MANAGEMENT AND ECONOMICS OF DIFFERENT POLYCULTURE SYSTEMS IN MONIRAMPUR UPAZILLA, JESSORE: A FIELD SURVEY FOR THE MOST PROFITABLE CULTURE PRACTICE

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Declaration

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The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.

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DEDICATED TO

My Beloved Parents

ACKNOWLEDGEMENT

All praises are to the Supreme Being, creator and ruler of the Universe, Allah; whose mercy keeps me alive and enables me to pursue my education in Fisheries and Marine Resource Technology Discipline and to complete my thesis for the degree of Master of Science (MS) in Fisheries and Marine Resource Technology.

I would like to expresses my indebtedness and gratitude to honorable teacher and thesis work's supervisor Dr. S. M. Bazlur Rahaman, Professor, Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna, for his scholastic guidance, constant supervision, worthy inspiration, criticism and valuable suggestions during the entire period of the study and writing up of this thesis and improving its expression so as to make it more readable.

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Md. Anowar Hossain

May, 2010

ABSTRACT

To identify a profitable polyculture system, field survey was conducted in 62 farms in Monirampur Upazilla under the district of Jessore during June to December, 2009. A questionnaire was used to collect relevant information through interview which included physical condition of the farms, pre & post-stocking management, production and cost-benefit analysis of different polyculture systems. In the surveyed area about 43.55% farmers were found to practice polyculture of different fin fish species whereas about 51.61% farmers were found to practice polyculture of prawn (*Macrobrachium rosenbergii*) and other fin fish species and only 4.84% farmers were found to practice polyculture of pangus fish (*Pangasius hypophthalmus*) and other fin fish species. Most of the farms were prepared through drying of bottom mud, repairmen of dikes, removal of undesired aquatic weeds and predator species. Urea, TSP, cow dung and oilcake were widely used as fertilizer during pre & post stocking periods. Pellet feed were used as supplementary feed along with others like rice bran, broken rice, oil cake, wheat flour etc. Production levels of the farms were found to depend on the management system, feeding practice and fertilization of the farms. The species composition of the stock was varied according to the target species of the culture. The stocking rate of the target species remained high in the surveyed area. It was observed from the survey that among the different polyculture practices, the pungus (*Pangasius hypophthalmus*) fish culture alongwith other fin fish species like rui, catla, mrigal and common carp attained the highest profit ranges from Tk.186,750/- to Tk. 304,000/- per hectare. Whereas the polyculture of different fin fish species attained profit ranges from Tk.34,700/- to Tk.59,800/- per hectare and polyculture of prawn (*Macrobrachium rosenbergii*) alongwith different fin fish species attained profit ranges from Tk. 63,050/- to Tk.118,600/- per hectare. Lack of sufficient capital was found to be a major problem of the farmers which is hindering the progress of aquaculture in Monirampur upazilla.

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LIST OF ABBREVIATION

Abbreviation	Elaboration
DOF	Department of Fisheries
FAO	Food and Agricultural Institute
g	Gram
GDP	Gross Domestic Product
ha	Hectare
Kg	Kilogram
Km	Kilometer
m	Meter
MT	Metric Tone
NGO	Non Government Organization
PL	Post Larvae
TFO	Thana Fisheries Officer
TSP	Triple Super Phosphate

CHAPTER ONE

INTRODUCTION

1. INTRODUCTION

Capture fisheries and aquaculture supplied the world with about 110 million tonnes of food fish in 2006, providing an apparent per capita supply of 16.7 kg. Of this total, aquaculture accounted for 47 percent. Outside China, per capita supply has shown a modest growth rate of about 0.5 percent per year since 1992. China remains by far the largest producer, with reported fisheries production of 51.5 million tonnes in 2006 (17.1 and 34.4 million tonnes from capture fisheries and aquaculture, respectively), providing an estimated domestic food supply of 29.4 kg per capita as well as production for export and non-food purposes. Overall, fish provided more than 2.9 billion people with at least 15 percent of their average per capita animal protein intake.

According to the data compiled by FAO on the basis of reports from national authorities and other sources (e.g. regional fishery organizations), global capture fisheries production in 2006 was about 92 million tonnes, with an estimated first-sale value of US$ 91.2 billion, comprising about 82 million tonnes from marine waters and a record 10 million tonnes from inland waters. China, Peru and the United States of America remained the top producing countries. World capture fisheries production has been relatively stable in the past decade. China remains by far the global leader with more than 17 million tonnes in 2006. Asian countries accounted for 52 percent of the global capture production. Overall catches in the Western Central Pacific and in the Western Indian Ocean continued to increase, whereas capture production decreased in both the Western and Eastern Central areas of the Atlantic Ocean. In the Eastern Indian Ocean, total catches in 2006 returned to growth after the decrease in 2005 caused by the destructive effects of the tsunami of December 2004. Catches from inland waters, almost two-thirds of which were taken in Asia in 2006, have shown a slowly but steadily increasing trend since 1950.

Aquaculture continues to be the fastest growing animal food-producing sector and to outpace population growth, with per capita supply from aquaculture increasing from 0.7 kg in 1970 to 7.8 kg in 2006, an average annual growth rate of 6.9 percent. This means that aquaculture continues to grow more rapidly than other animal food-producing sectors. While capture fisheries production stopped growing in around mid-1980, the aquaculture sector has maintained an average annual growth rate of 8.7 percent worldwide (excluding China, 6.5 percent) since 1970. Annual growth rates in world aquaculture production

between 2004 and 2006 were 6.1 percent in volume terms and 11.0 percent in value terms. World aquaculture is heavily dominated by the Asia–Pacific region, which accounts for 89 percent of production in terms of quantity and 77 percent in terms of value. Of the world total, China is reported to produce 67 percent of the total quantity and 49 percent of the total value of aquaculture production. Norway and Chile are the world's two leading producers of cultured salmons (salmonids), accounting for 33 and 31 percent, respectively, of world production.

Fisheries and aquaculture, directly or indirectly, play an essential role in the livelihoods of millions of people around the world. In 2006, an estimated 43.5 million people were directly engaged, part time or full time, in primary production of fish either in capture from the wild or in aquaculture, and a further 4 million people were engaged on an occasional basis (2.5 million of these in India). In 2006, the estimated number of fish farmers was nearly 9 million people, with 94 percent operating in Asia. In 2006, more than 110 million tonnes (77 percent) of world fish production was used for direct human consumption. Almost all of the remaining 33 million tonnes was destined for non-food products, in particular the manufacture of fishmeal and fish oil.

Fish plays a major role in meeting the animal protein demand, foreign exchange earning and socioeconomic development of the rural poor by alleviating poverty through employment generation in an agro based country like Bangladesh. This sub sector contributes about 4.57% to the Gross Domestic Product (GDP) and 4.50% to the foreign exchange earning (Economic Report, 2009). Fisheries contribute 80% of the national animal protein intake. Bangladesh fisheries have three sectors: marine capture, inland capture and inland culture. There are 265 species of freshwater finfish and 475 marine fish species reported from the country, together with 68 shrimps and prawns, 26 marine and freshwater turtles and tortoises, 24 amphibians, more than 300 molluscs, 2 crocodiles, 1 gavial, about 20 water snakes, about 182 aquatic or wetland birds, and 12 aquatic mammal species. There are 93 species of exotic fishes introduced in the country, of which 18 were introduced for culture fisheries and the rest for aquaria.

Bangladesh is bounded on the south by the Bay of Bengal. The coastline of Bangladesh is about 710 km long, and the continental shelf extends over an area of about 66,400 km^2, of which about 37,000 km^2 is within the 50-m-depth zone and has good fisheries resources. This sector can further divided into industrial and artisanal fishing subsectors. The main

catches from the Bay form two broad groups: finfish and shrimps. According to DoF 2007-2008 data, marine fishes were further grouped into 9 categories. Marine *hilsha* contributed the most (40.22 percent of total catch of 200,100 MT), followed by shrimp (53,206 MT; 10.69 percent), Bombay duck (Herpodonidae) (36,980 MT; 7.43 percent); Jew fishes (33,803 MT; 6.79 percent); catfishes (20,534 MT; 4.13 percent); pomfret (16,728 MT; 3.36 percent); sharks and rays (4,767 MT; 0.96 percent); and miscellaneous marine fishes (130,415 MT; 26.21 percent). Industrial (trawl) fishing contributed only 6.87 percent of the total catch from the Bay whereas the artisanal fisheries contributed 93.13 percent fishing in the same fiscal year, which was in total 463,414 MT, caught by powered and un-powered traditional boats, using gill nets, set bag nets, trammel net, long lines and other fishing gear. At present, approximately one-third of the Exclusive Economic Zone (EEZ) is fished, while the remaining area of the deeper part of the EEZ needs to be explored and developed. The marine fisheries comprise industrial and trawl fisheries and small-scale artisanal fisheries by coastal fisher communities. According to the 2007-2008 fish catch profile, industrial fishing was carried out by 133 trawlers catching 34,159 MT of finfish and shrimps. In the artisanal fishery, 20,342 powered boats and 23,618 un-powered boats equipped with 25,369 gill nets, 12,765 set bag nets, 1,103 trammel gear, 2,641 long lines and 2,082 other gear types were involved. Over 167,000 fishermen and support staff are employed in the marine sector. In addition, about 185,000 people are engaged in part-time shrimp fry collection activities.

Inland fisheries are the major source of fish to meet national demand. Major carps, exotic carps, catfishes, snakeheads, live fishes, *hilsha* fishes and small indigenous fishes are the most important fisheries in commerce, and 2007-2008 statistics show that the large and small indigenous species formed 45.61 percent of inland fish produced in the country, followed by major carps (21.37 percent), exotic carps (13.01 percent), large and small shrimps (8.70 percent) and *hilsha* fishes (11.31 percent). The total area under inland water bodies is about 4.6 million ha, of which 88.45 percent is open water and 11.55 percent closed water bodies (DoF, 2009).

The open water inland fishery is the major commercial fishery of Bangladesh. It consists of open water capture fisheries, which contributed about 41.36 percent of total national fish production in 2007-2008. The capture fisheries includes the fish catch from the vast uncultivated water bodies including the rivers and estuaries, the mangrove forest (Sundarban), wetlands like *Beel*, vast seasonal flood lands and the country's largest and

only hydroelectricity generation artificial lake, Kaptai. In 2007-2008, the river and estuary together produced 0.14 million metric tons of fish with a contribution of 160 Kg catch/ha area. Beels produced 0.08 million metric tonnes of fishes, which contributed 679 Kg catch/ ha area. The vast flood land is source of the major catch of the open water fisheries. In the same fiscal year, the flood lands produced about 0.82 million metric tons of fishes. In average, it was about 289 Kg catch/ ha area. The largest man made lake Kaptai produced 0.008 million metric tonnes of fish, in average about 120 Kg/ha area production (DoF, 2009). The major open water inland fisheries are divided into two broad groups: large fishes (mainly major carps, large catfish, eels and others) and small fishes (minor carps, barbs, minnows, snakeheads, etc.). The large fish fisheries are in the rivers while the small fishes are from the beels and canals. *Hilsha* is also available in rivers and their tributaries during its migration from the sea in the rainy season. The major fisheries and livelihoods of the poor fishermen mainly depends upon the open water fishing. Overexploitation is a major problem, in many cases resulting in loss of species diversity from many water bodies of the country, However, to maintain the stock and production from open water fisheries, various types of management attempts have been made. The inland open water fishery provides employment for 770 000 fishers through access to the water bodies.

