In order toestimate the farmers' knowledge on good aquaculture practices, the multiple regression analysis was used which is shown in the Table 4.14.

Table 4.14 Multiple regression coefficients of the contributing variables related to their knowledge on good aquaculture practices

Dependent variable	Independent variable	β	ρ	R^2	Adj. R^2	F
Farmers' knowledge on good aquaculture practices	Age	0.225	0.012*	0.673	0.639	20.188
	Education	0.243	0.000**			
	Experience in carp polyculture	0.070	0.401			
	Dependency ratio	0.055	0.440			
	Area under fish culture	0.138	0.107			
	Annual family income	0.004	0.951			
	Annual income from carp polyculture	0.016	0.829			
	Organizational participation	0.048	0.576			
	Cosmopoliteness	0.203	0.040*			
	Training exposure	0.147	0.049*			
	Extension contact for fish farming	0.457	0.000**			

** Significant at p<0.01; *Significant at p<0.05

Table 4.14 shows that there is a significant contribution of the respondents, extension contact for fish farming information, education, age, cosmopoliteness and training exposure. Of these, extension contact for fish farming information and education were the most important contributing factors (significant at the 1% level) while coefficients of other selected variables don't have any contribution on farmers' knowledge on good aquaculture practices.

The value of R^2 is a measure of how of the variability in the dependent variable is accounted by the independent variables. So, the value of R^2 = 0.673 means that independent variables account for 67% of the variation in farmers' knowledge on good aquaculture practices. The F ratio is 20.188 which is highly significant (ρ<0.000).

However, each predictor may explain some of the variance in respondent's knowledge on good aquaculture practices simply by chanced. The adjusted R^2 value penalizes the addition of extraneous predictors in the model, but values 0.639 is still show that variance is farmers' knowledge on carp poly culture can be attributed to the predictor variables rather than by chanced the suitable model (Table 4.14). In summary, the models suggest that the respective authority should be consider the farmers extension contact for fish farming information, education, age, cosmopoliteness and training exposure in this connection some predictive importance has been discussed below:

4.3.1 Significant contribution of extension contact for fish farming information to the farmers' knowledge on good aquaculture practices

From the multiple regression, it was concluded that the contribution of extension contact for fish farming information to the farmers' knowledge on good aquaculture practices was measured by the testing the following null hypothesis;

"There is no contribution of extension contact for fish farming information to the farmers' knowledge on good aquaculture practices".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of extension contact for fish farming information was significant at 1% level (0.000).

b. So, the null hypothesis could be rejected.

c. The b-value of media contact for fish farming information was 0.457. So, it can be stated that as media contact for fish farming information increased by one unit, farmers' knowledge on good aquaculture practices increased by 0.457 units. Considering the effects of all other predictors are held constant.

From the multiple regressions, it was concluded that extension contact for fish farming information of the farmers had highest positive contribution to their knowledge on good aquaculture practices. This implies that with the increase of extension contact for fish

farming information of the farmers will increase their knowledge on good aquaculture practices.

4.3.2 Significant contribution of education to the farmers' knowledge on good aquaculture practices

From the multiple regression, it was concluded that the contribution of education to the farmers' knowledge on good aquaculture practices was measured by the testing the following null hypothesis;

"There is no contribution of education to the farmers' knowledge on good aquaculture practices".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of education was significant at 1% level (0.000).

b. So, the null hypothesis could be rejected.

c. The b-value of education was 0.243. So, it can be stated that as education increased by one unit, farmers' knowledge on good aquaculture practices increased by 0.243 units. Considering the effects of all other predictors are held constant.

From the multiple regressions, it was concluded that education of the farmers had highest positive contribution to their knowledge on good aquaculture practices. This implies that with the increase of education of the farmers will increase their knowledge on good aquaculture practices. Education facilitates the way of communication with extention contact, cosmopoliteness,developing technologies to culture carp fishes .

4.3.3 Significant contribution of age to the farmers' knowledge on good aquaculture practices

From the multiple regression, it was concluded that the contribution of ageto the farmers' knowledge on good aquaculture practices was measured by the testing the following null hypothesis;

"There is no contribution of age to the farmers' knowledge on good aquaculture practices".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of age was significant at 5% level (0.012).

b. So, the null hypothesis could be rejected.

c. The b-value of age was 0.225. So, it can be stated that as age increased by one unit, farmers' knowledge on good aquaculture practices increased by 0.225 units. Considering the effects of all other predictors are held constant.

