PRESENT STATUS AND PROSPECTS OF INTEGRATED AQUACULTURE IN SOME SELECTED AREAS OF NILPHAMARI DISTRICT

A THESIS

BY

MD. HASANUR RAHMAN
Examination Roll No. 1605209
Session: 2016-2017
Semester: January- June 2017

MASTER OF SCIENCE

IN

AQUACULTURE

DEPARTMENT OF AQUACULTURE

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY

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Approved as to style and content by

__________________	________________
Dr. A.S.M. Kibria	**Md. Abu Zafar**
Supervisor	**Co-Supervisor**

____

Dr. Mst. Nahid Akter
Chairman

Examination Committee

and

Chairman, Department of Aquaculture

Hajee Mohammad Danesh Science and Technology University

Dinajpur

June 2017

DEDICATED

TO MY

BELOVED PARENTS

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The Author

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LIST OF ABBREVIATIONS

IPM = Integrated Pest Management

IAAS = Integrated Agro-Aquaculture System

BC = Before Christ

DoF = Department of Fisheries

FAO = Food and Agricultural Organization

IAASTD = International Assessment of Agricultural Knowledge, Science and Technology for Development

IIRR = International Institute of Rural Reconstruction

SRS = Self-Recruiting-Species

SIS = Small-Indigenous Species

DWR= Deep Water Rice

TSP = Triple Super Phosphate

MP = Murate of Potash

GIFT = Genetically Improved Farmed Tilapia

IA = Integrated Aquaculture

NGO = Non-Government Organization

DFO = District Fisheries Officer

UFO = Upazila Fisheries Officer

SSC = Secondary School Certificate

HSC = Higher Secondary Certificate

SPSS = Statistical Package for Social Sciences

BFRI = Bangladesh Fisheries Research Institute

CP = Charoen Pokphand

BBS = Bangladesh Bureau of Statistics

ABSTRACT

A yearlong study was conducted in some selected areas of Nilphamari district in order to observe the integrated aquaculture practices. For this purpose, a questionnaire was prepared and data were collected from 76 farmers. The present study indicated that the age of most farmers (76%) was between 41-60 years. Educational qualification of most of the farmers was secondary level (40%). Highest number of farm (79%) established within the last ten years and 49% of the farmers had their own plots. Formal training was received by 66% farmers. The average farm size was 0.34 hector. Three different types of integrated farming were found in the study area: rice-fish culture (46%), horticulture-fish (33%) and poultry-fish culture (21%). Most of the farmers collected fish seed from local seed traders (48%) followed by hatchery (30%) and BFRI sub-station, Saidpur (22%). Water retention capacity of the soil was not very high and fish culture was possible only 7-8 months a year. Banana, papaya, lemon, brinjal, green leafy vegetables, chili etc. were found to culture in the study area as horticulture crops. In case of fish-poultry farming, chicken (broiler) and duck was mainly integrated with fish farming. It was found that most of the farmers (73%) managed the water quality parameters. Farmers used artificial feeds (63%), home-made feeds (3%) and both artificial and homemade feed (34%). Average production of fish over 5434 kg/ha was reported by 55% farmers. A number of constraints such as low water retention capacity of soil, lack of quality seeds, poor loan facility, lack of capital, marketing problems etc. were report by the farmers. It was found that there were several low lands and ponds which were suitable for integrated aquaculture. The socio-economic conditions of the farmers can be developed to a considerable level by improving the farming systems and management practices applying modern technology and utilizing the unused aquatic resources through an integrated approach.

Key-words: Integrated aquaculture, Questionnaire, Rice, poultry, Horticulture and Nilphamari district

CHAPTER I

INTRODUCTION

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INTRODUCTION

1.1 General Background

Bangladesh is one of the poorest and most densely populated countries in the world. The people of Bangladesh are commonly referred to as ‘Macche-Bhate Bangali’ (i.e., the people made of fish and rice). Rice and fish have been an essential part of the life of Bangladeshi people from time immemorial. The staple foods of the people of Bangladesh are rice and fish. The demand for rice and fish is constantly increasing in Bangladesh with nearly three million people being added each year to the population of the country (Chowdhury 2009). Nevertheless, integrated fish farming offers a solution to this problem by contributing to food, income and nutrition. Many reports suggest that integrated fish farming is ecologically sound because fish improve soil fertility by increasing the availability of nitrogen and phosphorus (Giap *et al.* 2005; Dugan *et al.* 2006).

Integrated agro-aquaculture systems (IAAS) are those which link aquaculture to conventional farming systems. The development of such systems has been driven by different needs in different parts of the world, including a desire to improve food security on small, subsistence family farms; or to minimize pollution and use valuable resources (such as water) more efficiently and effectively.

Integrated fish farming systems refer to the production, integrated management and comprehensive use of aquaculture, agriculture and livestock, with an emphasis on aquaculture. China has a long and rich history of integrated fish farming. Written records from the first and second centuries B.C. documented the integration of aquatic plant cultivation and fish farming.

The development of rural or small-scale aquaculture is the only way to increase the availability of fish for the rural poor (Ahmed and Lorica 2002; Brummett and Williams 2000; FAO 2007b). These systems are mostly focused on the production of different, relatively low-value species for household consumption or local markets.

Integrated agro-aquaculture systems (IAAS) are defined as the concurrent or sequential linkage between two or more agricultural activities, of which at least one is aquaculture (Little and Edwards 2003). Generally, IAAS have been named on the basis of their interacting components, i.e. rice/fish, pig/fish, poultry/fish or multi-component farms with three or more linked elements. Typically, animal manure and crop wastes are used as fertilizers and feed, respectively, for fish ponds (Prein 2002).

The management of these synergies would reduce the need for external inputs, thus increasing total farm productivity and profitability in an ecologically sound manner through the increase in resource-use efficiency (FAO/IIRR/World Fish Center 2001). IAAS are also promoted as an efficient way to enhance food security (Karapanagiotidis *et al.* 2009; Kawarazuka 2010; Prein and Ahmed 2000).

IAAS have been described as more sustainable when compared with other food production systems (Prein 2007). Integrated farming systems are usually compared to less diverse and more open systems in terms of nutrients and energy, such as monoculture systems (Gomiero *et al.* 1997; Kautsky *et al.* 1997). It is considered that the diversity of enterprises in IAAS offers lower risks (Prein *et al.* 1998; Pullin 1998), so the introduction of integrated aquaculture can contribute to increased farm resilience (Bailey 2008). In many cases, the integration of aquaculture into agricultural production on family farms has enhanced income generation (Berg 2002; Dey *et al.* 2007; Hishamunda *et al.* 1998; Kumaresan *et al.* 2009; Middendorp and Verreth 1986; Pant *et al.* 2005; Shang and Costa-Pierce 1983), improving social status and food consumption (Ahmed and Garnett 2010).

Integration of fish with other animals and crops is the most efficient way of increasing production from per unit area of land. Integration within the farm has been a practical necessity, where farmed fish have been economically and nutritionally most important. Integrated aquaculture complement improves the overall yield in terms of labor input and efficiency, in terms of resource use.

1.2 Components of Integrated Aquaculture System

1.2.1 The Aquaculture Sub-System

Aquaculture production systems generally are classified in terms of their intensity which determines different levels of resource use. The degree of intensification, which depends on a wide variety of factors such as capital, labor and mechanization, generally is defined in aquaculture according to feeding practices. In the case of IAAS, aquaculture can be considered as semi-intensive, as it relies on fertilization to produce natural feed and/or supplementary feeds. Aquaculture operations can be classified as land-based, such as ponds or tanks, or flushed through water-based systems such as cages or long-lines (Muir 2005a). While most small-scale aquaculture is land-based, taking place in ponds and rice fields.

Ponds or rice fields for aquaculture are usually considered as ecosystems of their own. The biological components of these ecosystems can be classified as autotrophs and heterotrophs. The first group is constituted of primary producers, these include algae, macrophytes, and certain non-photosynthetic bacteria. The natural productivity of the water body supports the entire food chain. In contrast, the heterotrophs rely on the consumption of organic matter produced by the autotrophs. This group involves fungi, bacteria, mollusks, crustaceans, and fish. The balance between respiration and photosynthesis of the biological components primarily determines the daily dissolved oxygen and pH fluctuations.

The oxygenation of the pond bottom allows the decomposition of organic matter by aerobic bacteria, prevents the release of reduced compounds into pond water that are toxic to fish, and provides a good habitat for benthic organisms (Boyd and Bowman 1997).

1.2.2 The Agricultural Sub-System

By definition, IAAS involve an agricultural component that generally exists before the introduction of aquaculture. Agro-ecological conditions such as climatic, soil related and biotic factors determine the type of crop and animal system that has been developed at each location. Most IAAS are crop-dominated, but they generally also include livestock husbandry and non-cultivated areas such as woodlands. For instance, a typical farming system in South East Asia consists of rice as the main crop, with other enterprises occurring on the farm such as annual and perennial crops; a mixed garden around the homestead for fruits and vegetables, grass-fed cattle, and scavenging pigs or poultry (Devendra and Thomas 2002b; Edwards *et al.* 1988).

The diversity of activities within the agricultural sub-system often shapes the way in which aquaculture is introduced. Conversely, management of agricultural activities may change as a result of the introduction of fish farming. For instance, large variations in dissolved oxygen concentrations in rice-based systems may require the stocking of fish species that are adapted to such conditions, such as bottom-feeder carps (Mohanty *et al.* 2004). In turn, the stocking of fish into rice fields may reduce the use of chemical pesticides (Berg 2002; Weimin 2010). Furthermore, the introduction of fish farming may result in the development of new agricultural activities, such as the cultivation of fruit and vegetables in dikes (Ahmed and Garnett 2010; Edwards 2008) or the introduction of ducks (Soliman *et al*. 2000).

Agricultural activities play an important role in providing food for household consumption and products for sale in local markets. Although most studies on IAAS have been focused on the positive effects of fish on nutrition and income (Prein and Ahmed 2000), aquaculture is sometimes not the most profitable enterprise or the most efficient way of enhancing household nutrition (Hishamunda *et al.* 1998; Wetengere 2009). The production and sale of products such as rice, vegetables, and fruits within IAAS sometimes have stronger nutritional and economic benefits than fish farming (Bosma *et al.* 2007; Ruddle and Prein 1997). Agricultural crops and livestock are multipurpose, with importance beyond providing food and fiber. In integrated systems such as IAAS, each farm component is not only valued for the amount of product that it can produce, but also for its role in supplying inputs to other farm enterprises. For instance, grass-fed livestock such as cattle or buffalo are used for draft power in Asia or for milk production in India, but they are also important in providing manure for crop fertilization (Little and Edwards 2003). Cattle may also fulfill other roles, acting as a kind of savings account, and even as a display of status (Moll 2005). Furthermore, some crops or non-cultivated species can be used for farmers for social, ritualistic, or medicinal purposes (Tipraqsa *et al.* 2007).

1.2.3 Integrated Agro-Aquaculture Systems

The integration of aquaculture into existing farming systems aims to maximize the positive interactions among activities. Aquaculture systems, especially in nutrient poor environments, require a supply of nutrients to support significant yields (Hambrey 2004). On small-holder farms, these inputs are available mainly in the form of wastes from crops or animals. As part of an integrated farming system, aquaculture also plays a role as a supplier of inputs to other farm components. By-products of aquaculture such as enriched waste water and sediments can be used as inputs for other agricultural activities (Little and Edwards 2003).