The inland culture fishery i.e. aquaculture which is now recognized as a first growing fisheries subsector includes fishery husbandry activities in closed water bodies, some 528,390 ha of water area. The aquaculture includes pond and ditch (305,025 ha), *baor* or oxbow lake (5,488 ha), and shrimp farm (217,877 ha) production. The pond fisheries are countrywide. The closed water oxbow lakes (*baor*) fish culture is situated in the southwest of the country. The brackish water shrimp (*Penaeus monodon*) culture is in the southern, eastern and western coastal regions, while giant freshwater prawn (*Macrobrachium rosenbergii*) culture is expanding across all the country. Finfish production from ponds and ditches was 866,049 MT in 2007-2008. In the same period, *baor* production was 4,778 MT and shrimp production was 134,715 MT. Considering unit area production, pond production was highest at 2,839 Kg/ha, followed by 871 Kg/ha in *baor* and 618 Kg/ha in shrimp ponds (DoF, 2009). The main resources of the aquaculture sector are the fish species itself. A good number of fish species have commercial value. The indigenous species are major carps, minor carps and indigenous catfish. The exotic fishes include carps, tilapia, Thai barbs, Thai pangasids, etc. The country has made tremendous progress in hatchery

development through private entrepreneurs for fish seed production. Several world class large shrimp and prawn hatcheries have been established. The aquarium fish sector has good long-term prospects and is currently expanding fast. Bangladeshis are known as fish eaters. However, fish is now being exported globally. It can be seen that frozen shrimp is the major export item of the country. Recently this sector has been improved to meet HACCP and other export requirements. Fish and shrimp and the processed products are exported to USA, Canada, EU, Japan, Middle East and India.

In Bangladesh, there are about 1.5 million ponds of different sizes covering an area of about 146,955 ha of land of which about 52% is under extensive fish culture (Islam and Moniruzzaman, 1999). Different types of fresh water fish such as carp fish, cat fish, snake head fish, climbing fish are cultured in our country. Among them, most of the fresh water areas are practiced with carp fish. There are many carp fish culture technique in our country which is practiced in different fish farm such as poly culture, monoculture, integrated culture etc. Poly culture of carps and mono culture of thai pangus and cat fish in pond are the most widely practiced culture systems in Bangladesh. In 2009, total production from pond culture reached 866,049 MT, which constitute about 86% of total aquaculture production. Although, fish culture in pond is not a new practice in our country, the rate of production of fish is still lying far than what should be. Improper management and production techniques viz. high and low stocking rate, inadequate manuring and feeding etc. have been considered responsible for low production of fish. As most of the farmers are poor and living in rural area, it is not possible for them to support the intensive technologies of fish production which required higher input supply. An appropriate intermediate technology for the farmers of Bangladesh thus should be the semi-intensive culture technique that requires moderate inputs and production management based mainly on proper stocking rate and ratio and adequate regular manuring with or without supplementary feeding. Production of fish through semi-intensive poly culture or integrated fish farming by using animal or agricultural by-products in fish farm as manure and feed has appeared to be the most appropriate technique for rural farmer.

Monirampur is an important Upazila under the district of Jessore, south-west of Bangladesh consisting of 257 villages under 17 unions & 1 pourashava. It's total area is 44,591.50 hectares having total population of 319,278. There are 4 rivers named Harihar, Taka, Muktas Sori and Kapatakho measuring total 259 ha, 23 beels (Beel Bakor, Beel Kadaria,

Beel Tapu Balo Dhali, Arpata Beel, Beel Tatulia are mentionable) measuring total 9,200 ha and 5 baor named Jhapa Baor, Khedapara Baor, Harihornagar Baor, Khatura Baor and Parkhajura Baor measuring total 528 ha in Monirampur Upazilla. There are 10,418 ponds with 1,490.53 hacters in areas & 5,550 ghars with 5,017.42 hectors in areas in Monirampur Upazilla. Number of private hatchery is 5 and number of private nursery is 32. Among the total population 26,981 people are directly or indirectly involved with fisheries activities. Annual fish production in Monirampur Upazilla was 4,216 MT in 2009 out of which 3,840 MT was produced from aquaculture sector (Personal communication, Upazila fisheries officer, Monirampur, Jessore).

Annual fish production of Bangladesh is about 2.6 million metric ton for the financial year 2007-2008 (Economic Report, 2009). This production can not cope with the rapidly increasing demand. Fish production from inland open water has been decreasing due to various reasons such as, changing aquatic ecosystem, soil erosion, siltation in the river, construction of dam to control flood and irrigation, indiscriminate use of agro-chemicals, destructive fishing practices, over fishing etc. Inland capture fishery contributed 51.5 percent of the total fish production in 1987-88, whereas in 2007-2008 it contributes about 41.36 percent of the total production (Table1.1). By this time contribution from aquaculture has increased in two folds from 20.8 to 39.23 percent. To fulfill the need of time, dependency on culture fisheries and pond aquaculture increased to a greater extent, of which pond aquaculture is of greatest importance. Culture fish has come from a variety of farms ranging from small-scale owner-operated fish pond to large scale co-operative and corporate farms, supported by auxiliary industries such as, feed and equipment manufactures. Increased production is being achieved by the expansion of areas of land and water under culture and the use of more intensive and modern farming technologies that involve higher uses of inputs viz., water, feed, fertilizers and chemicals.

Table 1.1 Comparison of sector-wise fish production between 1987-88 and 2007- 08.

Sector	Percent contribution to total fish production	
	1987 - 1988	2007 -2008
Inland capture	51.5	41.36
Aquaculture	20.8	39.23
Marine fisheries	27.7	19.44

Source: BBS (1987), DoF (2009)

For the improvement of culture system and future planning, information about present aquaculture practices at the grass root level is absolutely necessary. So, survey which is systematic way of collection of information is of great importance. The word "Survey" refers to a method of study in which an overall picture of a given universe is obtained by a systematic collection of all available data on the subject (Efferson, 1953). Various aquaculture practices are being conducted in the villages of the Monirampur upazila. All aquaculture oriented unions have been selected for the present study. It is to be further noted that selected villages can serve as the representative of southwestern aquaculture practices.

Objectives of the study

The present survey work has been undertaken with the following objectives.

(1) To identify different polyculture systems with their management activities.

(2) To assess the most profitable polyculture system.

CHAPTER TWO

MATERIALS AND MATHODS

2. MATERIALS AND METHODS

Appropriate methodology is a prime necessity that enables the researchers to collect valid and reliable information and to analyze the information properly in order to achieve the objectives of any study. So, methodology is an indispensable and important part of a scientific research. The methodology includes the selection of the research title and objectives, selection of research area, identification of stakeholders, data collection and selection of analytical method (Fig. 2.1). There are several methods of collecting data and information. Selection of particular method depends on many considerations such as, the nature of the research problem, time constrains, and availability of funds etc. The present study was based on field survey where primary data were collected from the farm owners or manager. The survey method was chosen for the present study because it was thought to be more advantageous. The major advantage of this method is that it is less expensive and its coverage is much wider. But one of the major defects on this method is that the investigation has to depend solely upon the memory of the farmers as they have no written records regarding their culture practice. This was, however, overcome by repeated visit and asking question in such a manner that the farmer could answer from their memory as well as experience.

2.1 Selection of the study area

The selection of an area for the study depends on the objectives or purpose set for the study. The selection of study area in which a farm business survey is to be carried out depends on the particular purpose of the survey and possible co-operation from the farmers. Thus, information was collected for the fulfillment of the objective of the study. Primary information about fish farm present in Monirampur upazila under district of Jessore covering all union was collected from Upazila Fisheries Office of selected area. Map of the study area is furnished in Fig. 2.3.