From the multiple regressions, it was concluded that age of the farmers had highest positive contribution to their knowledge on good aquaculture practices. This implies that with the increase of age of the farmers will increase their knowledge on good aquaculture practices.

4.3.4 Significant contribution of cosmopoliteness to the farmers' knowledge on good aquaculture practices

From the multiple regression, it was concluded that the contribution of cosmopoliteness to the farmers' knowledge on good aquaculture practices was measured by the testing the following null hypothesis;

"There is no contribution of cosmopoliteness to the farmers' knowledge on good aquaculture practices".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of cosmopoliteness was significant at 5% level (0.040).

b. So, the null hypothesis could be rejected.

c. The b-value of cosmopoliteness was 0.203. So, it can be stated that as cosmopoliteness increased by one unit, farmers' knowledge on good aquaculture practices increased by 0.203 units. Considering the effects of all other predictors are held constant.

From the multiple regressions, it was concluded that cosmopoliteness of the farmers had highest positive contribution to their knowledge on good aquaculture practices. This implies that with the increase of cosmopoliteness of the farmers will increase their knowledge on good aquaculture practices.Better cosmopoliteness creats updated knowledge that helps the farmers information of fish culture. New technologies are introduced with the farmers for contacting famous hatcheries,upazila office, experienced farmers.

4.3.5 Significant contribution of training exposure to the farmers' knowledge on good aquaculture practices

From the multiple regression, it was concluded that the contribution of training exposure to the farmers' knowledge on good aquaculture practices was measured by the testing the following null hypothesis;

"There is no contribution of training exposure to the farmers' knowledge on good aquaculture practices".

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

a. The contribution of training exposure was significant at 5% level (0.049).

b. So, the null hypothesis could be rejected.

c. The b-value of training exposure was 0.147. So, it can be stated that as training exposure increased by one unit, farmers' knowledge on good aquaculture practices increased by 0.147 units. Considering the effects of all other predictors are held constant.

From the multiple regressions, it was concluded that training exposure of the farmers had highest positive contribution to their knowledge on good aquaculture practices. This implies that with the increase of training exposure of the farmers will increase their knowledge on good aquaculture practices. As a result misconception about fish culture like using animal waste,unlimited feed for fish etc are reducing by the help of training.

CHAPTER V
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents summary of major findings, conclusion and recommendation of the study. The study entitled “knowledge on good aquaculture practices.” The main purpose of the study was to describe farmers’ knowledge on good aquaculture practices and to determine the contribution of the selected characteristics of the farmers to their knowledge on good aquaculture practices. The location of the study was three unions of Natore Sadar Upazila under Natore district.

5.1 Summary of Findings

5.1.1 Selected characteristics of the farmers

The major findings of the study are summarized below:

Age: Age of the farmers ranged from 24 to 69 years, the average being 44.21 years and the standard deviation, 11.99. The highest proportion 40.00 percent of the farmers was "middle aged" category, while 31.67 percent of them was "old aged" category and 28.33 percent of the farmers was "young aged" category.

Education: The education scores of the farmers ranged from 0 to 18. The average was 9.96 and the standard deviation was 5.71. The majority (50.00 percent) of the farmers had above secondary level of education compared to 27.50 percent of them having secondary level of education. About 19.17 percent of the farmers were illiterate, while only 3.33 percent had primary level of education.

Experience in carp polyculture: Score of experience in carp polyculture of carp poly cultivators could range from 1 to 23 with mean and standard deviation of 6.35 and 3.21, respectively. The majority (71.66 percent) of the cultivator had medium experience in carp polyculture category, whereas only 14.17 percent had low experience category followed by 14.17 percent had high experience in carp polyculture category.

Dependency ratio: Dependency ratio of the farmers ranged from 0 to 300 with the mean and standard deviation of 87.81 and 73.09, respectively. The medium dependency ratio constitutes the highest proportion (61.67 percent) followed by the low dependency ratio (20.83 percent). Only 17.50 percent of the farmers had high dependency ratio.

Area under fish culture: The area of the respondents varied from 0.11 to 4.05 hectares.The average farm size was 0.65 hectare with a standard deviation of 0.49. Less than half (49.17 percent) of the farmers possessed small area compared to 9.19 percent of them having medium area and 39.17 percent marginal area and 2.49% of the farmers having large area.

