STUDIES ON THE NURSING AND TRADING SYSTEMS OF SHRIMP (*PENAEUS MONODON*) FRY IN SATKHIRA DISTRICT

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Declaration

Studies on the nursing and trading systems of shrimp (*Penaeus monodon)* fry in satkhira district

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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October, 2010

DEDICATED TO

MY BELOVED PARENTS AND HUSBAND

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 & Marine Resource Technology Discipline and to complete my project thesis for the degree of M.Sc. in Aquaculture (Masters.).

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Abstract

The study was conducted in three Upazilla (Satkhira sadar, Debhata and kaliganj) of Satkira district. The research work was based on a survey to the nursing and trading systems of shrimp fry in the nursery of Satkhira. The objectives of the study were to observe fry *(penaeus monodon)* rearing system, economic benefits and to observe the trading system of shrimp fry. The investigation was conducted on 30 nurseries. There were about 250-300 tanks or ponds in the 30 nurseries which are ranged from 6-10 sq.m. in size.were. Main sources (85%) of the fry were hatchery. Most of the shrimp hatcheries were located in the Cox's Bazaar region and 85% of the hatchery-produced fry was transported to the Satkhira and Khulna region from the Cox's bazaar by airfreight or road to study area. Transportation was done by air cargo, truck, bus, van, etc. Stocking density was 7000-9000 fry/sq. m. Duration of nursing was 3-10 days and the cycle of nursing was 20-25 per year. Survival rate of the shrimp fry in concrete tank nursery was (90-95) % and in the earthen pond nursery (80-90) %. Water quality parameter such as pH was 7-10, salinity was 8-16 ppt and temperature was (28-32) ° c in surveyed nursery. Different types of artificial feeds were used such as *Artemia*, dafnia, flake feed and mixed feed, etc. Trading was done in different ways such as the fry was directly bought by gher owners from the nursery or the fry was bought by the nursery owner or aratder from the different agent office of Satkhira, then the gher owner bought it from them .The price of the fry was highest (400-1300) Tk/1000 of fry in Feb-June and the lowest price (150-600) Tk/1000 of fry was Nov-January. The net profit was 20Tk/1000 fry. There were some problems in the nursing trading systems such as lack of credit facility, lack of technical knowledge and modern equipment, hazardous transportation process of fry, lack of policy etc.

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CHAPTER ONE
INTRODUCTION

Chapter-1

Introduction

1.1 . Back ground of the study

Bangladesh has great potential for shrimp farming. Shrimp cultivation and export in Bangladesh have undergone rapid expansion over the last two decades. Bangladesh stood eighth position among the shrimp producing countries of the world in terms of production (WB, NACA and FAO2002). Shrimp alone contributed about 84% of total export earning from fishery product. However, the average production was only 200kg•ha-1•year-1(2001) (Islam et al., 2003). This production level can easily be doubled with a little improvement of fry quality and farming practices. Currently, three different culture systems are being practiced. These are known as traditional, improved traditional and semi- intensive culture systems. More than 90% of the total farms still practice the traditional system.

The country's main shrimp production areas are located at Khulna, Satkhira and Bagerhat districts in the Southwest region and Chittagong and Cox's Bazaar districts in the Southeast region. Till early 1980s, coastal shrimp farming was almost traditional. The culture system was by trapping shrimp larvae that would enter the farms with tidal water during high tide. In this system, other species of shrimp and fishes including predator fish would enter the farms and thereby the production was very low. Afterwards the traditional culture system was gradually replaced by selective stocking of *Penaeus monodon* fry collected from natural water in the coastal regions.

During early 1990, some farmers started semi-intensive shrimp farming at a very small scale. The cause of the disease outbreak in Bangladesh was identified to be with the shrimp fries imported from Thailand. Thus, shrimp farmers of Bangladesh became dependent on the supply of natural fry. The tiger shrimp *(Penaeus monodon)* dominates Asian shrimp culture production because of its fast growth and adaptability to the pond environment and artificial feed.