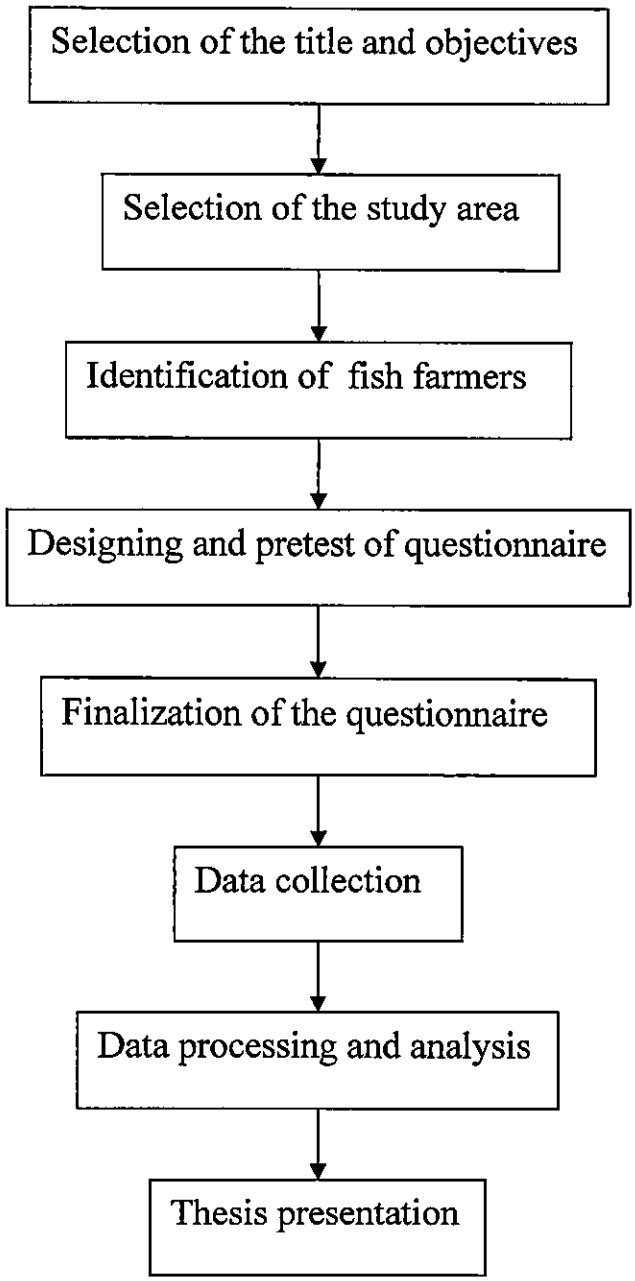
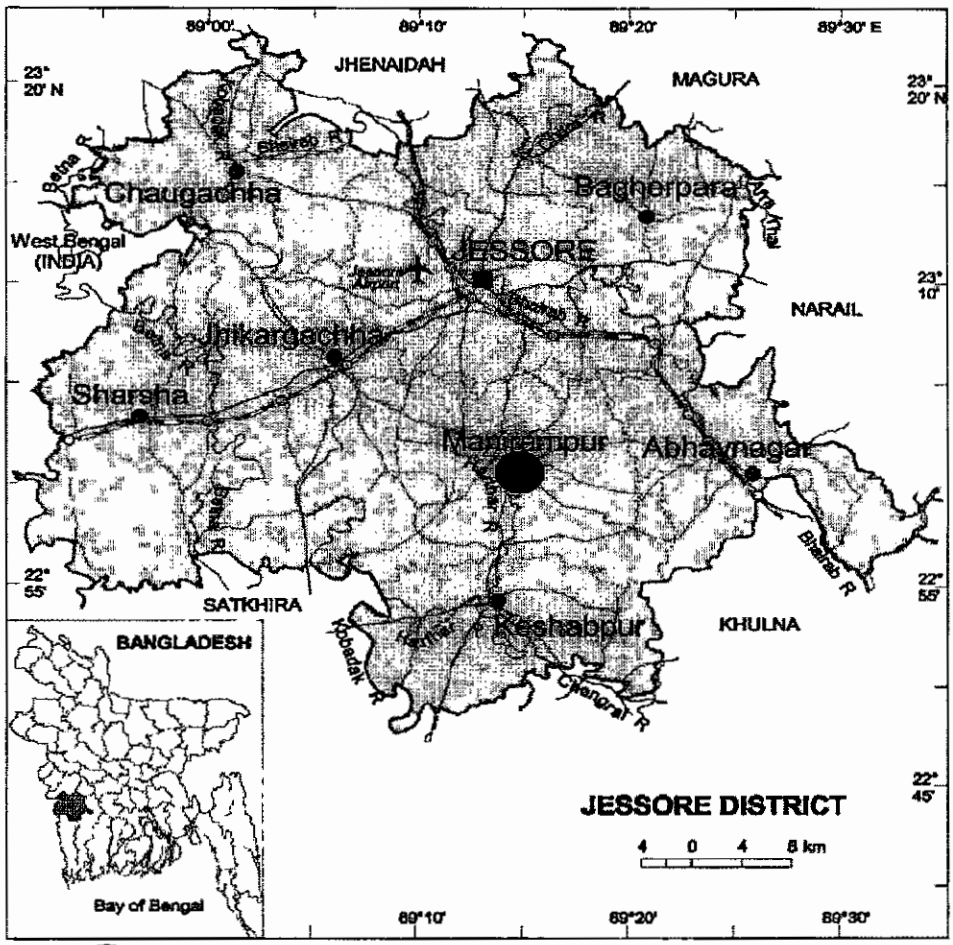
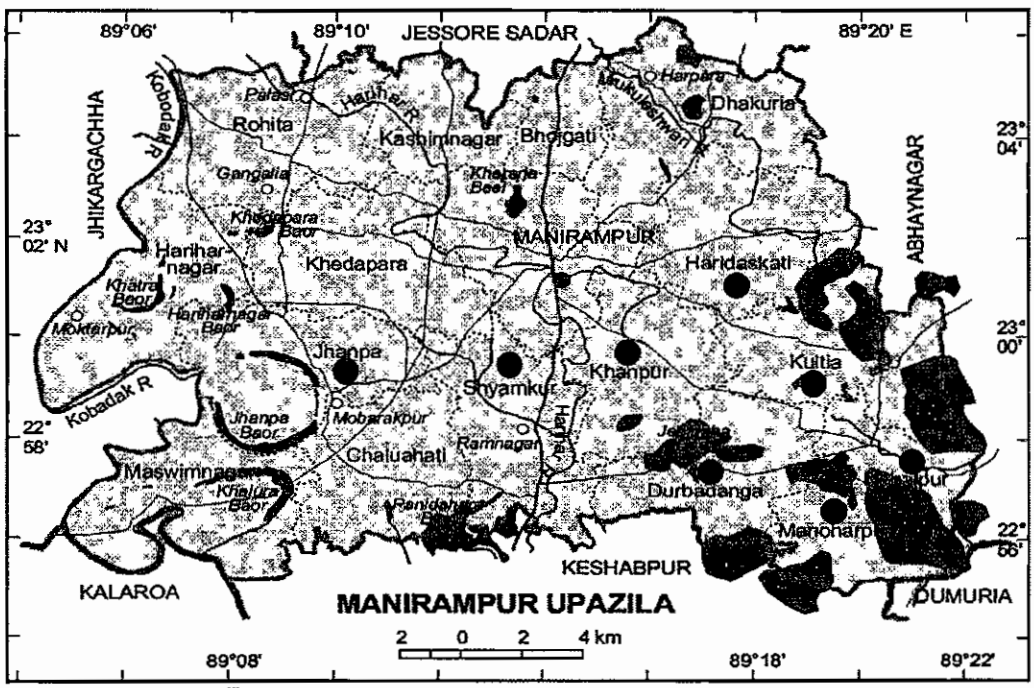


Fig. 2.1: Methodology followed for the study



Symbol shows the location of Monirampur Upazilla

Fig 2.2 : Map of Jessore District



Symbol shows the study locations

Fig. 2.3 Location of the sampling area of Monirampur Upazila

Finally data were collected from 62 farm owners/ managers randomly covering the selected study area. This area was selected considering the following reasons:

a) Large number of aquaculture farms in this area;
b) Fish culture is a rising trend in this area;
c) There are easy communication facilities;
d) The study area was not far away and thus it was less expensive as well as easier for data collection for the researcher;
e) Social norms and common believes were well known by the researcher; and
f) No research was conducted in this area under the present topic.

Table 2.1: Name of the Unions and villages and number of farms surveyed in the survey area

Sl. No.	Name of Union	Name of village	No. of surveyed farm
1	Haridaskathi	Bhulbaria	4
		Haridaskathi	5
		Pachbaria	5
2	Kultia	Mahisda	6
		Puradanga	3
		Kultia	5
		Moshihati	5
3	Nehalpur	Bazitpur	3
		Konakhali	2
4	Durbadanga	Shamnagar	3
		Harina	3
5	Balidha	Balidha	3
		Pachakari	2
6	Monoharpur	Monoharpur	4
		Bayardanga	3
		Hasamnagar	3
7	Jhapa	Jhapa	3
	Total		**62**

2.2 Sample size and sampling technique

The selection of sample size was one of the crucial aspects for the study. It was not possible to include all the farms under the study area because of limitation of time and resources. A reasonable size of sample to achieve the objectives of the study was considered. Considering these aspect 62 farm owners were selected for the study. The sampling was done randomly. Data collection was carried out from March to November 2009.

2.3 Designing of questionnaire

According to the objective of the study a draft questionnaire (consisting of two parts, one is for farm owners and another is for local people living near the farms) was prepared to collect the relevant data. Some questionnaires which were used in similar type of study were also consulted to gather idea to make a well-developed questionnaire.

2.4 Making final questionnaire

Initially prepared draft questionnaire was tested with 10 farmers by the researcher himself. In this pilot survey, much attention was given to any new information, which was not designed to be asked but was important to achieve the objective of the study. Thus some parts of draft schedule were improved, rearranged and modified according to the actual experiences gained from the pilot surveys.

2.5 Collection of data

Data were collected by direct interviews. With a set of interview schedule designed for this study, each respondent was given a brief introduction about the purpose of the study during the interview. Besides, the researcher asked the questions systematically in a very simple manner with explanations wherever it was felt necessary and the information was recorded accordingly.

2.6 Processing and analyzing of data

After collection of data, the collected data were summarized, tabulated and analyzed according to the objectives of the study. A tabular method of analysis was followed in analyzing the data.

2.7 Problems encountered during data collection

Following problems were encountered by the researcher during data collection (i) Most of the farm owner do not maintain written record of their farms and culture practice. So, the collected data were completely dependent upon the memory of the farmers; (ii) Many farm owners were unaware and illiterate so they hesitated to answer the questions and also to co-operate; (iii) Most of the respondent in the study area had no idea about research work and it was, therefore, difficult to explain the purpose of this research to convince them; (iv) The respondents used local units of measures in response to questions, which were often difficult to be converted into standard unit; (v) Some of the respondents thought the

researcher is a credit / NGO worker or wants to established new farm so sometimes they tried to overlook the actual information and (vi) the respondents were not aware of their problems.

CHAPTER THREE

RESULTS AND DISCUSSION

3. RESULTS AND DISCUSSION

3.1 Nature of aquaculture

During the study it was found that all the farmers of the study area practiced polyculture systems for obtaining highest profit from the aquaculture. It was also observed that among the polyculture systems farmers gave more attention to produce a single species or group of species and the stocking density of the targeted species was remained high among the cultured species. The culture practices followed in the surveyed area can be categorized into following 3 (three) major culture practice depending on the species composition of the stock and the target species of the culture:-

i. **Culture -1:** Polyculture of Indian major carps and Chinese carps like rui, catla, mrigal, mirror carp, grass carp, silver carp, etc.

ii. **Culture- 2:** Polyculture of prawn (*Macrobrachium rosenbergii*) and other fin fish species like rui, catla, mrigal, common carp etc. where prawn is the main target species.

iii. **Culture- 3 :** Polyculture of pangus (*Pangasius hypophthalmus*) fish and other fin fish species like rui, catla, mrigal, common carp etc. where pangus is the main target species.

The distribution of farms according to different polyculture system practiced in the surveyed area are shown in the Fig. 3.1.

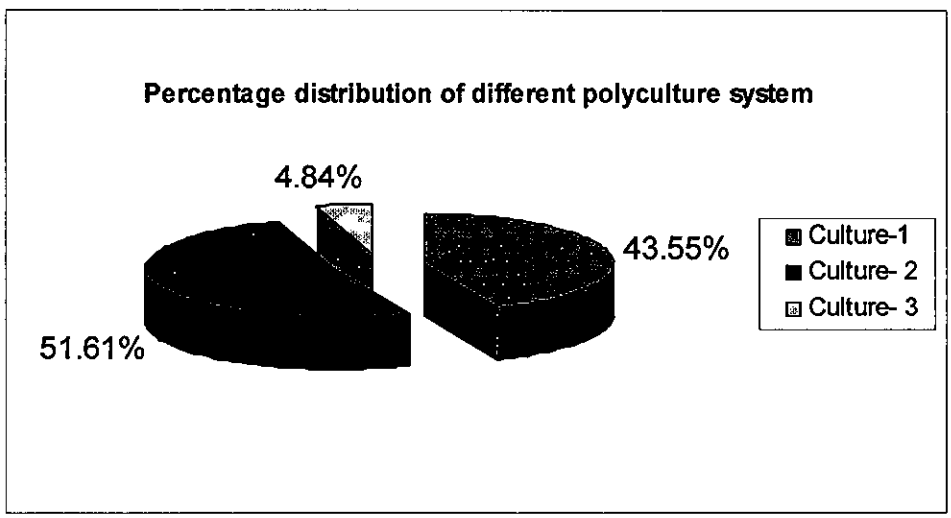


Fig. 3.1: Percentage distribution of the farms according to species composition

3.2 Physical conditions of the farms

3.2.1 Area of the farms

The survey showed that the area of the farms was varied from 0.25 ha to 2.04 ha. The average area of the farms was 0.76 ha. It was observed from the surveyed area that the area of fin fish cultured farms was relatively larger than prawn (*Macrobrachium rosenbergii*) or pangus fish (*Pangasius hypophthalmus*) cultured farms. The distribution of the poly cultured farms according to their area are shown in the following Table 3.1.