Annual family income: The score of annual family income of the cultivators ranged from 9.50 to 310 "0000" (BDT) with a mean and standard deviation of 50.48 and 37.77, respectively. The fish cultivators having medium income constitute the highest proportion (82.50 percent), while the lowest proportion had high income (8.33 percent) followed by low income (9.17 percent).

Annual income from carp poly culture: The score of annual income from carp poly culture of the cultivators ranged from 2.55 to 202 "0000" (BDT) with a mean and standard deviation of 47.99 and 41.44, respectively. The fish cultivators having medium income constitute the highest proportion (78.33 percent), while the lowest proportion had low income from carp poly culture (4.17 percent) followed by high income from carp poly culture (17.50 percent).

Organizational participation: The observed organizational participation score of the respondents ranged from 0 to 6. The mean score was 1.52 with the standard deviation 1.43. The majority (55.83%) of the farmers had low organizational participation as compared to (22.50%) and (17.50%) having no and medium organizational participation respectively and only 4.17 percent of the farmers had high organizational participation.

Training exposure: Training exposure score of the farmers ranged from 0 to 11 with a mean and standard deviation of 2.09 and 1.85, respectively. The highest proportion (54.17 percent) of the farmers had low training exposure compared to 35.83 percent

had no training exposure and 7.50 percent of the farmers had medium training exposure category, respectively.

Cosmopoliteness: Cosmopoliteness score of the farmers ranged from 0 to 15 with a mean and standard deviation of 7.55 and 3.72, respectively. The highest proportion (51.67 percent) of the farmers had medium cosmopoliteness and lowest cosmopoliteness had 23.33 percent of them having high cosmopoliteness and 25.00 percent of the farmers had low cosmopoliteness.

Extension contact for fish farming information: The observed score of extension exposure of the farmers ranged from 0 to 15 against a possible range of 0 to 24. The average score of the farmers' media exposure was 6.20 with a standard deviation 3.33 (Table 4.10). The highest proportion (68.55 percent) of the farmers had medium media exposure and lowest media exposure was 20.95 percent of them having low media exposure and 10.50 percent of the farmers had high media exposure.

5.1.2 Farmers' knowledge on good aquaculture practices

Farmers' knowledge on good aquaculture practices scores of the farmers ranged from 8 to 42 against possible score of 0 to 46. The average score and standard deviation were 31.24 and 8.53, respectively. The majority 19.17 percent of the farmers had high knowledge on good aquaculture practices, 26.66 percent had low knowledge and 54.17 percent had medium knowledge on good aquaculture practices.

5.1.3 Contribution of the farmers' knowledge on good aquaculture practices and their selected characteristics

Extension contact for fish farming information, education, age, cosmopoliteness and training exposure had significant positive contribution with farmers' knowledge on good aquaculture practices their selected characteristics. Experience in carp polyculture, Dependency ratio, Area under fish culture, annual family income, Annual income from carp polyculture and organizational participation had no significant positive contribution with their knowledge on good aquaculture practices.

5.2 Conclusions

Conclusions drawn on the basis of the findings of this study and their logical interpretation in the light of the other relevant factors are furnished below:

1. In the study area, farmers' knowledge on good aquaculture practices was found in various extents. The majority (19.17%) of the farmers had high knowledge, 54.17% had medium knowledge and 26.66% of the farmers had low knowledge. Therefore, it may be concluded that all the farmers of the study area had knowledge on good aquaculture practices in different degrees.
2. A great majority (89.67%) of the respondents had low to medium extension contact for fish farming information, while there had a very strong positive significant contribution with knowledge on good aquaculture practices. Therefore, it may be concluded that, low agricultural extension media contact farmers had low knowledge on good aquaculture practices and with the increase of agricultural extension contact of the farmers tends to increase their extent of knowledge on good aquaculture practices.
3. Majorities (19.17 percent) of the farmers were illiterate.This result has achieved because of there was fewer different NGOs' activities and lower educational institutes in the study area. There existed a positively significant contribution with education and their farmers' knowledge on good aquaculture practices. Therefore, it may be concluded that, high educated farmers had more knowledge on good aquaculture practices while the less educated ones are deficient.
4. A major portion (68.33 percent) of the farmers were young to middle age, while there had a positive significant contribution with their knowledge on good aquaculture practices. Therefore, it may be concluded that, farmers were increase in age, possesses more knowledge on good aquaculture practices.
5. A great majority (75.0 percent) of the farmers had medium to high cosmopoliteness, while there had a very strong positive significant contribution their knowledge on good aquaculture practices. Therefore, it may be concluded that, farmers who had higher cosmopoliteness had more knowledge on good aquaculture practices.
6. The majority (61.67%) of the farmers had low to medium training exposure, while there had a very strong positive significant contribution on their knowledge on good aquaculture practices. Therefore, it may be concluded that, with the increase in training exposure of the farmers tends to increase their rate of knowledge on good

aquaculture practices.