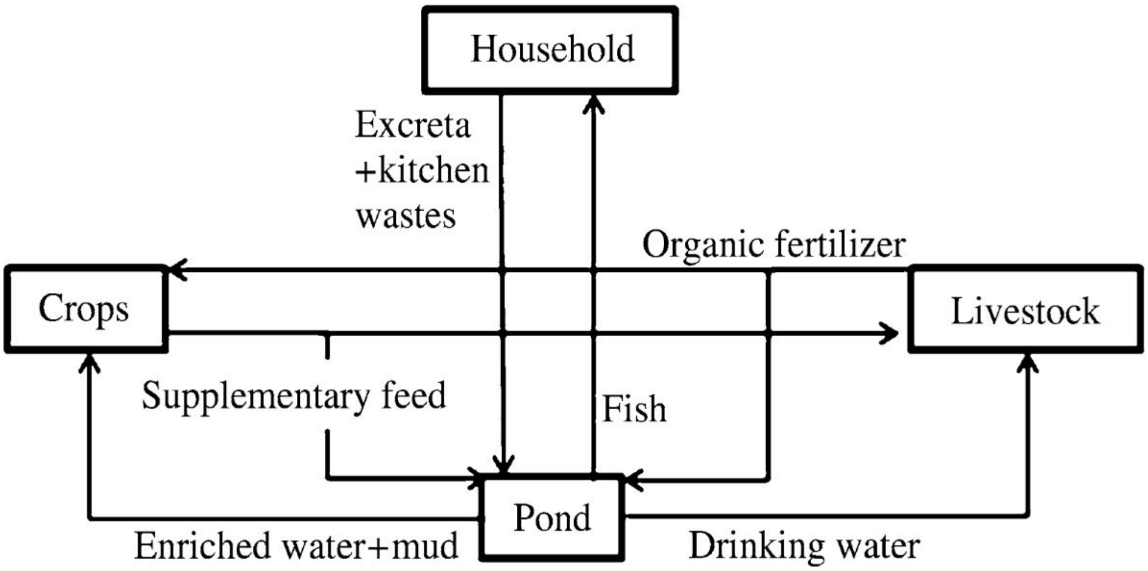

Fig. 1.1 Possible on-farm interactions between IAAS subsystems (Adapted from Edwards *et al.* 1988). Focus on the central role of aquaculture must be noted – for example, interactions also exist between households and livestock or crops, but they are not usually considered when IAAS are analyzed.

1.3 Objectives of the Study

This study on integrated aquaculture was set out to achieve the following objectives-

a. To have an initial understanding on present status and practices of integrated aquaculture in the study area;

b. To mark out the socio-economic and technical problems associated with integrated aquaculture; and

c. Advising the integrated aqua farmer’s for better combinations of species and management techniques sustainable for higher production and economic benefits per unit of area.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Since the integrated fish culture is an old technology but not enough researches have yet been done on integrated fish culture. The culture development and related decision need to be based on a comprehensive examination of integrated fish culture practices, potentials and constrains throughout the country. This chapter reviews studies concerning the culture suitability, production, farming pattern, profitability and constraints to integrated aquaculture.

From the ninth century, records showed fish farming in the paddy field. From the fourteenth to sixteenth centuries, there were records of rotation of fish and grass culture; and by the 1620s, the mulberry-dike fishpond, the integration of fish and livestock farming and complex systems of multiple enterprises integrated with fish farming were developed.

While IAAS are traditional and have a long history in some regions, in other regions they are only just being developed. The traditional rice-fish systems in China or in Vietnam have persisted for centuries, showing a high resilience in the face of different crisis (Lu and Li 2006; Mohanty *et al*. 2004; Weimin 2010). However, traditional IAAS also exist in other regions, such as the Chinampas systems in Mexico (Smardon 2006), and are being introduced successfully as new practices in Latin America (Pilarski *et al.* 2004; Zajdband 2009) and Africa (Brummett 1999). Finally, fish culture is not widespread in Asia and there it has the potential even in this region for aquaculture expansion (Fernando and Halwart 2000), even when agricultural expansion opportunities are over (Devendra and Thomas 2002b). The aim of this paper is to review the present status and to discuss the opportunity of the integrated aquaculture systems as a way to meet the challenge of producing more food, conserving the environment and enhancing food security in some selected areas of Nilphamari district.

It was not until after World War II that aquaculture gained much attention as a potentially large scale industry. In the 1960's, aquaculture became a significant commercial practice in Asia where it had mainly been used as a small-scale means of local community food production for thousands of years. In the last few decades, worldwide aquaculture production has increased significantly. But, aquaculture has not yet become the large-scale global food replacement for the numerous food-poor areas of the world, as many thought it would be.

2.1 Suitability

Rahman *et al.* (2012) studied socioeconomic impact of integrated fish culture in selected areas of Bangladesh. They stated that fish culture in suitable rice field reduced poverty, improved paddy yield, created employment opportunity, increased nutrient intake which brings food security for farmers.

Nesar *et al.* (2011) observed the socio-economic aspects of integrated farming in Bangladesh: opportunities, challenges and production efficiency. They concluded that integrated fish farming system is better than fish monoculture in terms of a range of social, economic and environmental measures.

Islam *et al.* (2010) noticed the changes in Dhaka city: trends and physico-environmental consequences. They observed that as the water bodies are shrinking with the passes of time in our country, fish culture with field crops would play key role here in maintaining aquaculture production.

Chowdhury (2009) examined population challenge facing Bangladesh. He concluded that the demand for rice and fish is constantly increasing in Bangladesh with nearly three million people being added each year to the population of the country. This additional people require more food and nutrition.

Wahab *et al.* (2008) assessed freshwater prawn-small fish culture concurrently with rice field in Bangladesh. They stated that Bangladesh has a total area of rice field is about 10.14 million ha and in additional 2.83 million ha remains water for four to six month in the rainy season. These additional areas are suitable for rice fish farming.

FAO (2000) examined forest resources of Bangladesh. They reported that the hydrological conditions of Bangladesh are also favorable for integrated` farming as this area is located within the monsoon tropics with an average annual rainfall of 2,500 mm.

2.2 Cost Benefit

Halwart (2008) practiced biodiversity, nutrition and livelihoods in aquatic rice-based ecosystems. He reported that the application of fertilizers and pesticides reduced in integrated based ecosystems conserve a great variety of aquatic flora and fauna.

Frei and Becker (2005) conducted a greenhouse experiment on growth and yield effects in integrated fish culture. They stated that integrated fish culture has numerous advantages, including efficient utilization of resources, economic benefits for the farmers, and improvement of food security in rural areas.

Roy (2005) assessed a study on the "Economic analysis of rice-fish under the north west fisheries extension projects in some selected areas of Dinajpur district". Activity budgets were prepared to find out the profitability of integrated fish culture. Cobb-Douglas production was also applied to determine the effects of individual inputs on integrated fish culture. Per hectare production cost for integrated rice-fish culture stood at Tk. 27,287. Per hectare rice and fish yields were 3,035 kg and 696 kg respectively. The net return integrated rice-fish farming was Tk. 25,789 per hectare.

Kohinoor *et al.* (2001) observed an experiment on poultry-fish culture and found that the net benefit from poultry-fish farming was Tk. 3,256/ha.

2.3 Farming Pattern

Frei *et al.* (2007) performed an experiment on Common Carp (*Cyprinous carpio*) and Nile tilapia (*Oreochromis niloticus*) in integrated rice-fish culture in Bangladesh. They reported that common carp, being a bottom feeder, was more efficient in controlling the benthic fauna than tilapia, which is mainly a column feeder.

Rahman *et al.* (1995) showed that boro rice was irrigated in 85 fields (0.08-1.2ha). The rice fields were provided with ditch covering about 2.8 % of the total area. The farmers were suggested to stocked fish at a density of 3000/ha. The fish species *C. carpio*, *P. gonionotus* and *O. niloticus* were stocked either in singly or in combination. The average fish production recorded under different plots. Higher yield of rice (6.4% by average) was recorded in 0.88 % rice field compared to those without fish. Average fish recovery recorded was 52.4%, 65.6% and 68.4% for *C. carpio*, *P. gonionotus* and *O. niloticus* respectively.

2.4 Production

Nahar (2010) assessed the impacts of rice-fish –prawn culture system on yield of rice, fish, prawn and limnological conditions. She found that the production of rice from rice-fish plot higher than single rice culture.

Lu and Li (2006) reviewed rice-fish-farming systems in China. They said that there is less use of fertilizers in concurrent rice-fish farming than rice monoculture. Fish wastes and the extra feed given to fish increased the amount of organic fertilizer in rice fields. Moreover, fish plays a significant role in controlling pests. They eat aquatic weeds and algae that carry disease, act as hosts for pests and compete with rice for nutrients.

Gurung and Wagle (2005) reviewed the ecological principles of integrated farming for environmental, economic and social benefits.

Uddin *et al*. (2001) observed the growth and yield of GIFT (*Oreochromis niloticus*) and Thai silver barb (*Barbodes gonionotus*) in rice field with horticulture. They obtained higher fish production (244.9 kg/ha) and income (Tk. 6,399/ha) by stocking *Puntius gonionotus* than that of *Oreochromis niloticus* (142.8 kg/ha and Tk. 2137/ha) in rice fish culture. They also obtained significant differences ($P<0.01$) in the yield of rice grain and straw between the treatments with fish and without fish.

Alam (1996) observed integrated farming of paddy and fish. He demonstrated that farmers got the yield of fish at about 234 kg/ha.

Dewan (1993) observed the rice-fish culture in Bangladesh. He stated that the yield of fish obtained in rice-fish farming varied from 223 to 700 kg/ha.

2.5 Social Conflict

The advent of industrial aquaculture has not only been a source of environmental concern, it has also been a source of social concern. Intensive practices used by some in the aquaculture industry pose significant threats to traditional, community-centered societies. As for example, integrated aquaculture practices in rural region can reduce the land for rice production.

However, it is mostly farmed in tropical areas, with production controlled by multinational corporations. Because IA production yields such a high profit, foreign or non-local individuals tend to exploit the areas where they can best be grown, without regard for the environmental or social implications, and then market them elsewhere, taking the profits as well as the product out of the region. The ecological impacts of large-scale IA production can leave the farming area unsuitable for small-scale production, damage local fisheries, and as a result damage the local economy.

Integrated farming, especially rice-fish, has been promoted as a means of generating socioeconomic benefits in rural and coastal areas. As farming methods have become more intensive, however, employment opportunities have declined. Additionally, as the industry attempts to further reduce costs and increase profits, it likely will become more sophisticated and employment will continue to decline. The industry has also impacted rural and coastal communities where integrated farming are done in commercial basis.

2.6 Making Improvements of Integrated Aquaculture

Recently, governments and industry have made efforts to curb unsustainable aquaculture activities. Many have realized that the focus of aquaculture must evolve into the development of an industry that is both environmentally and socially sustainable in the long term. Positive changes are being made with this growing interest and awareness of improving the sustainability of integrated aquaculture. With the expected expansion of integrated aquaculture in the coming years it will be vital that sustainable practices be implemented and further developed to avoid environmental and social problems.