Table 3.1 : Percentage distribution of the farms according to area

Types of culture	Percentage distribution of the farms				
	< 0.5 ha	0.5 ha-1.0 ha	1.0 ha -1.5 ha	1.5 ha - 2.0 ha	> 2.0 ha
Culture -1	11.11	18.52	51.85	11.11	7.41
Culture -2	37.50	46.88	3.13	6.25	6.25
Culture -3	33.33	66.67	-	-	-

3.2.2 Soil characteristics

The predominant soil texture in the surveyed area was sandy loamy and clay, with slightly acid to alkaline condition. The soil which consists of silt or clay or a mixture of these two with a small proportion of sand is good for water retention characteristics. The clay content should not be exceed 60%. It was observed that among the fin fish polycultured farms about 66.67% farms contained sandy loamy soil and in case of polyculture of prawn (*Macrobrachium rosenbergii*) and other fin fish species about 62.50% farms contained clay soil whereas incase of polyculture of pangus fish (*Pangasius hypophthalmus*) and other fin fish species about 66.67% farms contained clay soil. In the surveyed area there was no existence of peat or sandy soil which is not productive for aquaculture. Farms distribution according to their soil characteristics are shown in the following Fig. 3.2.

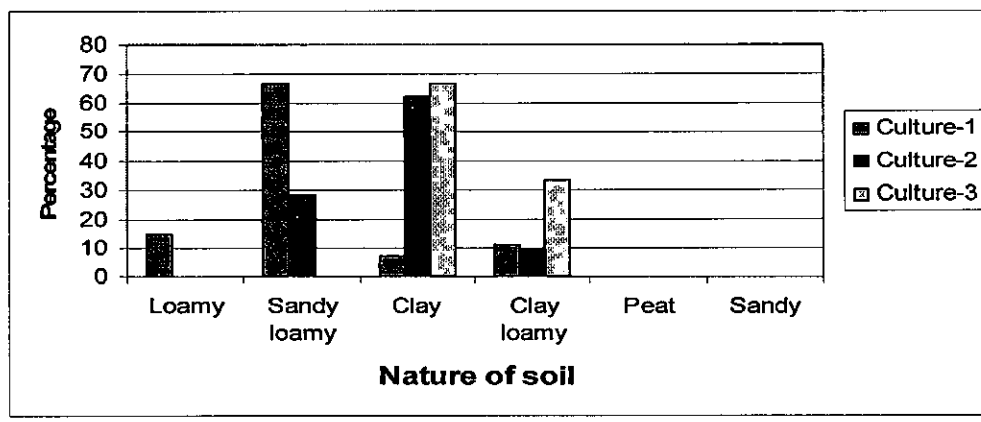


Fig. 3.2 : Percentage distribution of farms according to their soil condition

3.2.3 Water source

Rainfall is the prime source of water in the surveyed area for aquaculture. But due to shortage of rainfall the farmer uses underground water to continue their culture activities. Generally farmers started their culture activities during rainy season when farms were filled with rain water and used underground water during winter season to maintain the required water depth of the farm. The water sources of the farms in different culture system are shown in the following Table 3.2.

Table 3.2: Percentage distribution of farms according to source of water

Source of water	Percentage distribution of farms		
	Culture-1	Culture -2	Culture -3
Surface water	25.93	21.88	-
Surface & underground water	74.07	78.12	100.00

3.3 Pre Stocking Management

3.3.1 Farm preparation

Farm preparation is an important activity for starting any aquaculture practice. Almost every farmer of the surveyed area involved in preparation of farm before stocking fish fry. Farm management includes some important activities like dike repairmen, removal of bottom mud, aquatic weed control, predator control, water treatment etc.

3.3.2 Farm drying

Drying of farm's bottom is an important aspect for the successful growth and survival of the organisms. It was observed from the surveyed area that about 55.56% farms were dewatered after complete and final harvesting of the stock and left to sundry till watering for the next culture period. During this time the farmers repaired the dikes, guard shed and other infrastructure. About 44.44% farms were used for all the year round culture practice generally which were not dried. In this cases lime and different types of chemicals were used to kill the predator and disinfect the soil and water of the farms.

3.3.3 Dike condition of the farms and repairmen of dike

Dike is an important physical structure of farms particularly in our country like Bangladesh where flood is a recurring and devastating phenomenon. The top of the dike between farms should be about 1 meter in width to allow works to walk round the farm, carrying food and

harvesting gears (New and Singhloka, 1985). Dike must have 60 cm. high above the expected highest level of water of the farm.

In every year before starting of aquaculture most of the farmers of Monirampur Upazila usually more or less repair their farms. In the surveyed area about 43.55% of the surveyed farms were found as on well constructed dike and 51.61% farms were found moderate dikes that need to repair. Some of the farms were found newly constructed which were properly made. Farm dikes were constructed manually upto a height of about 1.0-1.5 m (average 1.30 m) and the width of the dike vary from 0.4-0.5 m. The dikes were built by excavating the top soil adjacent of the dikes. The performance of farmer in repairmen of the dike of farms in different culture system are shown in the Fig. 3.3.

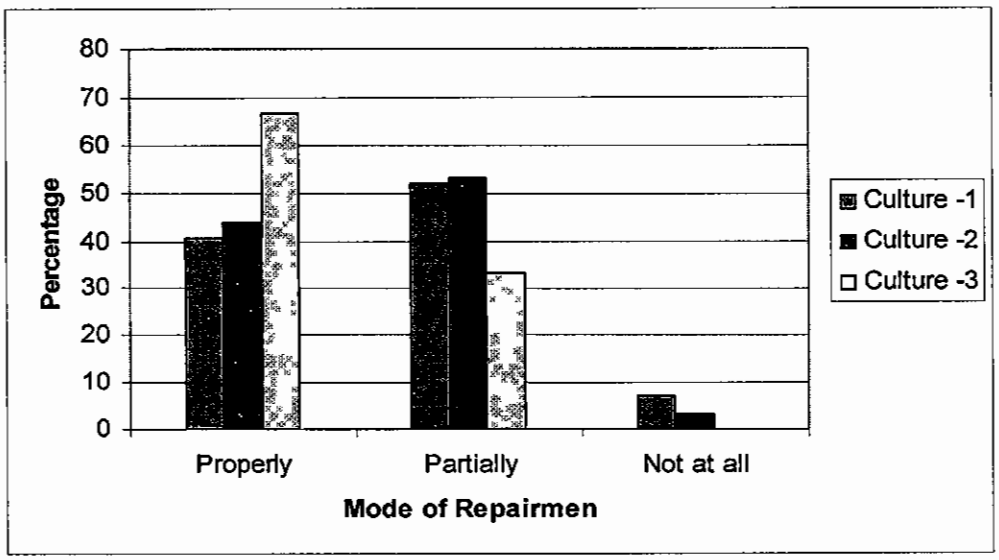


Fig. 3.3 : Performance of the farmers in repairmen of dike

3.3.4 Presence of aquatic weeds and their management

Most of the farms in Monirampur Upazilla were found free from aquatic weeds. Among the surveyed farms aquatic weeds were found in 25 farms (40.32%) and the rest 37 farms (59.68%) were fully free from any types of weeds. The undesirable aquatic weeds were controlled by manually. In some cases floating weeds were removed by netting. Generally the farms where grass carp (*Ctenopharyngodon idella*) were cultured aquatic weeds were used as their natural feed so the presence of aquatic weeds was observed in these farms. The status of the farms according to the mode of controlling measures of aquatic weeds in different culture system are shown in the Fig. 3.4.

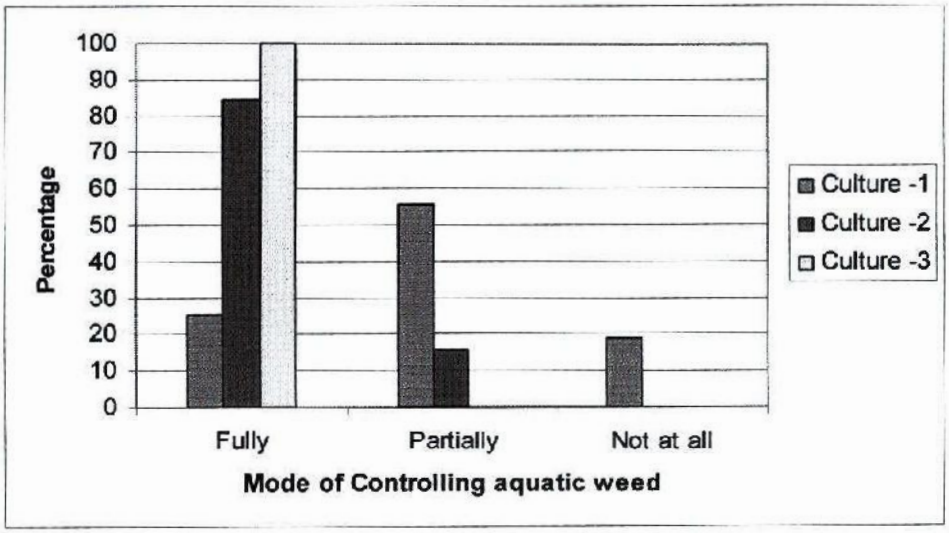


Fig. 3.4 : Status of controlling aquatic weeds

3.3.5 Controlling of undesired species

Most of the farmers in the surveyed area take different necessary actions to control the predator or undesired species of the farm. It was observed that about 67.74% of the surveyed farms were properly removed from undesired species and about 11.29% farms were partially removed from undesired species before stocking of fry. About 20.97% of the farms in the surveyed area were taken no steps to remove the predator or undesired species from the farm. In order to control the predator species most of the farmers dried their farms properly and rest of the farmers used chemical substances like rotenone and kerosene. To control predator species 3-5 ppm rotenone, 50 ppm sodium hypochlorite can be used in the farm (Paul, 1994). In order to control predator or undesired species by using chemicals, rotenone was used by the farmer at the rate of 5.880 kg to 8.900 kg per ha in the surveyed area. The status of the farms according to the mode of controlling predator and undesired species of different culture system are shown in the Fig. 3.5.