5.3 Recommendations

5.3.1 Recommendations for policy implications

Recommendations based on the findings and conclusions of the study are presented below:

1. A majority (73.34 percent) of the farmers had medium to high knowledge on good aquaculture practices. All the sample farmers were more or less involved in good aquaculture practices. But their extent of knowledge was not satisfactory. Therefore, it may be recommended that necessary steps should be taken to increase their knowledge on good aquaculture practices in the study area.
2. Extension Media contact had significant positive contribution with their knowledge on good aquaculture practices. Therefore, it may be recommended that, there should be conducted more organization works for educating and training the farmers which will be supportive to knowledge on good aquaculture practices.
3. Education of the farmers had significant positive contribution with their knowledge on good aquaculture practices. Therefore, it may be recommended that, adult education should be provided to the farmers so that they could increase their educational level which might be helpful to increase their knowledge on good aquaculture practices.
4. Age of the farmers had significant positive contribution with their knowledge on good aquaculture practices. Therefore, it may be recommended that, extension service providers as well as other parties should increase their contact with farmers so that their knowledge about good aquaculture practices of farmers could increase. So, government should take necessary steps to improve the above characteristics of the farmers.
5. Cosmopoliteness of the farmers had significant positive contribution with their knowledge on good aquaculture practices. Therefore, it may be recommended that necessary technical support to be provided to the low and medium experienced good aquaculture practices farmers for increasing their knowledge on good aquaculture practices.
6. Training exposure of the farmers had significant positive contribution with their knowledge on good aquaculture practices. Therefore, it may be recommended

that, government and NGOs should provide training facilities as well as other parties should increase their attitude so that their knowledge on good aquaculture practices could increase.

5.3.2 Recommendation for further study

This study investigated farmers' knowledge on good aquaculture practices of Natore Sadar upazila under Natore district. As a small and limited research has been conducted in the present study cannot provide much information related to this aspect. Further studies should be undertaken to cover more information in the relevant matters. So the following suggestions were put forward for further research:

1. It is difficult to determine the extent farmers' knowledge on good aquaculture practices. Measurement of farmers' knowledge on carp poly culture is not free from questions. More reliable measurement of concerned variables is necessary for further study.
2. The present study was conducted only in six villages of Natore Sadar upazila under Natore district. Findings of the study need further verification through similar research in other parts of the country.
3. The study investigated the relationship of 11 characteristics of the farmers with their farmers' knowledge on good aquaculture practices. So, it is recommended that further study would be conducted with other dependent and independent variables.
4. Research should be undertaken on farmers' knowledge on good aquaculture practices and other related organizations in helping farmers for adoption of technologies.

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APPENDIX-I

Department of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University, Dhaka-1207
An Interview Schedule for the Study Entitled

CARP POLYCULTURE FARMERS' KNOWLEDGE ON GOOD AQUACULTURE PRACTICES

Name of the respondent: ……. Serial No. …….
Village: ……..…. Contact No. ……..
Union: …… Upazila:…….

(Please provide the following information. Your information will be kept confidential and will be used for research purpose only)

1. Age
How old are you? ..... years.

2. Level of Education

Please mention your level of education.
a) I can't read and write
b) I can sign only
c) I read up to class……
d) I have passed… class.