2.7 Future Challenges for Integrated Agro-Aquaculture Systems

Aquaculture must play an important role in the future of food production, and IAAS offer many advantages, especially when compared with more intensive forms of aquaculture. However, integrated aquaculture is not a one-size-fits-all practice, especially in marginal environments, where integration does not always offer the most efficient way to increase farm productivity (Michielsens *et al.* 2002). Socio-economic and environmental conditions should be evaluated before IAAS are promoted in a given region (Hambrey *et al.* 2008). This implies that approaches for analyzing IAAS must involve scales broader than the farm level to understand their contribution to sustainable rural development (Bondad-Reantaso *et al.* 2009).

The potential contribution of IAAS to poverty reduction and food security is related to their ability to become a source of income for poor farmers or hired workers, and to increase the availability of cheap animal protein for poor consumers (Ahmed and Lorica 2002). The introduction of aquaculture and its integration within farming systems must be focused on the poor to be an effective way of enhancing food security.

Negative environmental consequences derived from the adoption of IAAS mainly occur outside the farm, involving broader spatial and temporal scales than those generally utilized in the assessment of IAAS. The most important environmental impact of IAAS is related to the use of alien species and water pollution. The introduction of alien species can result in escapees of these fish. If non-native species escape from ponds, they can contribute to habitat deterioration, increased competition for resources, and disease transmission (De Silva *et al.* 2009). The adoption of IAAS also can contribute to increased water pollution as a consequence of nutrient discharge from ponds. Other environmental impacts associated with IAAS are related to the emission of greenhouse gases such as methane and nitrous oxide (Datta *et al.* 2009). IAAS tend to be considered as resilient systems because of their diversity (Bailey 2008).

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the methodology, which was adopted to attain the objectives of the study. It explains the selection of research tools, methods of data collection, selection of research sites, selection of target groups and selection of analytical methods that were used in the study. The study is based on field survey, obtaining information through survey among the integrated fish farmers.

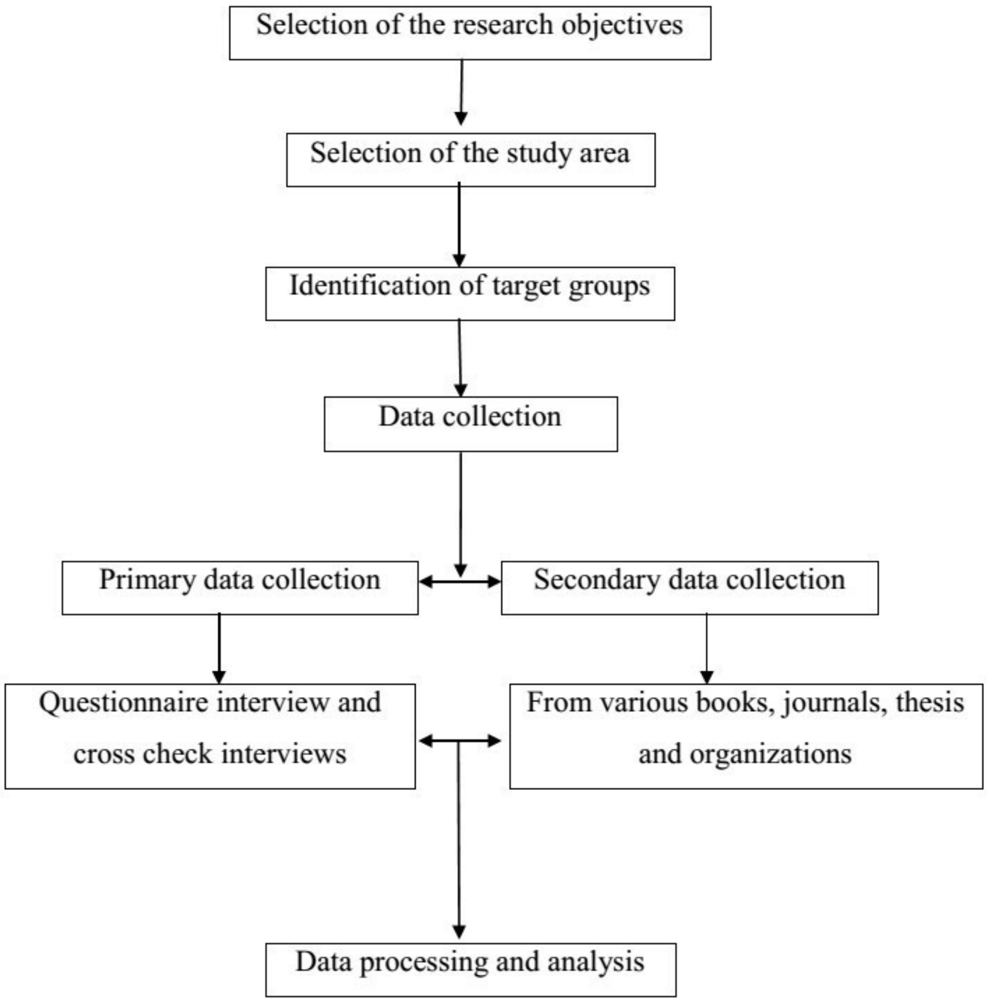

Figure 3.1 Methodology followed for the study.

3.1 Selection of Study Area

The study was conducted in some selected areas of Nilphamari district. Nilphamari is a district of northern Bangladesh. It is 400 km from the capital Dhaka in north and west side. It has an area of 1,547 square kilometers. Total population is 1,843,231 (census 2011). Nilphamari subdivision was established in 1875 and turned into a district in 1984. It consists of eight upazila. Selected Study areas are Saidpur and Kishoreganj upazila.

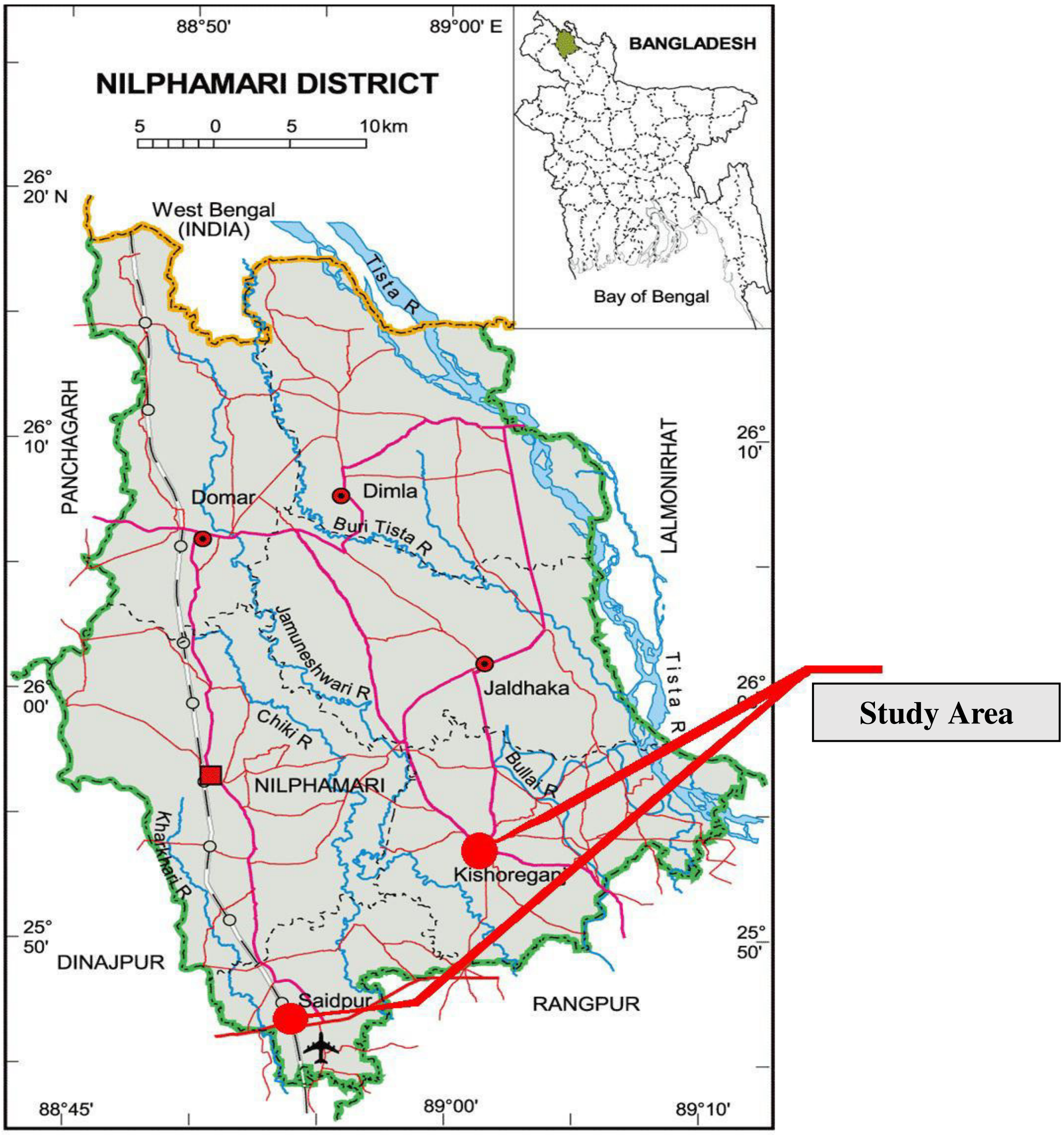

Figure 3.2 Map showing the study area of Saidpur and Kishoreganj upazila of Nilphamari district.

3.2 Duration of the Survey

The survey was carried out for a period of one year from July 2016 to June 2017.

3.3 Preparation of Questionnaire

Preparation of questionnaire is very important for survey technique. Draft questionnaire was prepared (Appendix). Relive finalization of the questionnaire, it was pre-tested by interviewing a few farmers of the study area. After pre-testing a set of final survey questionnaire was developed after necessary corrections and modifications. The questionnaire was elaborated to include all types of questions relating to integrated fish culture system and the objectives of the study.

3.4 Data Collection Procedures

According to the questionnaire, primary data collected from the farmers in the study area through individual interview. Secondary data were collected from various sources viz., District Fisheries Officer, Upazila Fisheries Officer and NGO workers. The farmers were interviewed at their culture sites. Most of the respondents had no written documents regarding purchase, consumption, sales and other aspects of integrated culture. For that reason, some elements of bias may be incorporated into the data. The methods followed for data collection are shown below-

3.4.1 Primary Data Collection

For primary data collection, a questionnaire was filled up through direct interview. Interviews were conducted at the culture areas. Farmers took part in interview in their culture site as a result there was a scope to observe their culture systems.

3.4.2 Secondary Information

Secondary data based on information collected from some published reports, papers and some official (DFO, UFO, NGO etc.) documents and reviews the existing information on the different aspects practices in the study area.

3.5 Variable of the Study and their Measurement

In the study several variables were selected namely age, family members, educational qualification, gender, profession, annual income, land size, location of land, types of integrated culture, training condition, harvesting time, production, profit margin etc. The procedures followed for noted the variable of the study are presented below:

3.5.1 Age

Age of a respondent was measured in terms of complete years from their (farmer) birth to the time of interview. A unit score was assigned for each year of one's age.

3.5.2 Family Size

The family size of a respondent was measured on the basis of the actual number of members in their (farmer) family living in a dwelling unit and used to eat from the same cooking arrangement. The family members included the respondent him/herself, husband/wife, children together with dependent members who lived jointly.