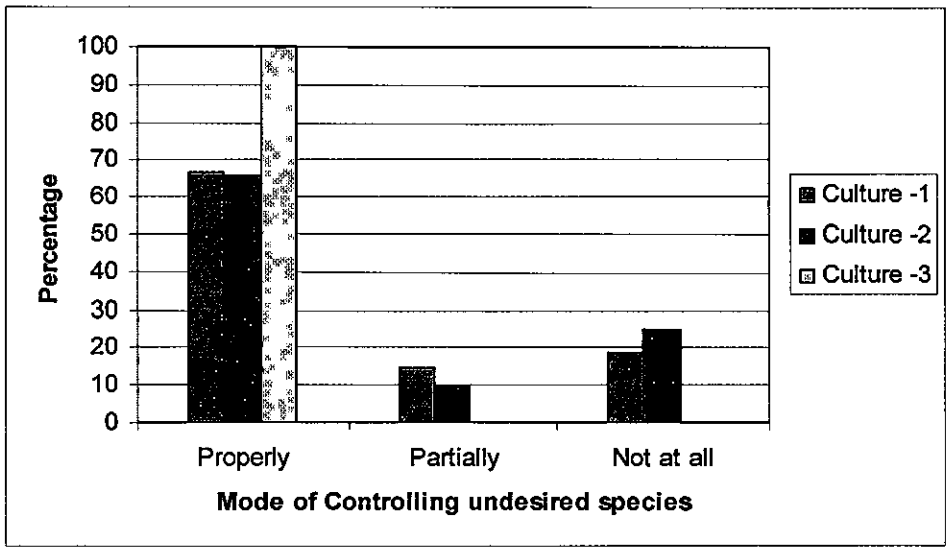


Fig. 3.5: Percentage distribution of farms according to mode of controlling predator or undesired species.

Distribution of farms wherein different types of controlling measures were taken to remove pest, predator or undesired species are shown in Table 3.3.

Table 3.3 : Percentage distribution of farms according to controlling measures of undesired species

Types of controlling measures	Percentage distribution of farms		
	Culture-1	Culture - 2	Culture - 3
Pond drying	55.56	59.37	100.00
Use of chemical substance	25.92	18.75	-
Netting	18.52	21.87	-
Others	-	-	-

3.3.6 Liming

The application of lime mainly depends on soil pH and if the pH value is 7 or >7 than there is no need of liming (Paul, 1994). In surveyed areas, the farmers could not measure the soil pH of the farm but they applied lime in their farms according to their practical experience or as prescribed by the Thana Fisheries Office or different training programme. It was observed from the surveyed area that about 80.64 % farms were used lime and about 19.36% farms were found no use of lime. The percentage distribution of farms according to use of lime in different polyculture system are shown in Table 3.4.

Table 3.4: Status of liming in the farms

Nature of culture	Condition of liming	No. of farms	Percentage distribution of farms
Culture -1	Liming	20	74.07
	Non-liming	7	25.93
Culture- 2	Liming	29	90.63
	Non-liming	3	9.37
Culture -3	Liming	1	33.33
	Non-liming	2	66.67

In Monirampur Upazilla the amount of applied lime in different culture system vary from farm to farm. It was observed from the surveyed area that in case of fin fish polyculture system lime was used in the farm ranges from 85 kg – 335 kg per hectare at pre-stocking management period. In case of polyculture of prawn (*Macrobrachium rosenbergii*) and other fin fish species farms were limed ranges from 35 kg – 267 kg per hectare. Whereas in case of polyculture of pangus (*Pangasius hypophthalmus*) and other fin fish species lime was used ranges from 225 kg – 245 kg per hectare. The percentage distribution of farms according to amount of used lime in different polyculture system are given in Table 3.5.

Table 3.5 : Percentage distribution of farms according to the dose of lime

Nature of culture	Amount of used lime (Kg/ha)				
	None	<100 kg	100 kg -200 kg	200 kg -300 kg	>300 kg
Culture- 1	25.93	11.11	18.52	40.47	3.70
Culture -2	9.37	28.13	18.75	28.13	15.62
Culture- 3	33.33	--	--	66.67	-

3.3.7 Fertilization

Fertilizer (organic & inorganic) is used in the farm to enhance the natural productivity of the farm by promoting the growth of phytoplankton and zooplankton that serves as a natural feed of cultured species. The rate of application of inorganic fertilizers ranges from 2-8 kg/decimal (Nuruzzaman, 1993). The rate of application of organic fertilizer rages from 100 to 400 kg/decimal (Nuruzzaman, 1993).

The survey showed that 100% fin fish cultured farms were fertilized by both organic & inorganic fertilizer in pre-stocking management period. But in case of polyculture of prawn (*Macrobrachium rosenbergii*) and other fin fish species out of 32 surveyed farms only 25 farms (78.13%) were used fertilizer whereas 7 farms (21.87%) were no types of fertilizers were used. In case of polyculture of pangus (*Pangasius hypophthalmus*) and other fin fish species out of 3

only 2 farms (66.67%) were used fertilizer whereas 1 farm (33.33%) was no types of fertilizers were used. Fertilizer was spreaded over the soil during dried condition of the farm and mixed with the soil by ploughing the earth. Name and amount of different fertilizers used by the farmers in different poly culture system are given in Table 3.6.

Table 3.6:- Name and amount of fertilizers (organic & inorganic) used in different farms

Name of the fertilizer	Nature of culture	No. of used farm (%)	Amount of fertilizer (Kg/ha)
Urea	Culture- 1	60.00	80 -120
	Culture- 2	42.86	36 – 58
	Culture- 3	66.67	350 - 370
TSP	Culture- 1	60.00	47 -53
	Culture- 2	85.71	23 -106
	Culture- 3	66.67	350 - 370
MP	Culture- 1	-	-
	Culture- 2	-	-
	Culture- 3	66.67	50 - 60
Cow dang	Culture- 1	40.00	24700 - 49400
	Culture- 2	14.29	2500 -3500
	Culture- 3	66.67	4500 - 5000
Oil cake	Culture- 1	60.00	125 -175
	Culture- 2	71.43	200 -250
	Culture- 3	66.67	500 - 550
None	Culture- 1	-	-
	Culture- 2	21.87	-
	Culture- 3	33.33	-

3.4 Stocking Management

3.4.1 Source of fry and farmer's performance

Fry quality has a major impact on production along with the profitability of the culture. Therefore farmers have to select good quality fry to ensure profitable harvest. Stocking of larger size fry can improve survivability due to more developed resistance to disease, stronger benthic feeding behavior and improved predator resistance. It was observed from the survey area that the body length of the stocking fry vary from 1 inch to 6 inch. There are two sources of fry i.e. wild and hatchery bred fry. Hundred percent of the farmers under each category firstly preferred wild fry because they are stronger in nature, readily available and adjusted to the local water parameter. When there was shortage of wild fry and the price hiked up, farmers were compelled to buy hatchery bud fry regardless of prices. It was found that all types of fin fish fry like rui, catla, mrigal, mirror carp, grass carp, silver carp, tilapia, pangus etc. were

collected from different hatchery of Jessore district specially from Chachra Bazar, Jessore. Prawn post larvae were collected from Chuknagar Bazar, Dumuria under district of Khulna. Some farmer collects the fry directly from hatchery. They went to the hatchery and brought the fish fry to the farm using a large size hari/ plastic or iron made barrel. During the carry of fish fry air was mixed with water by shacking hand to supply sufficient oxygen for the fry. Some farmer collects the fry from fish fry retailer who brings the fry to sell in the farm area. Percentage distributions of farms according to source of fry are shown in the Fig. 3.6.

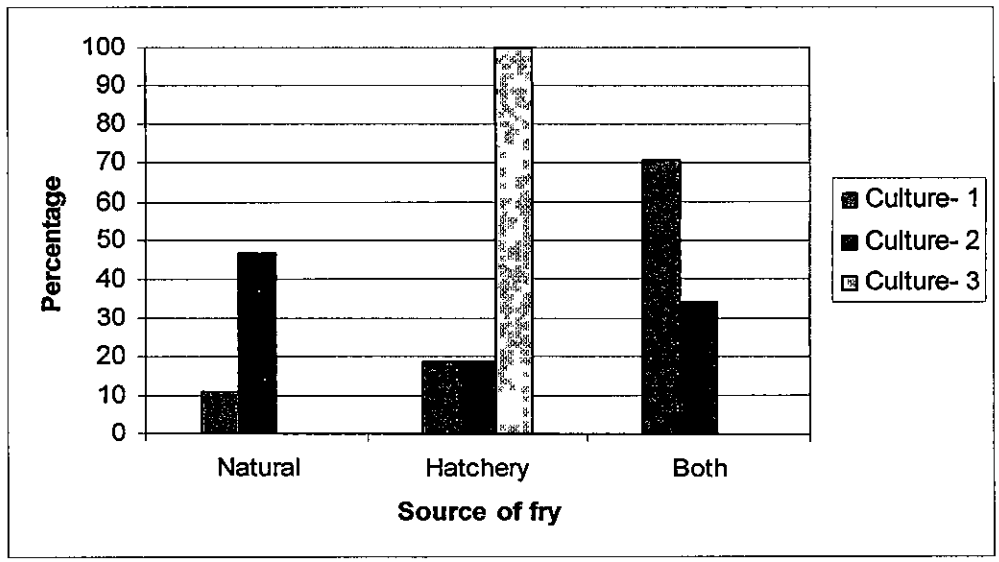


Fig. 3.6:- Percentage distribution of farms according to source of fry

3.4.2 Stocking time

In case of fin fish polyculture system (culture-1) stocking of fry was started from Baishak - Jaishto (May) and continued for the next 2 – 3 month i.e. till Ashar - Shrabon (August). In case of polyculture of prawn and other fin fish species (culture-2), farmer stocked post larvae of prawn in the farm within the month of Baishak to Jaisto (May). Subsequently when the water level was increased due to heavy rainfall then fin fish fries were stocked from the month of Ashar (June - July). But in case of polyculture of pangus and other fin fish species (culture-3), the farmers stocked pangus fry in the farm in the month of Falgun (February – March) for 1st time and again stocked in the month of Ashar (June – July) for the 2nd time after complete harvesting of 1st stock of pangus fish. And other fin fish species were stocked from the month of Baisakh (April - May).

3.4.3 Stocking density

Stocking rate of fish species is a very important criteria for polyculture system. The farmer stocks the farm disregarding the fry size, soil condition, presence of natural feed, water depth and water quality. Stocking rate depends on the size of fry. It is varied from farmers to farmers, farm conditions and also from area to area. It was observed from the survey area that the species composition for the polyculture system depended on the target species of the culture which was desired to produce more by the farmer. The stocking rate of the target species was remained high in every culture system. The stocking density of different polyculture system are given in the table 3.7, 3.8 & 3.9.