3. Experience in Carpfish Culture

How many years have you been engaged with carpfish Culture?.....years

4. **DependencyRatio**
Please mention numbers of the family members

Dependency Ratio =

$$100 * \left\{ \frac{\text{(No. of people aged 0 to 14) + (No. of people aged 65 and above)}}{\text{Number of people aged 15 to 64}} \right\}$$

5. Area under Fish Culture

Please indicate the area of lands under Fish Culture

Sl. No.	Types of resources	Area (ha)
1	Ponds	
2	Others	
Total Area		

6. Annual Family Income

Please state the income from different sources during the last one year

Sl. No.	Sources of Income	Monthly income (Tk)	Annual income (Tk)
1	**Agriculture**		
	➢ Rice		
	➢ Jute		
	➢ Vegetables		
	➢ Fruits		
	➢ Livestock		
	➢ Poultry		
	➢ Nursery		
2	**Business**		
3	**Service**		
4	**Day Labour**		
5	**Others**		
Total Income			

7. Annual Income from Carpfish Culture

Please state the income from carpfish culture during the last one year

Sl. No.	Name of Carpfish Species	Annual Income (Tk)
1	Pangas	
2	Shing	
3	Magur	
4	Tengra	
5	Pabda	
6	Boal	
7	Rita	
9	Ayre	
10	Others	
Total Income		

8. Organizational Participation

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

Sl. No.	Name of Organizations	Nature of Participation		
		Ordinary member	Executive committee member	Executive committee officer
1	Fish farmers' cooperative committee			
2	Mosque/Madrashah/Mondir/Church/Pagoda committee			
3	NGO committee			
4	Union Parishad			

9. Cosmopoliteness

Please indicate the number of times you have visited the following places for agricultural purposes:

Sl. No.	Place of Visit	Nature of Visit			
		Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)
1	Relative or other known persons located outside of your own village	5-6 times/month	3-4 times/month	1-2 times/month	0 times/month
2	Own Union parishad office	8-10 times/year	5-7 times/year	1-4 times/year	0 times/year
3	Other Union parishad office	8-10 times/year	5-7 times/year	1-4 times/year	0 times/year
4	Own Upazila sadar	5-6 times/month	3-4 times/month	1-2 times/month	0 times/month
5	Other Upazila sadar	5-6 times/month	3-4 times/month	1-2 times/month	0 times/month
6	Own District sadar	4 times/year	3 times/year	1-2 times/year	0 times/year
7	Other District sadar	4 times/year	3 times/year	1-2 times/year	0 times/year
8	Capital city	3 times/year	2 times/year	1 times/year	0 times/year

10. Training Exposure

Do you have participated in any training relative to Carpfish Culture?
Yes …….. No. ……..
If yes, mention the following information

Sl. No.	Subject of Training	Duration of Training (Days)

11. Extension Contact for Fish Farming Information

Please state the extent of your contact with the following personnel

Sl. No.	Extension Contacts	Extent of Participation			
		Regularly	Occasionally	Rarely	Never
1	Model fish farming				
2	Input dealer				
3	NGO worker				
4	Field worker of fisheries department				
5	Upazila fisheries officer				

12. Farmers' Knowledge on carp poly culture

Please state the extent of the following knowledge on carp poly culture

SL. No:	Questions	Full marks	Marks Obtained
01.	Why pond drying is necessary step in pre-stocking?	2	
02.	Why aquatic weed eradication is necessary step in pre-stocking?	2	
03.	What is the recommended dose of lime for carp poly culture in pre-stocking?	2	
04.	What is the recommended dose of pesticide for removing undesirable fish species?	2	
05.	What do you think about the usefulness of salt application for fish species?	2	
06.	What is the recommended dose of organic fertilizer in pre-stocking?	2	
07.	Mention three culture type of different fish species with carp species?	2	
08.	How will you examine if there is enough natural food in the pond water?	2	
09.	How will you calculate carp fry species according to your pond volume?	2	
10.	Mention two ways of identifying good quality carp fry?	2	
11.	What is the suitable time for releasing fry in ponds?	2	
12.	What are the facilities needed for high stocking density in carp polyculture?	2	
13.	How will you examine the water quality of your pond is good enough for culture?	2	
14.	How will you understand that there is lack of oxygen in pond water?	2	
15.	Why it is important to count the fingerlings before releasing the pond?	2	
16.	What qualities (nutrients) are the most preferences in feed ingredients?	2	
17.	Why natural food is important than artificial feed?	2	
18.	Mension two name of fish disease generally you faced?	2	
19.	What curative measures are required be taken against fish disease?	2	
20.	What preventive measures are required be taken against fish disease?	2	
21.	What is the suitable time for fish harvesting?	2	
22.	Mension What matters are to be kept in mind while transportation of carp fishes?	2	
23.	What is the importance to keep record book and expenditure book you think?	2	

Thank you for your kind co-operation in data collection.

Dated:…… (Signature of the interviewer)