3.5.3 Educational Qualification

Educational qualification was measured in terms of primary, secondary, SSC, HSC and bachelor. Educational qualification was categorized on the basis of passing level and coded as 1, 2, 3 etc. for passing of each level. For example, if a respondent passed primary level his/her score was taken as one (1). A score of two (2) was assigned to that respondent who completed secondary level and so on.

3.5.4 Gender

Gender as male or female depending on visual observation.

3.5.5 Annual Income

The annual income of a farmer was measured on the basis of his family's yearly earnings from crops, fish farm, livestock, land lease, business, service and others. The family income was express in Taka. In measuring the variable, total earning in Taka of a respondent was converted into unit score.

3.5.6 Farm Size

Farm size of a respondent refers to the total area of land on which integrated culture is carried out. It is measured in terms of hectare.

3.5.7 Culture Types

Culture type refers to what type of integration is practices by the farmers. Either it is rice-fish, fish-horticulture or fish-poultry.

3.5.8 Production

Per hectare production from the view point of individual farmers measured in terms of kg.

3.6 Data Processing and Analysis

After collection of data, questionnaire data were edited, coded, entered into Microsoft Excel spreadsheet. Primary analysis (descriptive, graphs, pivot tables etc.) was carried out using Microsoft Excel. SPSS Version-20 was used for qualitative data which converted into quantitative numbers if required after processing, scaling and indexing of the necessary and relevant variables to perform subsequent statistical analyses for drawing inferences.

CHAPTER IV

RESULTS

CHAPTER IV

RESULTS

The results of the study are presented in this chapter with the help of proper statistical analysis. This study has been conveniently presented according to the objectives. The first section deals with the socioeconomic condition of farmers. The second section deals with the fish farming information. The third section deals with the management system practiced by the farmers and the fourth section deals with the farming pattern of rice -fish culture practiced by the farmers have been discussed, the cost and benefit in rice cum fish culture and the fifth section deals with the problems associated with rice-fish culture.

4.1 Selected Socioeconomic Characteristics of Farmers

Socioeconomic characteristics of the farmers were very important to the livelihood condition (including religion, age, education, income source etc.) of the farmers.

4.1.1 Age

The age of the respondents varied from 20 to 70 years with a mean of 47 years. The respondents were classified into three categories on the basis of their age: age between 20-40 years coded as 1; age between 41-60 years coded as 2; and age above 61 coded as 3. On the basis of the age, the respondents were distributed in the diagram (Fig. 4.1).

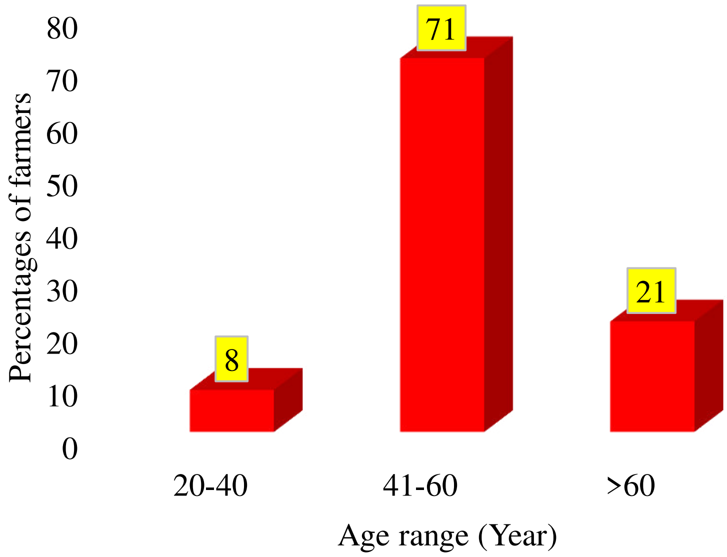

Figure 4.1 Age group of integrated farmers in the study area.

4.1.2 Family Size

The minimum and maximum family member's scores were 2 and 8 respectively. The average family members was 6. According to family members respondents were classified into two groups like family member between 1-4 coded as1 (32%) and family member between 5-8 coded as 2 (68%) (Fig. 4.2).

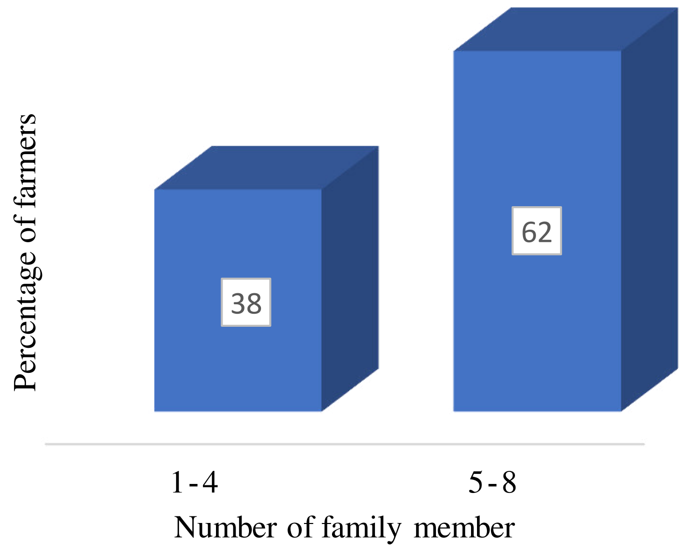

Figure 4.2 Family size of integrated fish farmers.

4.1.3: Level of Education

Education status can play vital role in efficient management and operation as well as in successful production of fish. Based on the educational qualification the respondents were classified and coded as primary (1), secondary (2), SSC (3), HSC (4) and bachelor (5). The distribution of the respondents on the basis of their educational qualification has been presented in Table (4.1)

Table 4.1 Educational qualification of the integrated farmers in the study area

Categories	**Number of farmers n=76**	**Percentage of farmers**
Primary	18	24
Secondary	30	40
SSC	20	26
HSC	07	8
Bachelor	01	2

4.1.4 Gender

The current study showed that all of the farmers in the study area was male.

4.1.5 Profession of Farmers besides Fish Farming

Fish farming had become not a main income source for the majority of farmers. Profession of the farmers besides fish farming found in the study area were farmer (49%), shopkeeper (14%), rickshaw puller (9%), government employer (16%) and business (12%) that presented in the diagram (Fig. 4.3).

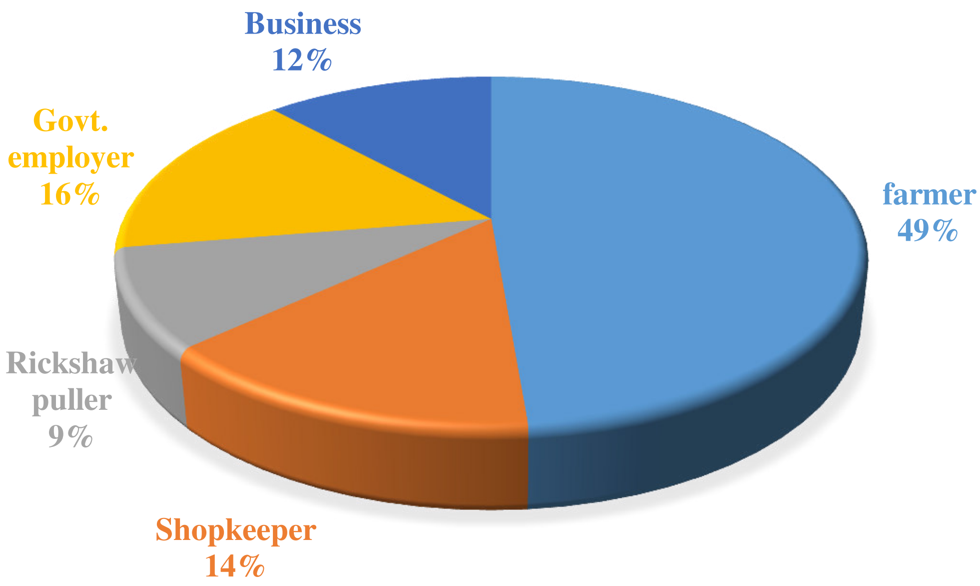

Figure 4.3 Profession of farmers besides fish farming in the study area.

4.1.6 Annual Income

The annual income score of the respondents ranged into four categories; 1.2-1.5 lacs (1), 1.51-1.8 lacs (2), 1.81-2 lacs (3), >2 lacs (4). According to the annual income scores, the result obtained from the study area are shown below (Fig. 4.4).

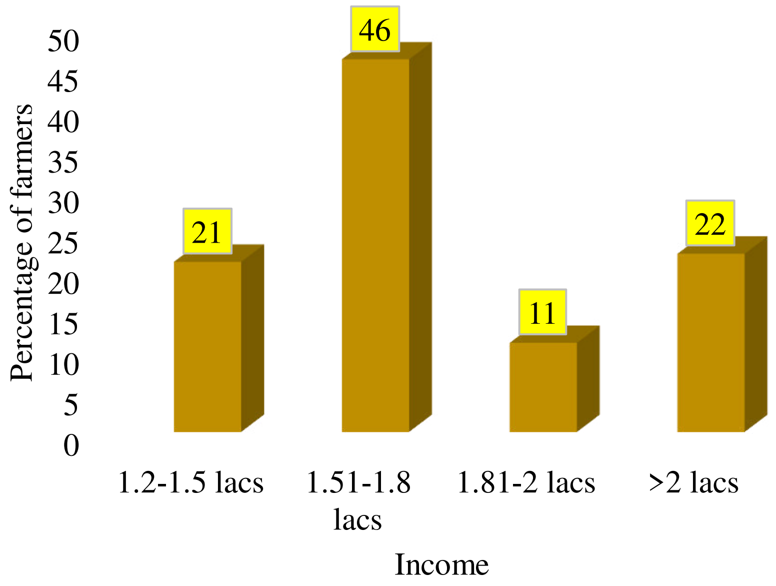

Figure 4.4 Diagram showing annual income of integrated farmers.

4.2 Fish Farming Information

4.2.1 Experience of Farmer

Experience of farmers (in year) was calculated by counting of starting year of integrated farming. Farmers started farming between the year 2005 and 2017. According to the data collected from the study area farmers experience ranged into three categories; 3-5 years (47%), 6-9 years (32%) and above 10 years (21%). (Fig. 4.5)

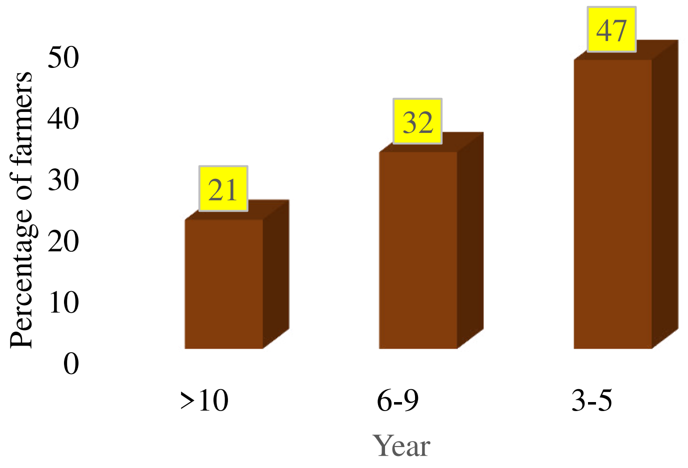

Figure 4.5 Experience of farmers in integrated aquaculture.

4.2.2 Farmer's Training Condition

Training experience and technical assistance play an important role for influencing fish production. Of the total 76 interviewed fish farmers, 66% farmers received formal training on the fish culture. Farmers obtained training from Fisheries Training and Extension Project, Youth development center, NGOs, Upazila Fisheries Office and BFRI sub-station, Saidpur. The duration of the training were 3 days to 1 month.