Table 3.7: Stocking density of polyculture of different fin fish species (culture -1)

Sl. No.	Name of species	Stocking density/ha
1.	Rui (*Labeo rohita*)	600 - 800
2.	Catla (*Catla catla*)	100 - 300
3.	Mrigal (*Cirrhinus mrigala*)	200 - 400
4.	Silver carp (*Hypophthalmichthys molitrix*)	1,300 - 1,600
5.	Grass carp(*Ctenopharyngodon idella*)	100 - 200
6.	Common carp (*Cyprinus carpio*)	300 - 400
7.	Thai Sharputi (*Puntius sarana*)	1,400 - 3,000
8.	Kalibasuh *(Labio kalbasu)*	-
9.	Tilapia (*Oreochromis nilotica*)	8,200 - 10,700
10.	Bata *(Labio bata)*	1,400 - 2,200
	Total	**13,600 – 19,600**

Table 3.8: Stocking density of polyculture of prawn and other fin fish species (culture -2)

Sl. No.	Name of species	Stocking density/ha
1.	Prawn (*Macrobrachium rosenbergii*)	5,400 - 8,500
2.	Rui (*Labeo rohita*)	500 - 800
3.	Catla (*Catla catla*)	200 - 300
4.	Mrigal (*Cirrhinus mrigala*)	100 - 200
5.	Silver carp (*Hypophthalmichthys molitrix*)	800 - 1,200
6.	Grass carp(*Ctenopharyngodon idella*)	250 - 300
7.	Common carp (*Cyprinus carpio*)	50 - 100
8.	Thai Sharputi (*Puntius sarana*)	200 - 800
9.	Kalibasuh *(Labio kalbasu)*	--
10.	Tilapia (*Oreochromis nilotica*)	--
	Total	**7,500 – 12,200**

Table 3.9: Stocking density of polyculture of pangus fish and other fin fish species (culture -3)

Sl. No.	Name of species	Stocking density/ha
1.	Thai pangus (*Pangasius hypophthalmus*)	11,800 – 15,600
2.	Rui (*Labeo rohita*)	600 – 800
3.	Catla (*Catla catla*)	600 – 700
4.	Mrigal (*Cirrhinus mrigala*)	400 – 500
5.	Silver carp (*Hypophthalmichthys molitrix*)	-
6.	Grass carp(*Ctenopharyngodon idella*)	-
7.	Common carp (*Cyprinus carpio*)	1200 -1300
8.	Thai Sharputi (*Puntius sarana*)	-
9.	Kalibasuh *(Labio kalbasu)*	-
10.	Tilapia (*Oreochromis nilotica*)	600 – 700
	Total	**15,200 – 19,600**

3.4.4 Frequency of stocking

In the study area it was observed that multiple stocking was widely practiced by the farmer in case of all types of poly culture system during the culture period. In case of fin fish polyculture system about 7.40% farmers practiced single stocking whereas about 92.60 % farmer practiced multiple stocking of fry. In case of polyculture of prawn (*Macrobrachium rosenbergii*) and other fin fish species 100% farms were stocked for several times but in case of pungus culture the farmers stocked the pangus fry only for 2 times during the culture period. For pangus culture system it was found to stock the pungus fry for second time after complete harvesting of first stock.

3.5 Post Stocking Management

3.5.1 Feeding

Feeding and feed management is one of the most important functions in aquaculture. Feeding practice incurs the large operational cost of farming and every effort should be made to ensure efficient utilization of feed for growth. The exact level of feeding depends on the growth and survival rate of fish and standing crop of the farm at a specific time (New and Singhloka, 1985).

3.5.1.1 Types of feeding practice

In the surveyed area 3 (three) types of feeding practices were observed depending on the nature of supplementary feed.

i. Supply of formulated supplementary feed only,
ii. Supply of natural supplementary feed only &
iii. Supply of both formulated & natural supplementary feed.

The percentage distribution of the farms according to the nature of supplied supplementary feed are shown in the Table 3.10.

Table 3.10: Percentage distribution of the farms according to the nature of supplied feed.

Nature of feed	Percentage distribution of the farms		
	Culture -1	Culture -2	Culture -3
Formulated feed only	40.74	12.50	100
Natural feed only	59.26	9.38	-
Both (formulated & natural)	-	78.12	-
None	-	-	-

3.5.1.2 Amount of feed

The quantity of different types of used feed for different culture system are given in Table 3.11, 3.12 & 3.13.

Table 3.11: Amount of formulated supplementary feed used in different poly culture system during the culture period where only formulated feed were used as supplementary feed

Nature of culture	Amount of feed (Kg/1000 piece stock)
Culture -1	200- 250
Culture -2	200-250
Culture -3	450 - 500

Table 3.12 : Name and amount of natural supplementary feed used for polyculture of different fin fish species (culture-1) and polyculture of prawn (*Macrobrachium rosenbergii*) alongwith other fin fish species (culture-2) during the culture period

Sl. No.	Name of feed	Amount of feed (Kg/1000 piece stock)	
		Culture- 1	Culture- 2
1.	Rice bran	45 - 50	-
2.	Broken rice	5 – 10	65 -70
3.	Wheat bran	15 – 20	-
4.	Wheat flour	-	20 - 25
5.	Mastered oil cake	15 - 20	50 – 55
6.	Snail meat	-	-
7.	Cow dung	350 - 425	-
8.	Grass	-	6,540 – 7,850

Table 3.13 : Name and amount of supplementary feed for polyculture of prawn (*Macrobrachium rosenbergii*) and other fin fish species (culture-2) where both the formulated and natural feed were used simultaneously

Sl. No.	Name of feed	Amount of feed (Kg/1000 piece stock)
1.	Pellet feed	50 – 100
2.	Rice bran	-
3.	Broken rice	50 – 70
4.	Wheat bran	-
5.	Wheat flour	-
6.	Mastered oil cake	45 – 50
7.	Cow dung	-
8.	Grass	5350 - 7650

3.5.1.3 Process of feeding

The formulated feed were supplied directly over the water. But the natural supplementary feeds were mixed initially with water in a brick built tank or iron or plastic made barrel before providing into the farms and kept for 24 to 48 hours in the tank for the purpose of rotting the mixture. Some farmers used urea fertilizer with the feed mixture for promoting the rotting process of natural supplementary feed. Then the mixture of feed was spreaded over the farm water.

3.5.1.4 Frequency of feeding

It observed from the surveyed area that most of the fin fish polycultured farms (about 74.07%) were provided supplementary feed for twice in a day and rest of the farms (25.93%) were provided supplementary feed for once in a day. But in case of polyculture of prawn (*Macrobrachium rosenbergii*) and other fin fish species, 100% farms were provided supplementary feed for twice in a day. In the morning feed were supplied in the farm for fin fish and in the evening for the prawn. In case of polyculture of pangus (*Pangasius hypophthalmus*) and other fin fish species feed were supplied for twice in a day. The daily feeding rate was gradually increased from the beginning of the culture to the end during the culture period. It was found that the supplementary feed was provided at the rate of 5 – 7% of the total standing crop of the farm.

3.5.2 Post stocking fertilization

Fertilizers were used to increase the productivity of natural food of the farms. The amount of fertilizer and its application time were variable and depended on the stocking density, the

management system, water quality, weather and feeding intensity. It was observed that about 14.81% of fin fish polycultured farms and 15.62% of the prawn cultured farms were provided fertilizer at post stocking management period. In case of pangus fish culture it was found that there was no use of fertilizer at the post stocking management period. Most of the farmer used inorganic fertilizer like urea and TSP in their farm at the post stocking management period. The percentage distribution of the farms according to post stocking fertilization in different poly culture system are shown in Table 3.14.

Table 3.14 : Distribution of the farms according to post stocking fertilization

Nature of culture	Condition of fertilization	No. of farms
Culture -1	Used	4
	Non-used	23
Culture- 2	Used	5
	Non-used	27
Culture -3	Used	0
	Non-used	3

The frequency of fertilization in the farm varied from 1 – 4 times per month in the surveyed area. Generally fertilization was more frequent when the water depth of the farm were relatively high in the month of Ashar, Srabon and Vadro (June to September) and it was reduced with the decreasing of water depth. The farmer of the surveyed area reported that the frequency of fertilization was estimated according to water color change. The name and amount of fertilizer used at post stocking management period in different poly culture system are given in the Table 3.15.

Table 3.15: Name and amount of fertilizer used at post stocking management period in different polyculture system.

Name of the fertilizer	Amount of fertilizer (Kg/ha)		
	Culture -1	Culture -2	Culture -3
Urea	350 – 450	200 – 450	-
TSP	100- 200	150- 300	-

3.5.3 Post stocking liming

Post stocking liming mainly depends on the variability of pH of farm water. Liming was done whenever any outbreak of disease or abnormal condition was prevailed. Lime has to be applied if the pH drops below 7.5 or if it fluctuates by more than 0.5 in 24 hours. Lime effects on the

concentration of alkalinity that increases the availability of carbon for photosynthesis and enhances the natural food production (Ameen, 1987). The percentage distribution of the farms according to post stocking liming in different polyculture system and amount of used lime are shown in Table 3.16.

Table 3.16 : Distribution of the farms according to post stocking liming and amount of used lime

Nature of culture	Condition of liming	No. of farms	Amount of lime (Kg/ha/time)
Culture -1	Limed	13	50 – 150
	Non-limed	14	-
Culture- 2	Limed	8	25 – 75
	Non-limed	24	-
Culture -3	Limed	0	-
	Non-limed	3	-

3.5.4 Sampling

Sampling is an important activity for aquaculture to check the fish growth and identify the presence of any disease or nutritional deficiency in fish body. The farmer of the surveyed area reported that usually it was done at the time of harvesting with the help of 'Tana jal' or 'Ber jal' but it has no fixed time interval.

3.5.5 Water exchange

Exchange of farm water is required for proper management of aquatic environment of the farm. In the surveyed area it was observed that the farmer did not exchange the farm water during the culture period but they only added water only to maintain the required water depth of the farm to continue the culture practice. Out of surveyed 62 farms 51 farms (about 82.26%) were added underground water to continue the culture activity during the culture period.

3.6 Harvesting and marketing management

3.6.1 Harvesting

Harvesting is the final step of the management practice. It observed from the surveyed area that harvesting time & frequency varied with the nature of culture, cultured species and market demand of the species. In case of fin fish poly culture system farmers started harvesting after 4-6 months from the stocking time of fry and continued till the month of Poush and Mugh (December to January) whereas in case of polyculture of prawn (*Macrobrachium rosenbergii*)

and other fin fish species farmers started harvesting after 6-8 months from the stocking time and continued till the month of Poush and Mugh (December to January). In case of polyculture of pangus fish (*Pangasius hypophthalmus*) and other fin fish species farmers started harvesting after 4 months from the stocking of fry and stocked again for the second time. Most of the farmer practiced multiple harvesting ranges from 4 to 8 times during the culture period. But in case of pangus culture farmers practiced only twice harvesting during the culture period, firstly in the month of 'Ashar' and secondly in the month of 'Aghrayon'. Farmers used 'Tana jal' and 'Ber jal' for harvesting the cultured species of the farm. But at the end of the culture period, complete harvesting was carried on by dewatering the farm.