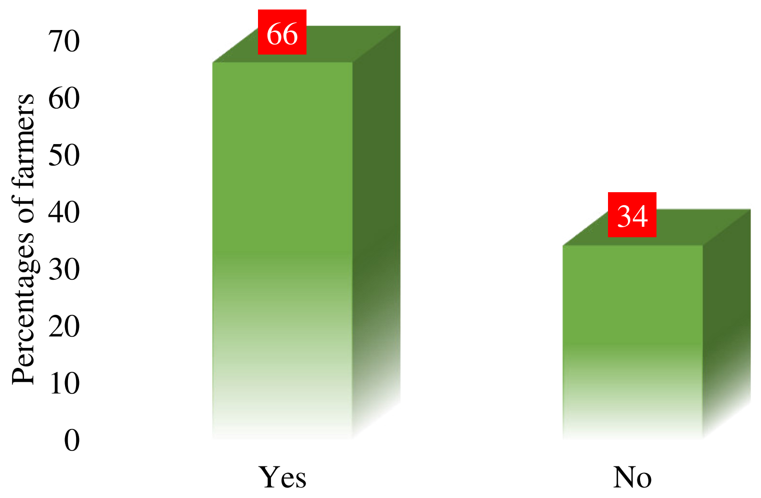

Figure 4.6 Percentages of fish farmers obtained training in the study area.

The data furnished that 50% farmers were received training from govt. UFO, 26% from different NGOs and 24% farmers were received training from BFRI Sub-station, Saidpur. (Fig. 4.7)

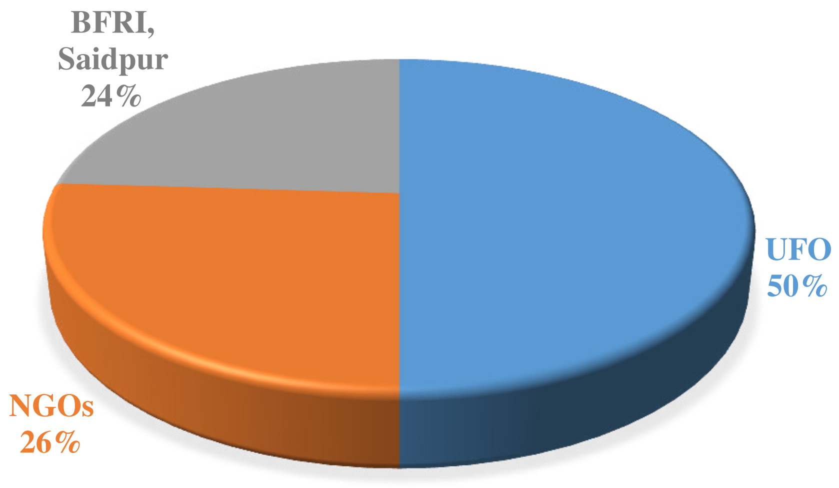

Figure 4.7 Diagram showing the institutions of training received.

4.2.3 Farm Size

The study showed that the total farm area of 25% farmers had 0.13-0.20 hector, 57.9% had 0.21- 0.28 hector and 17.01% had 0.29-0.36 hector. (Table 4.2)

Table 4.2 Total area of the farm in the study area

Range (hector)	**Farmers number n=76**	**Percentage of farmer**
0.10-0.20	19	25
0.21-0.30	44	58
0.31-0.40	13	17

4.2.4 Ownership of the Plot

Ownership of plots also an essential factor to make smooth decision regarding fish farming. It was found that in the study area 64% farmers had their own land, 25% retained joint ownership and 11% were leased lands from the others. (Table 4.3)

Table 4.3 Land ownership of integrated farmers

Ownership	**Farmers number n=76**	**Percentage of farmer**
Single	49	64
Joint	19	25
Leased	08	11

4.3 Pond Management System

4.3.1 Preparation of Plot and Ditch

Pond preparation is a pre-requisite to successful fish culture. A suitable pond is required to minimize the production cost and maximize the production of fish. So, different questions were asked to the farmers regarding the different aspects of pond preparation. Before releasing fish fingerlings into the pond most of the farmers repair dike to protect the pond from over flooding. Few farmers were not aware of the importance of pond dike repair. Before stocking, 92% of farmer's repaired pond dykes. (Fig. 4.8)

Plot preparations include the dike repairmen, removal of weeds, land plowing for planting. Ditch preparations include ditch drying, eradicate weed fish, ditch drug etc.

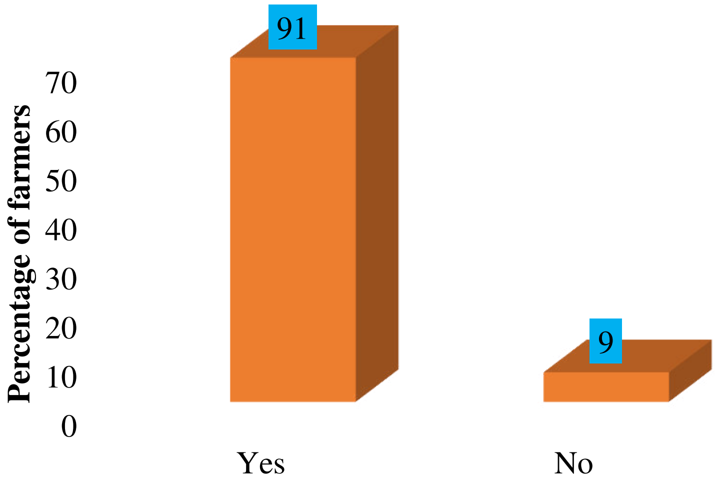

Figure 4.8 Percentage of farmers who prepare their plot and ditch for integrated aquaculture in every year.

4.3.2 Use of Fertilizer

According to the survey, 96% farmers in study area used fertilizer. The commonly used fertilizers were urea, Triple Super Phosphate (TSP), and cow dung. The average fertilization rate of urea, TSP, and cow dung were 220 kg/ha, 150 kg/ha, and 300 kg/ha respectively. (Table 4.4)

Table 4.4 Average fertilization rate used by integrated farmers (kg/ha)

Name of fertilizer	**Amount of fertilizer (kg/ha)**
Urea	220
TSP	150
Cow dung	300

4.3.3 Feed, Feeding Rate and Frequency

In the current study it was found that 100% farmers used feed. Farmers were used artificial feed (63%), homemade feed (3%) and both artificial and homemade feed (34%). The most common artificial feeds were mega, quality, lili, narish. CP, aftab and aman. The homemade ingredients that use as feed are rice bran, wheat bran, oil cake etc.

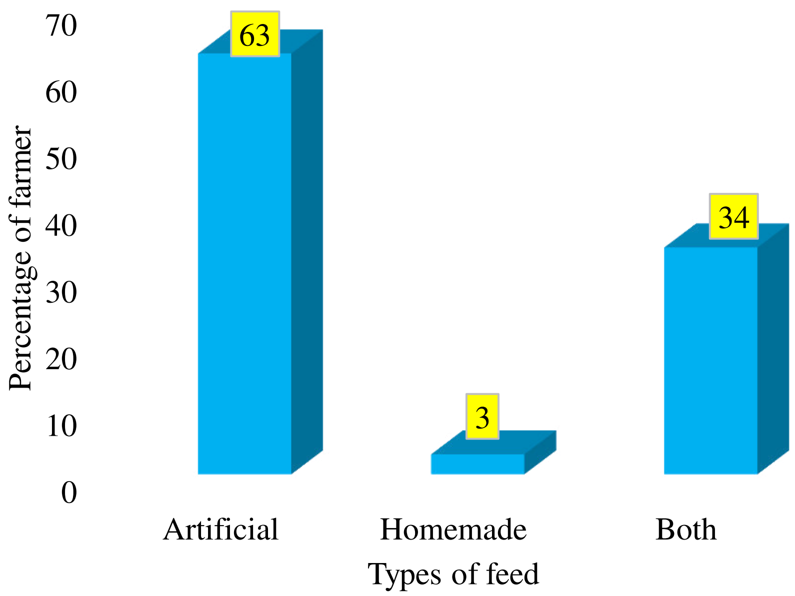

Figure 4.9 Types of feed used in integrated aquaculture in the study area.

Feeding rate depends on the fish body weight and total area of ponds. Study showed that 60% farmers used feed as per pond area and remaining 40% used feed according to the body weight.

In the study it was found that 22% of the farmers supplied feed once daily and 78% farmers supplied feed twice daily.

Table 4.5 Schedule of feed application in integrated farming systems in the study area

Time	**Number of farmer n=76**	**Percentage**
Morning	11	14
Evening	06	8
Morning and evening	59	78

Data contained in the Table (4.5) indicated that 14% of the farmers were supplied feed in the morning, 8% in the evening and rest 78% were in both morning and evening.

4.3.4 Water Quality Management

It is essential to measuring water quality to keep suitable condition in the pond to get the optimum production. In the study area, all farmers managed water quality by measuring temperature, dissolve oxygen, transparency, pH, ammonia and alkalinity. But the range of these parameters could not mentioned because of inadequate facilities. Current study indicated that 72% farmers had properly managed the water quality and 28% had no idea to manage the water quality. (Fig. 4.10)

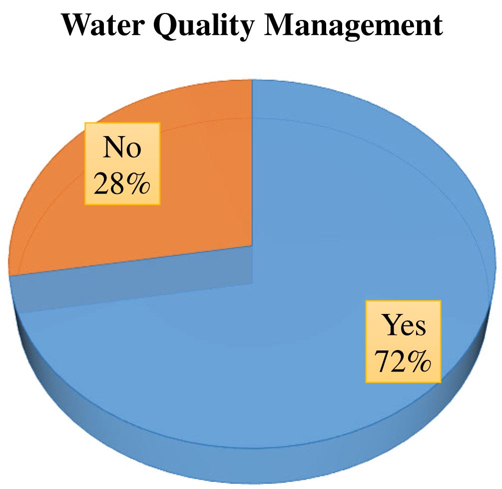

Figure 4.10 Water quality management for integrated aquaculture.

4.3.5 Disease Treatment

It was found that in the study area 87% of the farmers had idea how to treat the disease occurred in the farming system and 13% had no idea to diseases treatment (Fig. 4.11). Every farmer took preventive measures in the way such as pond drying, liming, weed control, removed of undesirable fishes, adding of water etc. to keep away the disease infection in their pond.

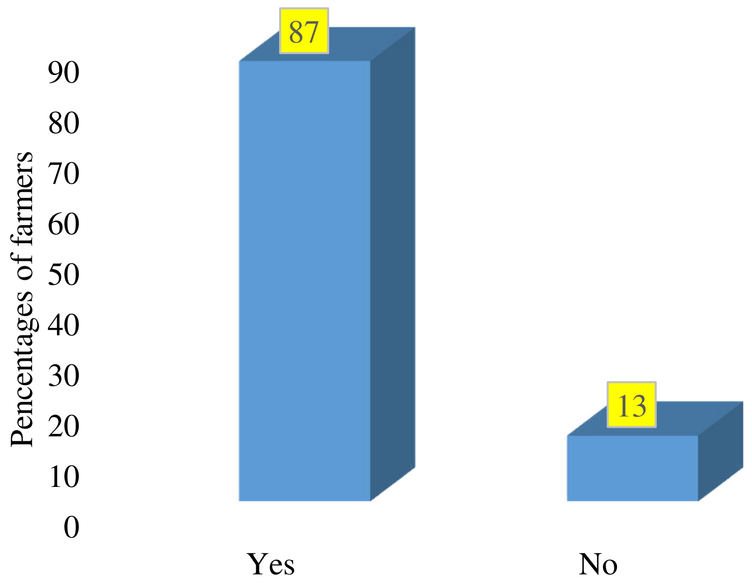

Figure 4.11 Diagram shown the percentage of farmer had idea how to treat the disease in integrated culture.

4.3.6 Pest and Predator Control

In the current study it was found that among the 76 farmers, 91% of the farmers controlled pest and predators in their culture sites. The farmers were used bamboo or net fencing for pest and predators control.

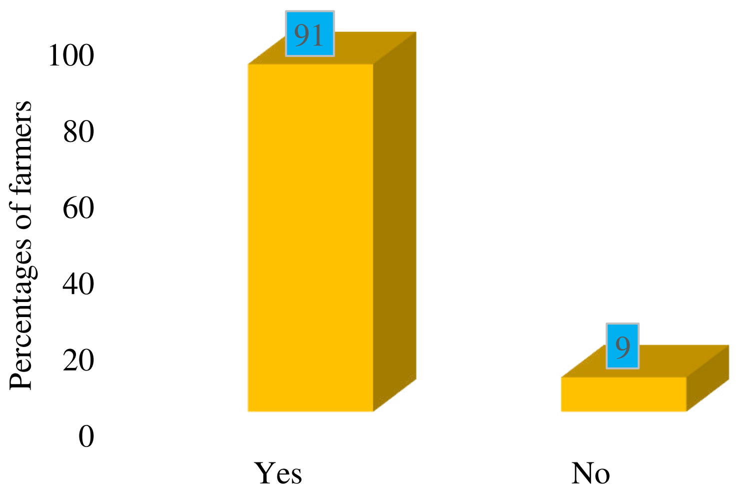

Figure 4.12 Control of pest and predator in integrated system.

4.4 Integration Pattern Practice by the Farmer

4.4.1 Process of Farming Followed by Farmers

Three different types of integrated aquaculture systems found in the study area, these were rice cum fish culture, fish-horticulture and fish-poultry integration. Farmers practiced rice-fish in the concurrent or alternative farming process. In the rice cum fish culture, after 10-15 days of rice plantation, farmers released fish fry into the ditch. Concurrent system practiced during Aman season in moderate or low paddy fields where water exists for 4-5 month naturally. In the alternative system rice and fish were grown rotationally. This system was farmed in deeply flooded low lands.

The top, inner and outer dykes of ponds as well as adjoining areas were used for horticulture crops. Vegetables and fruits bearing plants were found in the study area. Banana, papaya, lemon, brinjal, green leafy vegetables, chili etc. were cultivated as horticulture crops. Ponds were prepared during March-April and stocked of fry in May-June. Harvesting of fish taken place during December-January. The land was prepared for horticulture crops and plantation taken place during August-September and harvested in December - January.

Table 4.6 Overview of rice-fish integration

Categories	Pond preparation	Rice plantation	Fingerling stocking	Harvesting of rice	Harvesting of fish	Culture duration (month)
Concurrent	June-July	July-August	August	October-November	January-February	6-7
Alternative	February-March	March-April	April	May-June	November-December	8-9

Chicken (broiler) and duck raising mainly integrated with fish was found in the study area. Chicken and duck were raised over or adjacent to the ponds. The house use for birds farming was made with bamboo or any other locally available cheap materials. Broilers reached a marketable size (1.5-1.7 kg) within 4-6 weeks.

The study indicated that all the farmers followed polyculture as a strategy to cultivate different species. These species include rohu (*Labeo rohita*), Catla (*Catla catla*), mrigal (*Cirrhinus mrigala*), silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*), bighead carp (*Hypophthalmichthys nobilis*), sorputi (*Puntious sophore*), tilapia (*Tilapia mossambica*) etc.

4.4.2 Types of Integrated Aquaculture

Types of integration found in the study area were rice cum fish culture, fish-horticulture and fish poultry integration. The current study presented that farmer practiced rice cum fish culture, fish-horticulture and fish-poultry farming 46%, 33% and 21% respectively. (Table 4.7)

Table 4.7 Types of integrated aquaculture practices found in the study area

Categories	**Farmers number n=76**	**Percentage of farmer**
Rice-fish	35	46
Fish-horticulture	25	33
Fish-poultry	16	21

4.4.3 Fish Culture Practice

The study indicated that all the farmers followed polyculture as a strategy to cultivate different species.

4.4.4 Species Composition in Polyculture System

The use of species composition was found in the study area shown in the diagram (Fig. 4.13).

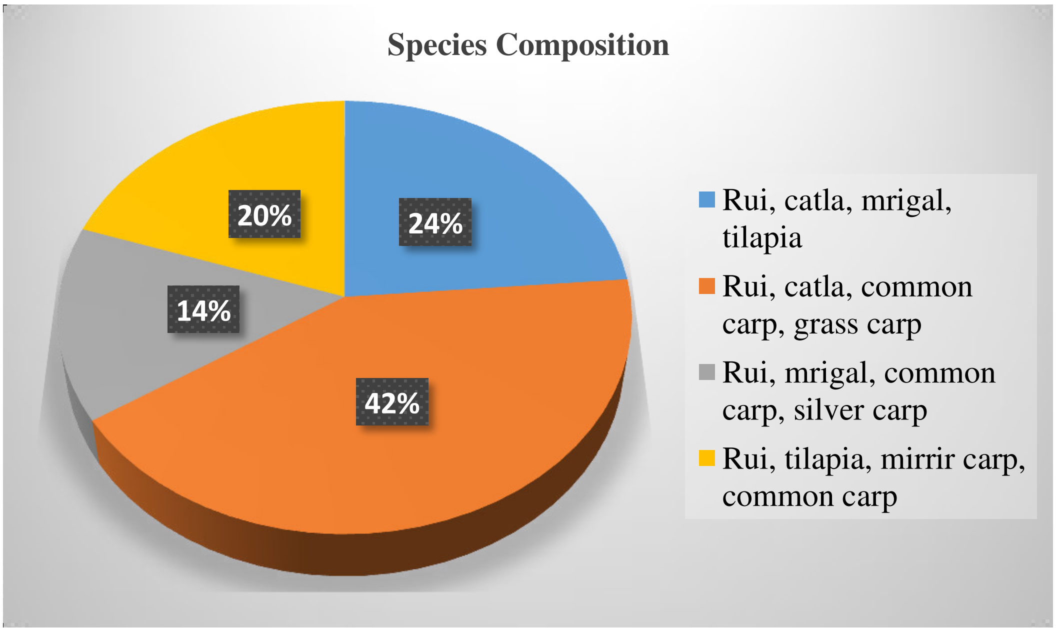

Figure 4.13 Diagram showing the species composition in polyculture system.

4.4.5 Source of Seed

In the study area farmers used seeds from the sources of hatchery (30%), local fry traders (47%) and from BFRI sub-station, Saidpur (23%). Result obtained from the study is shown in the diagram (Fig. 4.14).

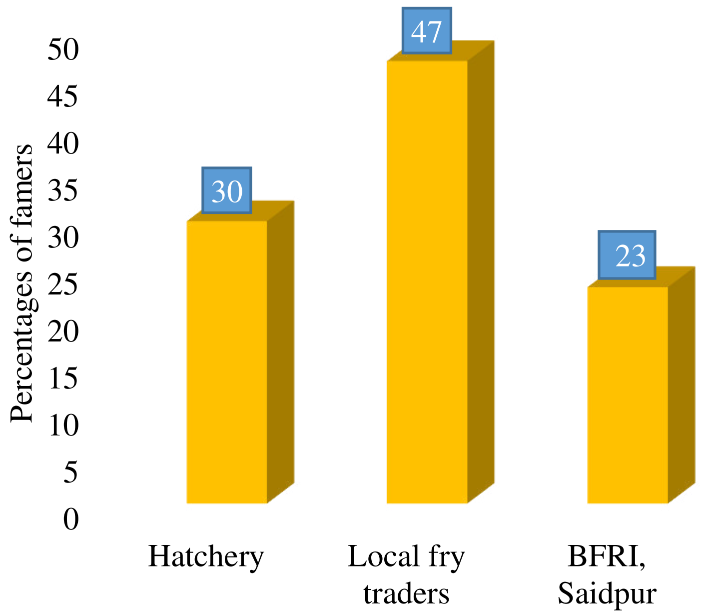

Figure 4.14 Source of seeds used in integrated culture.

4.4.6 Production of Fish and Field Crops

Fish productions in the study area was fully depend on the water retention capacity of pond because water retention capacities in the study area was not very high. Farmers cultured fish only 7-8 month in a year and harvested fish once, twice or threes per cycle. According to the survey, the highest average production of fish was 6,175 kg/ha which was achieved by 55% farmer and the lowest average production was 4,199 kg/ha for 7% farmer. The annual average production of fish was 5,434 kg/ha. (Fig. 4.15)

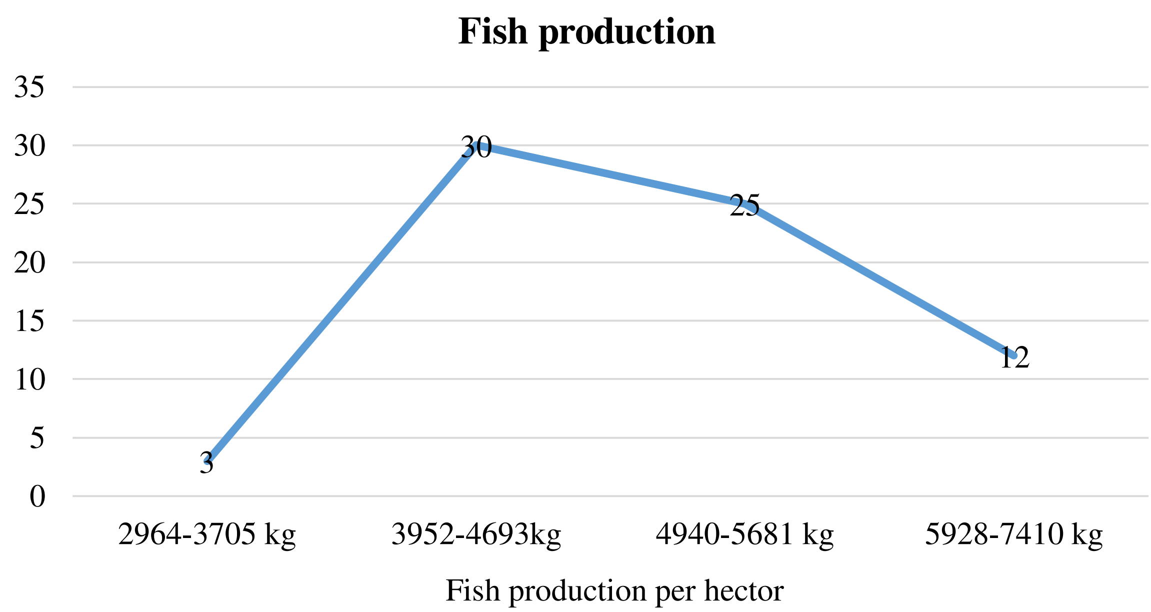

Figure 4.15 Production of fish

The production of field crops depends on the varity uses. Broiler reached marketable size within 4-5 weeks after stocking and the attained weight was 1.5 kg-1.7 kg. The highest production of broiler was 2,099 kg/ha and lowest production was 1,295 kg/ha (Table 4.8). On the other hand 33% farmers used fish-horticulture system where banana, papaya, green leafy vegetables, brinjal, cabbage, lemon, chili etc. were cultured as horticulture crops.