3.6.2 Marketing

Fish marketing is of paramount important in fish culture operation which dictates the sustainability of this industry. Marketing of fish in the surveyed area had some different characteristic features. A very small proportion of the farmers (about 12%) were found to take their fish to the nearest market for disposal; whereas, most of the farmers (88%) preferred to sell their fish to the paikers (intermediate traders) directly or through commission agent in Monirampur Bazar. The pikers supply the stock outside of the Monirampur Upazilla specially towards Dhaka. The farmer also sold the fish to the paikers directly from the farm and the paikers supplied it to the retailer in the local market who sold it to the consumer. The following marketing channels were found to operate in the surveyed area.

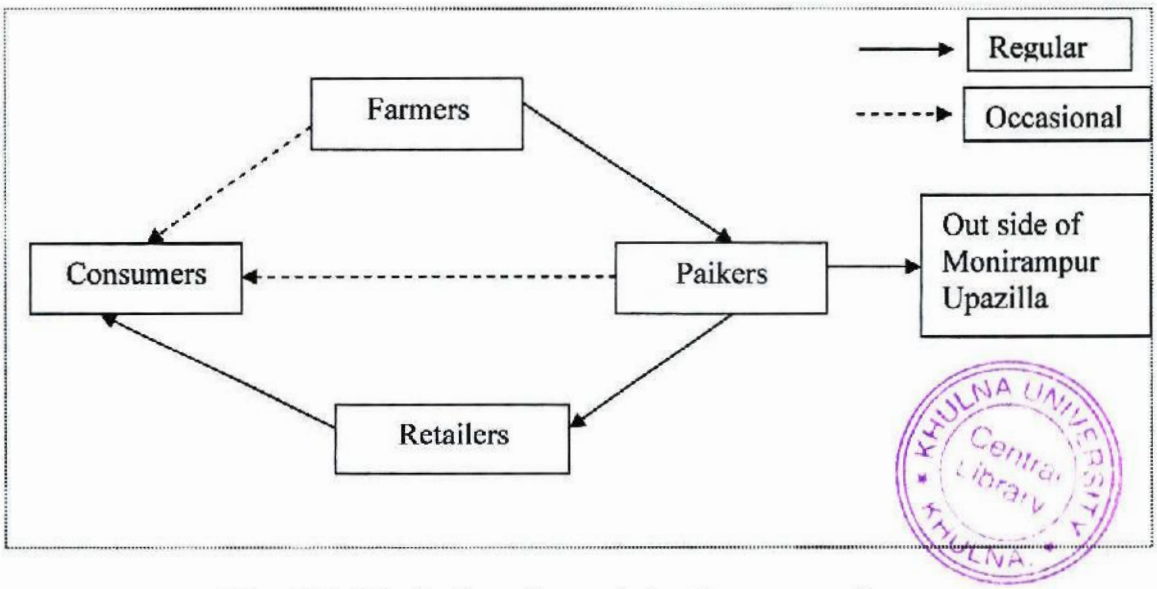


Fig. 3.7: Marketing channels in the surveyed area

3.7 Other crop cultivation

Out of 62 surveyed farm it was found that 45 farms (about 72.58%) were seasonally cultured farms. i.e. culture was started at the beginning of rainy season (Baishak - Jaishto) and continued upto winter season (Poush – Magh) and rest 17 farms (about 27.42%) were found to culture all the year round. In the seasonally cultured farm farmer continued their culture activity upto the month of Poush to Magh (January – February). Then the farms were drained out and farmer started cultivation of paddy. Some cases fish were kept in the cannel of the farm and paddy was cultivated another parts of the farm.

3.8 Cost benefit analysis

Cost benefit is the analysis of total cost for the production and the returns from the investment. Cost and benefit analysis would provide the necessary information to determine the relative profitability of various production techniques, compare the utility of major inputs, such as hand, labor and capital, with that of alternative production activities improve the efficiency of the farm operation.

3.8.1 Production cost

The production cost includes the purchasing cost of fish fry, lime, fertilizer, feed, harvesting gears etc. Production cost also considers the cost of labor management, infrastructure repairing, security and transport etc. The production costs of different polyculture system in the surveyed area are given in the Table 3.17, 3.18 & 3.19.

Table 3.17 : Production cost for polyculture of different fin fish species (culture -1)

Sl. No.	Particulars of cost	Tk./ha.
1.	Farm repairmen	7,000 - 8,000
2.	Weed control	1,250 - 1,500
3.	Undesired species control	200 - 250
4.	Liming (pre & post stocking)	2,500 - 3,000
5.	Fertilization (pre & post stocking)	10,750 - 25,250
6.	Cost of fry	42,000 - 45,500
7.	Feeding	55,500 - 85,500
8.	Disease control	1,500 – 2,000
9.	Watering	10,750 - 11,750
10.	Harvesting	4,750 - 5,500
11.	Marketing	1,500 - 1,750
12.	Others	2,200 - 3,000
	Total	**139,900 – 193,000**

Table 3.18 : Production cost for polyculture of prawn and other fin fish species (culture -2)

Sl. No.	Particulars of cost	Tk./ha.
1.	Farm repairmen	4,750 – 9,000
2.	Weed control	1,500 – 3,500
3.	Undesired species control	250 – 500
4.	Liming (pre & post stocking)	1,250 – 2,000
5.	Fertilization (pre & post stocking)	18,750 – 20,500
6.	Cost of fry	51,000 – 63,000
7.	Feeding	57,000 – 60,500
8.	Disease control	1,200 – 2,500
9.	Watering	1,000 – 2,500
10.	Harvesting	5,500 – 7,500
11.	Marketing	2,000 – 2,200
12.	Others	3,500 – 4,500
	Total	**147,700 – 178,200**

Table 3.19 : Production cost for polyculture of pangus and other fin fish species (culture - 3)

Sl. No.	Particulars of cost	Tk./ha.
1.	Farm repairmen	6,500 – 6,750
2.	Weed control	1,000 – 1,500
3.	Undesired species control	--
4.	Liming (pre & post stocking)	1,750 – 2,000
5.	Fertilization (pre & post stocking)	25,500 – 30,000
6.	Cost of fry	95,750 – 114,500
7.	Feeding	233,000 – 262,000
8.	Disease control	1,500 – 1,750
9.	Watering	1,000 – 1,250
10.	Harvesting	2,500 – 3,000
11.	Marketing	1,000 – 1,250
12.	Others	5,200 – 5,500
	Total	**374,700 – 429,500**

3.8.2 Income from different polyculture systems

Production of culture practice indicates the success of the culture. The amount of production from different polyculture system in the surveyed area is given in the Table 3.20, 3.21 & 3.22.

Table 3.20 : Income from polyculture of different fin fish species (culture - 1)

Sl. No.	Species	Amount of production (Kg/ha)	Unit Price (Tk./40Kg)	Value of total production in Tk./ha
1.	Rui	360 – 480	4500	40,500 – 54,000
2.	Catla	100 – 200	3500	8,750 – 17,500
3.	Mrigal	160 – 320	4500	18,000 – 36,000
4.	Silver carp	960 – 1240	2000	48,000 – 62,000
5.	Grass carp	80 – 100	2800	5,600 – 7,000
6.	Common carp	140 – 160	3000	10,500 – 12,000
7.	Sharputi	160 – 360	1700	6,800 – 15,300
8.	Tilapia	520 – 680	2000	26,000 – 34,000
9.	Bata	140 – 200	3000	10,500 – 15,000
10.	Others	--	--	--
	Total	**2,620 – 3,740**		**174,650 – 252,800**

Table 3.21 : Income from polyculture of prawn and other fin fish species (culture - 2)

Sl. no.	Species	Amount of production (Kg/ha)	Unit Price (Tk./40Kg)	Value of total production in Tk./ha
1.	Prawn	320 – 400	13,000	104,000 – 130,000
2.	Rui	320 – 600	4500	36,000 – 67,500
3.	Catla	160 – 180	3500	14,000 – 15,750
4.	Mrigal	100 – 140	4500	11,250 – 15,750
5.	Silver carp	640 – 960	2000	32,000 – 48,000
6.	Grass carp	160 – 180	2800	11,200 – 12,600
7.	Common carp	20 – 40	3000	1,500 – 3,000
8.	Sharputi	20 – 100	1700	850 – 4,250
9.	Others	-	-	-
	Total	**1740 – 2600**		**210,800 – 296,850**

Note: Prawn production: 320 Kg - 400 Kg & others fin fish production : 1420 Kg - 2200 Kg

Table 3.22 : Income from polyculture of pangus and other fin fish species (culture - 3)

Sl. no.	Species	Amount of production (Kg/ha)	Unit Price (Tk./40Kg)	Value of total production in Tk./ha
1.	Pangus	8,200 – 10,880	2000	410,000 – 544,000
2.	Rui	400 – 520	4500	45,000 – 58,500
3.	Catla	400 – 480	3500	35,000 – 45,000
4.	Mrigal	280 – 400	4500	31,500 – 45,000
5.	Common carp	480 – 520	3000	36,000 – 39,000
6.	Tilapia	80 – 100	2000	4,000 – 5,000
	Others			
	Total	**9,840 – 12,900**		**561,500 – 733,500**

Note : Pangus production: 8,200 Kg – 10,880 Kg & others fin fish production: 1,640 Kg– 2,020 Kg

3.8.3 Cost-benefit analysis

Production cost, income and net profit of different polyculture system are shown in Table 3.23.

Table 3.23: Profit/loss of different polyculture system.

Nature of poly culture	Total production cost (Tk./ha)	Total income (Tk./ha)	Net profit (Tk./ha)
Culture - 1	139,950 - 193,000	174,650 - 252,800	34,700 - 59,800
Culture - 2	147,750 - 178,250	210,800 - 296,850	63,050 - 118,600
Culture - 3	374,750 - 429,500	561,500 - 733,500	186,750 - 304,000

Percentage distributions of the farms in terms of profit are shown in the Fig. 3.8.

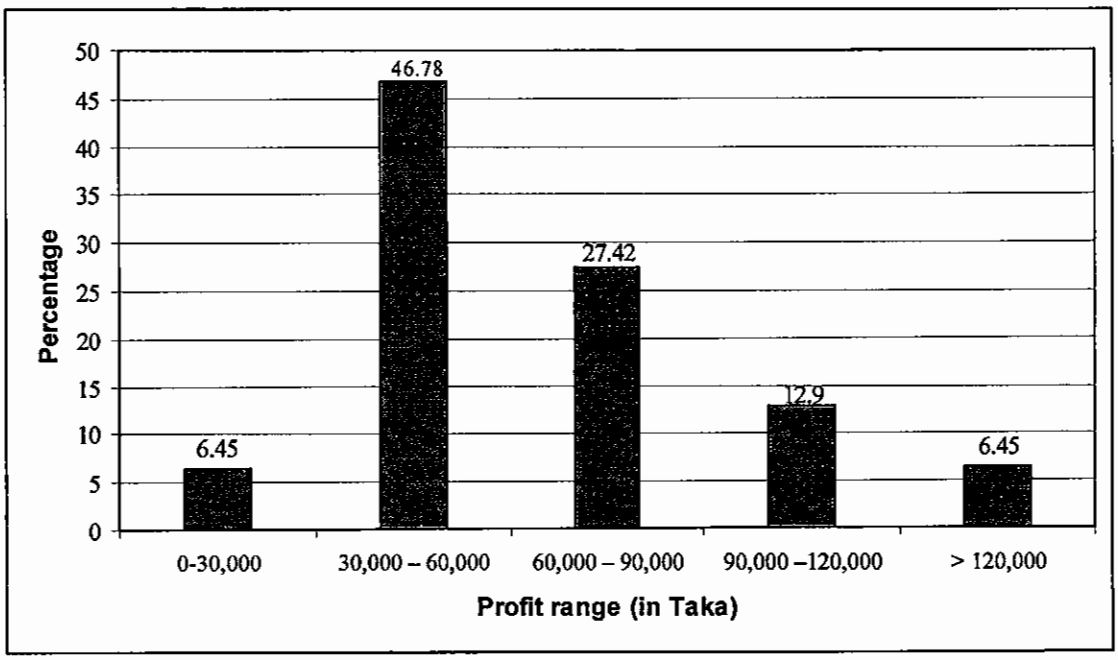


Fig. 3.8 Percentage distribution of the farms in terms of profit

CHAPTER FOUR

CONCLUSION

4. CONCLUSION

There are three types of major polyculture practice followed in the survey area. Among the surveyed culture systems polyculture of pangus fish and other fin fish species like rui, catla, mrigal, common carp, tilapia etc. was the most profitable poly culture system. About 60-70% profit margin gained from polyculture of pangus fish and other fin fish species whereas 40-50% profit margin gained from polyculture of different fin fish species and 50-60% profit margin gained from polyculture of prawn and other fin fish species. But the pangus culture was highly cost and labor intensive. Moreover pangus culture is not being popular in the surveyed area. In the surveyed area fin fish polyculture and prawn culture along with other fin fish species like rui, catla, mrigal, common carp, tilapia etc. were widely practiced. The farmer practiced prawn culture but some times faced acute disease outbreak and acquired huge loses. As a result farmers are being interested in fin fish polyculture system instead of prawn culture. In spite of having a lot of profit in polyculture system the farmers in the surveyed area are facing some major problems viz. (i) lack of capital, (ii) high price of inputs, (iii) low price of fish in the market, (iv) lack of communication system (v) lack of knowledge regarding aquaculture management practice etc. Despite all constraints exist in the aquaculture the production may reach to a considerable level by applying modern technology and improving management level. The farmers need to have training and fund support as well as other facilities to improve their culture system.

CHAPTER FIVE

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APPENDIX

Management and economics of different polyculture in Monirampur Upazilla, Jessore: a field survey for the most profitable culture practice

Sl. No. …… Date ……..

Interview schedule for the farm owner

1. Name of the farm : ……..
   Address: Village: …….. Union:……..Upazila: Monirampur
   District: Jessore
2. Year of establishment of the farm:
3. Name of the respondent: ……..……..
   Relation of the respondent to the farm:
   Farm owner ☐ Farm manager ☐ other (please specify)……
4. Type of farm: Commercial ☐ Homestead ☐
5. Income sources of farm owner:
   a) Main source :……
   b) Other (Secondary) source :……
6. a) Area of the farm……..acre……..ha
   b) Shape of the farm:-
   Square ☐ rectangular ☐ round ☐ Others ……..
7. Category of land ownership :
   Own ☐ Leased ☐ Both ☐
8. Before farm establishment the area was:
   Agriculture land ☐ Wet land ☐ Low land ☐ Derelict pond ☐
   Unused land ☐ Grazing place ☐ others ……..
9. Number of pond in the farm……

Pre stocking management:

10. Culture period from the month of …… to……
11. Nature of soil of the farm
    Loamy ☐ Sandy loamy ☐ Sandy ☐ Clay ☐ Clay loamy ☐
    Peat ☐ others ……..

12. Sources of farm water:

Surface water ☐ Underground water ☐ Both ☐

13. Depth of pond water : Maximum.....ft, Minimum.....ft

14. a) Do you prepare dike of your pond?

Fully ☐ Partially ☐ Not at all ☐

b) Do you prepare bottom of your pond?

Fully ☐ Partially ☐ Not at all ☐

c) Total cost for preparing dike & bottom of the farm: .....

15. a) Do you control aquatic weeds from your ponds?

Fully ☐ Partially ☐ Not at all ☐

b) If yes, how?

Manually/Mechanically ☐ Using chemicals ☐ Biologically ☐

Other.....

c) If using chemicals what chemicals are used?

Name of chemical	**Dose/bigha**	**Cost/ bigha**	**Name of chemical**	**Dose/ bigha**	**Cost/ bigha**
Copper sulphate			2,4D		
Copper citrate			Phostoxin		
Sodium arsenite			Other		

d) Total cost for controlling aquatic weeds:- .....

16. a) Do you control pests, predators and undesirable species before stocking?

Fully ☐ Partially ☐ Not at all ☐

b) If yes, how?

Pond drying ☐ Netting ☐ Using chemicals and other toxic Substances ☐

Others.....

c) When using chemicals and other toxic substances what are these?

Name of chemical	**Doss/bigha**	**Cost**	**Name of chemical**	**Doss/bigha**	**Cost**
Rotenone			Diesel		
Phostoxin			Bleaching powder		
Dipterex			Other		
DDT			Endrin		
Aldrin			others		

d) Total cost for controlling pests, predators and undesirable species:-

17. a) Do you apply **lime** in the ponds?

Yes ☐ No ☐

b) Quantity/bigha.: .....

c) Total cost for Liming: - .....

18. a) Do you use fertilizers in the pond?

Yes ☐ No ☐

b) If yes, fertilizers are-

Name of fertilizer	Quantity/ bigha	Cost	Name of chemical	Quantity /bigha	Cost
Urea			Cow dung		
TSP			Poultry excreta		
MP			Other		

d) Total cost for fertilizing the farm:- .....

Post stocking management:

19. Culture system apply

Traditional ☐ Improve Traditional ☐ Semi intensive ☐ Intensive ☐

20. a) Sources of fish fry/fingerling

Hatchery ☐ Natural ☐

b) Species culture and stocking density:

	Species	Stocking density/bigha	Cost of fry
1.	Rui		
2.	Catla		
3.	Mrigal		
4.	Silver carp		
5.	Grass carp		
6.	Common carp		
7.	Sharputi		
8.	Thaipangus		
9.	Kalibasuh		
10.	Tilapia		
11.	Mirror carp		
12.	Others.....		
	Total		

21. Foods and feeds used for farm fishes:

a) Do you feed the fish?

Yes ☐ No ☐

b) What types of feeds do you use?

Types of feed	**Quantity/bigha /day**	**Cost**	Types of feed	**Quantity/ bigha/day**	**Cost**
Pellet feed			Mustard oil cake		
Soybean meal			Soybean oil cake		
Rice bran			Trash fish		
Rice polish			Snail meat		
Wheat bran			Duck weed		
Wheat flour			Others		
Banana leaf					
Total cost:-					

c) Feeding rate (daily).....% body weight and frequency.....

d) Total cost for feeding during the culture period: - .....

22. a) Do you use fertilizers in the pond?

Yes ☐ No ☐

b) If yes, fertilizers are-

Name of fertilizer	**Quantity/bigha**	**Cost**	**Name of fertilizer**	**Quantity/ bigha**	**Cost**
Urea			Cow dung		
TSP			Poultry excreta		
MP			Other		
Total cost:-					

c) Frequency of using fertilizer per month or culture period:-

d) Total cost for fertilizing the farm for culture period: - .....

23. a)Did you face any disease problem in the farm?

Yes ☐ No ☐

b)If yes, what was it?

Name of Disease	**Name of Disease**
EUS	Gas babble disease
Tail and fin rot	Oxygen deficiency disease
Dropsy	Argulosis
Nutritional deficiency	Saprolegniasis
Others	

24. Prevention and control if diseases

a) What were the preventing and controlling measures taken against disease?

Name of the measures	**Name of the measures**
Use chemicals	Appropriate feeding
Use antibiotics	Stop fertilizing
Kill the diseased fish	Aeration
Change water	Others.....
Remove sick fish to another area	

b) If used chemicals and antibiotics, what were these?

Name of chemicals & antibiotic	Quantity /bigha	Cost	Name of chemicals & antibiotic	Quantity /bigha	Cost
Salt			Methylene blue		
Lime			Calcium hypochlorite		
Formalin			Malachite green		
$KMnO_4$			Copper sulphate		
Dipterex			Sumithion		
Malathion			Oxytetracyclin		
Terramycin			Streptomycin		
Salfamerazine			Others		
Total Cost:-					

c) Total cost for preventing and controlling disease during the culture period: -

25. a) Do you exchange/discharge your farm water?

Exchange ☐ Adding ☐ discharge ☐ None ☐

b) Frequency of exchange/discharge per month or culture period:-

c) Total cost for exchanging/discharging farm: - .....

26. Was the farm over flooded in any year?

Yes ☐ No ☐

If yes, in.....year.

27. Were the farmed fishes yet escaped from the farm?

Yes ☐ No ☐

If yes, how?

Over flood ☐ Jumped ☐ Runoff/rain water ☐ Through breaking the embankment of pond ☐ During exchanges the water ☐ Others.....

28. Harvesting & Marketing:-

a) Harvesting start after ..... month stocking of fish.

b) Frequency of harvesting for a month or during the culture period.

c) Target population of the products:-

Local ☐ outside of the locality ☐ outside of the country ☐

Others.....

d) Total cost for harvesting & marketing during the culture period: -

29. Cost of the production:-

Particulars	Cost/Bigha.
Farm preparation	
Fertilization (pre & post stocking)	
Watering	
Cost of fry	
Feeding	
Weed control	
Chemical & antibiotic	
Maintenance	
Harvesting	
Marketing	
Others	
total	

30. Value of products :-

Products	Quantity/bigha.	Unit price	Total price
Rui			
Catla			
Mrigal			
Silver carp			
Grass carp			
Common carp			
Sharputi			
Thaipangus			
Kalibasuh			
Tilapia			
Mirror carp			
Prawn			
Others.....			

31. Profit loss ratio:-

Cost of production/dec.	Gross sale/dec.	Profit/Loss

32. What are the problems of fish farming?