Table 4.8 Horticulture crops production in the integrated farming

Horticulture crops	**Production (kg/ha)**
Papaya	2964-3952
Green leafy vegetables	1482-2470
Brinjal	3458-4446
Chili	741-988
Lemon	1482-1976

4.4.7 Marketing System

Fish marketing has great importance in fish culture operation which constrains the sustainability of this industry. A number of middle men were involved in the marketing process between farmers and consumers in fish marketing in the study area. The market chain from farmers to consumers was passes through a number of intermediaries such as local fish traders (paikers), wholesalers and retailers.

4.5 Problems and Constraints of Integrated Culture

Like other agro- business, fish culture in the study area was also affected by many problems. The main problem in the study area was water did not remain whole year in the pond. Then the pond owners' cultured fish 7-8 month in a cycle which did not fulfill their demand and production. Fish seed collection and supply was also a major problem in the study area. Farmers collected fry/ fingerling from long distance under different upazila/ district.

A number of constraints for fish farming were reported as follows:

- High price of feed and fertilizer;
- Lack of capital;
- Inadequate technical knowledge;
- High leasing money;
- Poor loan facility;
- Water are not remain in pond farm whole year;
- Non availability of quality fingerlings;
- Unsatisfactory growth of fish;
- Reduction of water level in the spring and summer ;
- Poaching/ theft;

- Poor water quality;
- High labor cost;
- Transportation problems;
- Problems with pest and predator etc.

CHAPTER V

DISCUSSION

CHAPTER V

DISCUSSION

The purpose of this chapter is to discuss the results and verify the results with other findings of previous studies.

The present study showed that majority farmers were (40-60 years) involved in integrated farming activities. Rana (1996) found that 70% farmers were in 18-43 age groups. Mitali (2005) reported that 53% farmers were in 31-40 age groups which is more or less similar with present study.

The estimated average family size was 6. Current study revealed that 68% farmer had family member of 5-8. The data indicate that a few farmers (20%) family size in the study area was higher than the national average of 4.85 (BBS, 2016). Masud (2000) observed that average family size of farmers related to farming in inundated water bodies was 6 and 65% farmers were lived in nuclear family.

The present study revealed that the education level of the most fish farmers was primary (24%), secondary (40%) and SSC (26%) level. Only few a farmers found HSC and bachelor level. According to the BBS report (2016) the national literacy level of Bangladesh was 62% which is more or less similar with the present study.

Professions of the farmers besides fish farming that was found in the study area farmer, shopkeeper, rickshaw puller, government employee and business. The current study showed that the profession of majority people was farmer (49%). All of the farmers in the study area were male.

The study showed that the majority farmer’s main income source was integrated fish cultivation. The average annual income found in the study area was Tk. 1.12-1.56 lacs.

According to BBS (2016) the national average income was Tk. 1, 02,400 which indicate the more or less similar result of the study.

Training is very important for any farming system. According to the survey 66% farmer received training. Among them 50% farmers received training from UFO, 26% from different NGOs and 24% from BFRI sub-station, Saidpur. The duration of the training was 3 to 30 days.

In the study the average area of plots was 0.29 ha. Islam and Dewan (1987) stated that size of land is an important variable for the production of fish. On the basis of per unit area, land efficiency was greater in medium size plots (Mollah *et al.* 1986).

Three types of integrated culture systems were observed in the study area depending on bio-physical conditions. These were: rice cum fish culture, fish-horticulture and fish-poultry integration. In the study area it was found that 46% farmer practiced rice cum fish culture, 33% fish-horticulture and 21% practiced fish-poultry farming.

Farmers practiced rice-fish culture system both concurrent and alternative farming process. In the study area, most of the farmers practiced integrated farming in Aman rice fields and some were practiced during Boro season. Farmers avoid fish culture with rice in dry season (boro rice) due to a scarcity of water. In this process, rice seedlings were planted and fish seeds were stocked in the same plot. In concurrent system, rice was cultured from July to October. Fingerlings were stocked during July- August and harvested in November. On the other hand, in the alternative system, fingerlings were stocked in the paddy field in June-July after collecting of rice and were harvested in November-December, a culture period of 5-7 month until rice plantation in the next year. Many alternate farmers in deep water rice fields cannot choose rice-fish integration because of water management problems. However, culture of deep water rice with fish during the flood season, followed by dry season rice farming can be established in flood-prone rice field ecosystems (Dugan *et al.* 2006).

Fish-horticulture was the second most popular integration system among the farmers in the study area. Some farmers practiced horticulture and poultry, horticulture and rice integration with fish culture at a same time. The top, inner and outer dykes of ponds as well as adjoining areas were used for horticulture crops. Vegetables and fruits bearing plants were planted in the dyke as horticulture crops. Banana, papaya, lemon, brinjal, green leafy vegetables, chili etc. were found. For fish-horticulture integration system ponds were prepared during March-April and stocked with fry/fingerlings in May-June. Ponds water were used for irrigation and silt, a high quality manure, was used for field crops. Harvesting of fish was taken place in December-January. The dykes and adjoining area were prepared for horticulture crops and plantation was done during August-September which was usually harvested in December - January. The vegetables were grown and harvested twice in a year- once during August/September and another in March/April. The farmer consumes a portion of the harvested fruits and rest was sold in the market as cash crops.

Fish-poultry integration was not popular practice. However, it is growing attention to the farmer day by day. Fish-poultry farming system was practiced by 21% farmers in the study area and all the farmers used broiler (for meat) and duck as poultry crops. The chicken house were constructed over or adjacent to the ponds. Broiler reached a market size of 1.5-1.7 kg in 5-6 weeks after stocking.

A range of fish species were cultured in rice fields, depending on the farming system. Mainly Indian major carps and exotic carps were stocked. The survey indicated that all of the farmers followed polyculture. Different species, like rohu (*Labeo rohita*), catla (*Catla catla*), mrigal (*Cirrhinus mrigala*), silver carp (*Hypophthalmicthys molitrix*), bata

(*Labeo bata*), bighead carp (*Hypophthalmicthys nobilis*), Sorputi (*Puntius sarrana*) were used in integrated farming. Das and Dewan (1982) examined that different fish species, like mrigal, common carp and tilapia showed better growth in monoculture than in polyculture. However, many farmers reported that they avoid common carp because rice plants were uprooted and consumed if rice fields stocked with common carp.

Supplementary feed was applied by most of the farmers, although small-scale fish farming in rice fields is an extensive aquaculture system that primarily relies on the natural food (phytoplankton, zooplankton, periphyton, and benthos). In integrated culture, farmers mainly used on-farm inputs, such as rice bran, wheat bran and mustard oilcake. The study showed that 100% farmers used feed. Among them the using intensity of artificial, homemade and both artificial and homemade feed were 63%, 3% and 34% respectively. Feeding rate depends on the fish body weight. Most of the farmers applied feed as 3-4% body weight of fish. Saha *et al.* (1995) had also found the farmers used rice bran and oil cake in rice-fish farming. The most common artificial feeds which used in the study area were mega, quality, lili, narish. CP, aftab and aman. The feeding frequency was two, some farmers used once a day who practiced rice-poultry integration.

A variety of fertilizers such as urea, triple super phosphate (TSP) and cowdung were used for integrated fish farming that found in the study area. The purpose of using fertilizers was to grow natural fish food and improve soil fertility, thereby increasing fish and land crops yields. The quantity of fertilizer was related to the farming system practiced. The average fertilization rates of urea, TSP, and cow dung were 220 kg/ha, 150 kg/ha, and 300 kg/ha respectively. Khan *et al.* (1997) recommended Urea, TSP, MP and Gypsum for use in rice-fish farming. Mitali (2005) in her study in Mymensingh district found that the average rate of fertilization were urea 150 kg/ha, TSP 70 kg/ha. In the present study the rate of fertilization was high due to the higher production involves the high fertilization rate.

The highest average production of fish found in the study area was 6,175 kg/ha (55% farmers) and the lowest average production was 4,199 kg/ha (7% farmers). The highest production of broiler was 2,099 kg/ha and lowest was 1,295 kg/ha. The production of horticulture crops were vary depending on the verity used and management practiced. According to the survey, banana and papaya had highest production value among the horticulture crops. Mitali (2005) found that the yields of fish and rice were estimated at 593 kg/ha/year and 4,345 kg/ha/crop respectively. In the present study the results indicate higher production of fish and rice due to the application of modern technology and protein rich feed supplied by the farmers.

The present study found several problems which act as a barrier for integrated aquaculture. Marina (2009) found the problems of rice-fish culture including lack of sufficient funds, lack of good quality seeds or fries, high price of input, low price of output, lack of scientific knowledge and technology, lack of extension services, problems of thefts and multiples ownership. Robbani (2002) stated that majority of farmers faced various problems such as inbreeding problems in fish seed, lack of quality seed, inadequate technical knowledge on scientific fish culture, incidence of fish disease, poor credit facilities, security, marketing, multiple ownership and lack of feed were identified as the constraints to fish culture in Mymensingh, Jessore and Laxmipur region. Similar results were found in the present study. So the Government of our country, different NGOs should take necessary measures to improve this sector which in turn develop our national economy.

It was found that there were several low lands and ponds which were suitable for integrated farming. The integrated farming systems found in the study area were still very poor. Most of the farmers were practiced tradition culture system due to lack of modern technological knowledge and scarcity of training facilities. The management system also very impecunious. The proper utilization of the unused low lands and ponds makes better improvement in both production and socio-economic condition of the farmers in the study area. It is also essential to spread the modern technological knowledge and provide training facilities among the integrated fish farmers which will increase the overall farm output as well as the management efficiency of the farmers.

5.1 Food security and environmental safety

Integrated fish farming produces more food than alternate farming of horticulture and rice monoculture. Nevertheless, productivity in integrated farming is lower than it could be because of the low level of inputs. Present study suggests higher yields can be achieved by increasing inputs. Intensification of the fish culture in rice fields could also result in higher performance (Vromant *et al.* 2002). However, the most suitable level of intensity is mainly determined by the availability of resources and the farmer's management ability. According to Shang and Tisdell (1997), higher production can be obtained by improving existing culture techniques and practices, removing bottlenecks or a combination of these alternatives.

There was a strong association between food production and consumption. As a result of integrated fish farming, the households of integrated farmers were able to eat rice three times a day. Rice fields can potentially contribute considerable amounts of protein to fish farming households. Thus, the switch from rice monoculture to integrated fish farming is not merely a change in cropping system, it is also a shift to a more balanced diet

(i.e., rice and fish). The diet of integrated farmer's households contained significantly more fresh fish than that of alternate farmers. In the alternate system, fish farming was a cash crop, and thus 85% of the production was sold to local markets with only 15% consumed by the households. In contrast, farmers using the integrated system consider fish as a secondary crop in terms of economic return. Therefore, 40% of the fish production was consumed by the households with just 60% sold to local markets. It was reported that farmers' households tend to eat small fish and sell the bigger ones. In addition to animal protein, small fish are a valuable source of micronutrients, vitamins and minerals.

Several reports have suggested that rice monoculture and horticulture is not environmentally sustainable in the long-term and is eroding the natural resource base (Berg 2001; Halwart and Gupta 2004; Frei and Becker 2005; Lu and Li 2006).

Reduced fertilizer and pesticide use through the adoption of IPM (Integrated Pest Management) is one long-term option to improve farm productivity in an environmentally friendly manner (Berg 2002; Gupta *et al.* 2002). Reduced application of fertilizers and pesticides in rice-based ecosystems conserve a great variety of aquatic flora and fauna (Halwart 2008). According to Rothuis *et al.* (1998), the main benefits of integrated fish farming are environmentally sustainable, system biodiversity, and decreased use of fertilizers and pesticides.

Increased application of fertilizers and pesticides in rice monoculture and horticulture has been releasing more radio-nuclides and residues leading to soil toxicity. Increased toxicity of the soil and water in rice fields has severely damaged the aquatic habitat, with the number of aquatic species in rice fields declining by 48–60% in Bangladesh (Ali 2004).

Therefore, the integrated fish farming system can provide a sustainable alternative to any other monoculture practices, if farmers can take advantage of its environmental benefits.

CHAPTER VI

SUMMARY AND CONCLUSIONS

CHAPTER VI

SUMMARY AND CONCLUSIONS

This chapter constitutes a summary of the results of previous chapters, some conclusions on the basis of data analysis and recommendations to the existing obstacles of integrated fish farming in Bangladesh. A study on present status and prospects of integrated aquaculture in Saidpur and Kishoregonj upazila of Nilphamari districts was conducted for a period of one year.

Integrated culture can help to great extent to meet the increased demand of foods, fish and rice. Keeping this in view, the present study was designed. An attempt has been taken to know the present status and future aspects of integrated fish culture development in some selected areas of Nilphamari district.

A structured interview schedule was prepared keeping the objectives in mind for data collection through structured interview method. The questionnaire contained both open and close formed questions. Question related to integrated aquaculture such as culture methods practices, cultured fish species, annual production, income and environmental impacts etc. According to the questionnaire data was collected from the farmers in the study area through personal interview. The data obtained from the interview methods was coded, categorized and analyzed by using statistical software, SPSS (V-20) to describe the present status and prospects of integrated aquaculture of the study area. A total of seventy six farmers were randomly selected from the study area. The formal data was collected for six months from March to August 2017. In this study an attempt was taken to know the status and practices of integrated aquaculture, and to identify the socioeconomic and technical problems associated with integrated aquaculture. It also attempt to advise the integrated aqua farmers better combinations of species and management techniques for sustainable higher production and economic benefit per unit of area.

The study indicated that majority farmers was (40-60 years) involved in integrated farming activities and all were male. Secondary level of education (40%) was the prominent level of education among the integrated fish farmers. Percentage of graduate and above was very few. The main occupations were agriculture and fishing/fish cultivation. Majority of farmers (46%) were in the low to medium income category (range Tk. 1.51 to 1.8 lac). It also observed farmers in the study area were found to engage in other occupation besides rice-fish farming including shopkeeper (14%), rickshaw puller (9%), government employer (16%), business (12%) and farmer (49%). The current study present that majority of the farmer family consist 5-8 members (68%). Above 60% farmers in the study area were received training from UFO, NGOs and BFRI, Saidpur. Majority of the farmers started integrated farming in the year between 2009 and 2015. The greater number of farmers (64%) had single ownership plot and remaining had multiple ownership or leased plot.

There were three types of integrated culture systems found in the study area depending on bio-physical conditions, these were rice cum fish culture (46%), fish-horticulture (33%) and fish-poultry integration (21%).

Farmers practiced rice-fish culture system both concurrent and alternative farming process. In the study area, most of the farmers practiced integrated farming in Aman rice fields and some were practiced during Boro season. The top, inner and outer dykes of ponds as well as adjoining areas were used for horticulture crops. Vegetables and fruits bearing plants were planted in the dyke as horticulture crops. Banana, papaya, lemon, brinjal, green leafy vegetables, chili etc. were found. Fish-poultry farming system was practiced by 21% farmers in the study area and all the farmers used broiler (for meat) and duck as poultry crops. The chicken house were constructed over or adjacent to the ponds.

All the farmers followed polyculture. In the survey, area average farm size was 0.29 hectare. Fish species such as silver carp, rohu, mrigal, catla, common carp, grass carp tilapia etc. was found to stock by all the farmers. Ruhu, catla, tilapia, common carp were cultured by majority farmers. Few farmers were cultured bata and mirror carp species. For pre-stocking management, 96% farmers in study area used fertilizer. The commonly used fertilizers were urea, Triple Super Phosphate (TSP), and cow dung. The average fertilization rate of urea, TSP, and cow dung were 220 kg/ha, 150 kg/ha, and 300 kg/ha respectively. The survey indicated that the average production of rice was 5928 kg/ha and the fish was 5434 kg/ha/season. With regard to major problems faced by farmers including lack of sufficient funds, lack good quality seeds or fries and feeds, high price of input, low price of output, lack of scientific knowledge and technology, lack of extension services, lack of proper training facilities, transportation and marketing problems, water source and water quality problems, problems with poaching and poisoning, pest and predatory problems and multiples ownership. Several low lands and ponds found in the study area suitable for integrated farming. Proper utilization of the unused low lands and ponds makes better improvement in both production and socio-economic condition of the farmers in the study area.

Bangladesh is a developing country. It has been experiencing huge quantity of food grain shortage almost every year. To minimize the food storage, it has become an urgent need of the time to increase the production of foods through multiple utilization of the scarce resources of the country. In order to meet the soaring demand for food, there is a need for increased rice and fish production in Bangladesh. This study concludes that fish integration could be a viable option for diversification. Such farm diversification will enhance food security and safety. Integrated fish farming increases fish yields and makes the field ecosystem an efficient and environmentally sound production system for fish and field crops. Rice monoculture cannot alone provide a sustainable food supply, while integrated rice fish farming is the best in terms of resource utilization, productivity and food supply. It is therefore suggested that integrated farming is a sustainable alternative to rice monoculture. Overall integrated fish farming should play an important role in contributing to food security in Bangladesh.

Although integrated farming increases the supply of food, this type of farming has not yet been attempted on a large scale in the country. It is, therefore, suggested that integrated farming should be extended with the help of government organizations, NGOs, donor agencies, and other key stakeholders. In order to increase food supply, the government should promote integrated farming throughout the country. Considering the role of integrated farming, a much greater benefit could be obtained if future government policies encourage the expansion of integrated farming, as well as the implementation of a workable strategy to bring it about.

It can be concluded that integrated farming is highly profitable. If modern inputs and production technology can be made available to farmers in time, yield and production of rice, fish and horticulture crops may be increased which can help the farmers to increase income and improve livelihood conditions. Integrated fish farming can help in improving the nutritional status in rural people. Therefore, it may be concluded that where there is lots of paddy fields and irrigation facilities, farmers can profitably produce fish with rice instead of only rice. The domestic and foreign consumption of rice and fish is likely to increase in future.

Recommendations

To enhance the effectiveness of small-scale integrated farming, the following recommendations are made as a part of formulating strategy for intensifies aquaculture development in Nilphamari district.

- Re-orient extension and training program
- Establish strong network for better inputs (seed, feed) supply and outputs (rice, fish production) supply
- Need to extend and re-orient credit program
- Build up information center in rural region
- A numbers of hatcheries should be established for sufficient supply of fish fry
- Co-ordination with other integrated farming system
- Strengthening food security; income and poverty alleviation programmes
- A positive policy at government level should be given attention to support sustainable rice-fish farming
- Improve the transportation and marketing system
- Ensure to supply of high quality fish feeds
- To reduce the uses of inorganic fertilizers
- Employ guards to reduce poaching and poisoning etc.

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APPENDIX

APPENDIX

Department of Aquaculture

Hajee Mohammad Danesh Science and Technology University, Dinajpur

Questionnaire

Research Tittle: Present status and prospects of integrated aquaculture in some selected areas of Nilphamari District

Respondent No.: Date:

(Please answer the following questions)

A. Personal Information:

Name of the farmer: ………………………………………………………………

Address: Village………………………… Union………………………..

Contact No. :

1. Age: …………..Years
2. Family members: ……………….
3. Educational qualifications:

☐ Primary ☐ Secondary ☐ SSC ☐ HSC ☐ Bachelor

4. Gender: ☐ Male ☐ Female

5. Profession:

a) …………………………………………….

b) Beside fish aquaculture: ………………………………………………

6. Farmers annual income: …………………TK.

7. Have you receive any training: ☐ Yes ☐ No

If yes, Time: …………………….. Duration………………………

Institution:…………………………………………………

B. Assessment of the Farming System:

Basic Information of the Farm:

1. Location of the Farm: ………………………………………….
2. When did you start fish farming activity? Yrs ………………
3. Total area of the cultured land :……………..decimal
4. Ownership of the plot?

☐ Self ☐ Multiple ownership ☐ Leased

5. Type of integrated culture:

☐ Rice-fish (concurrent/alternative) ☐ Fish-horticulture ☐ Fish-poultry

☐ Others……………………………………

6. Fish culture practice: ☐ Monoculture ☐ Polyculture

If poly culture, species composition:

a) c)

b) d)

7. Time of pond preparation……………………………………………..

8. Time of fish stocking: ………………………………………………….

9. Source of fish seed and stocking density:

Species	Sources	Stocking density/decimal

10. Cultured field crops:

Categories	Cultured species	Time of land preparation/Housing	Time of plantation/stocking
Rice			
Horticulture			
Poultry			
Others			

11. Harvesting:

Categories	Partial harvesting	Complete harvesting	Time

12. Production and cost analysis:

Categories	Production (kg/dec.)	Total cost (Tk.)	Total income(Tk.)	Total benefit(Tk.)

C. Management System Practice:

1. Do you repair your plot every year? ☐ Yes ☐ No

2. Do you dry your ditch every year? ☐ Yes ☐ No

3. Do you fertilize your pond? ☐ Yes ☐ No

If fertilize, then……… ☐ All over the land ☐ Inside the ditch.

Name and amount of fertilizer use;

Name of the fertilizer	Amount (kg/dec.)
Urea	
TSP	
Cow dung	
Lime	

4. Do you supply feed? ☐ Yes ☐ No

If yes, then…… ☐ Artificial ☐ Homemade/Farm-made

Name and amount;

Name of feed	Amount / % Body wt.

5. Time of feed supply (Feeding frequency: ………..)

☐ 9.00-10.00 AM ☐ 12.00-1.00 PM ☐ 3.00-4.00 PM ☐ 6.00-7.00 PM

6. Water quality management: ☐ Yes ☐ No

If yes, which parameters: ……………………………………

How ……………………………………..

7. Diseases treatment: ☐ Yes ☐ No

If yes, how……………………………………………………………………

8. Pest and predator control: ☐ Yes ☐ No

If yes, then how ………………………………………………..

Problems in IA System:

Please mention the problems you face during integrated fish farming:

1.

2.

3.

4.

5.

Proposed Solution to the above Mentioned Problems:

Please mention your proposed solution for the above mentioned problems:

1.

2.

3.

4.

5.

Thank you for your kind information and cooperation.

________________________ ________________________

(Signature of the interviewer) (Signature of the farmer)