Culture technology has developed rapidly over the past decade-and-a-half and, in those countries with open economies, shrimp culture production has expanded at a tremendous rate. For example, Thailand's output of tiger shrimp went from 110 tin 1985 to 150,000 tin 1992. Indonesian production has grown similarly, from 12,000 t in 1985 to 130,000 t in 1992 (Rosenberry, 1992). Although about 108,000 ha are devoted to shrimp culture in Bangladesh, the yield is only of the order 200 kg/ha (Anon 1993). The culture is mainly 'extensive', which accounts for the low productivity. There are many reasons for this situation, Government land policy; Shortage of investment funds; antiquated investment policies; and Poor access to modern technology. Intensification of culture in existing farms and construction of many new farms are increasing the demand for post-larvae (PL). But the hatchery industry is still in its infancy in Bangladesh. This means the pressure on natural sources will grow dramatically in the next few years. Shortages are already occurring, as evidenced by rising prices. A significant amount of seed is imported into Bangladesh from West Bengal, India. There is, at the same time, substantial waste in the seed-collection and distribution system. High mortality occurs from the time the tiger shrimp seed is landed till it reaches the farmer. On top of this, there is the mortality due to the primitive pond and water management practices of the farmers. Management practices vary widely. Very few intensive farms are likely to be established in Bangladesh because high investment is needed, operating costs are substantial and risks due to diseases are considerable. But even the present demand has not led to hatchery development on a large scale in Bangladesh. Such development as there has been very slow and is likely to remain so. Suitable sites are largely restricted to the south east coast, where infrastructure is poorly developed. One commercial hatchery has been established at Kalitali, Cox's Bazar, but is not yet in full production. Shrimp farming will, therefore, continue to depend on wild fry for the foreseeable future. And the shrimp seed collectors will remain the first and crucial step in the wild fry supply chain the concentration of shrimp farming in the area under culture system promotion country reflects the area wise distribution of shrimp fry-collection. Chittagong and Khulna are the main districts. Shrimp fry are collected from the coastal areas of 40 upazilas under 12 coastal districts along the 710 km long coast. The huge numbers of by-catch like eggs, larvae and juveniles of non-target fish and shrimp during *P. monodon* fry collection are discarded in the land after sorting of target fry. Thereby, the coastal biodiversity has been decreased day by

day. Khan (2002) reported that the total catch amounts of 3000 million post larvae of *P. monodon* together with a further 30,000 million other species, 62% of which was zooplankton, 10.9% othershrimp, 13% caridean prawn and 13% fin fish larvae. Therefore, the government of Bangladesh banned wild fry collection in 2002 in order to protect the coastal fishery biodiversity.

The potential demand and scarcity of wild *P. monodon* fry initiated special attention to the development of hatchery technology in order to produce *P. monodon* fry in 1998 - 2001. According to the shrimp hatchery association of Bangladesh 50 shrimp hatcheries (at various stages of operation and management) produced nearly 7 billions post larvae in 2004 (SHAB, 2005) which was sufficient to supply the entire shrimp culture industry in Bangladesh. Moreover, many of those hatcheries had to stop production in the last two years due to market over supply and consequent price falls. Shrimp hatcheries produced *P. monodon* fry from mother shrimps under controlled condition. Most of the shrimp hatcheries were located in the Cox's Bazaar region and the fries were transported by air or road to the south-west regions. Among the many concerns about fry catching is the potential loss of other biodiversity in the form of by-catch as the fry are sifted from the surf. The FAO (1990) estimate that the rate of "wastage" is significant when compared with the total amount of Bagda fry collected. Although the FAO report that there is a diversity of estimates for wastage, the consensus is that approximately 5,000 other fry are wasted for every 100 Bagda fry. These other fry includes *Macrobnachlum rosenbergii* (or white chingri) fry , Chaga or red chingri fry and a number of fish fry. The fish fry include paisha, chauma, tengra (Mystus spp), and bekti. While many fry catchers claim that they return the by-catch to the sea, a non-trivial proportion is clearly lost. Additionally, the fry catchers recognize that shrimp fry are lost during the sorting process. The respondents interviewed estimated that 5 to 10 percent of shrimp fry were lost during the sorting process. Nurseries are where the fry are adapted to the production environment. Technical expertise and infrastructure are required for the operation of a nursery. Supply of oxygen is provided at every stage of nursing. Because of the reliance on electricity a generator is used to compensate for power outages.

Typically there are only men working in the nursery. Nursery culture is a new value addition option in the shrimp value chain that may help to improve survival rates of hatchery produced fry.

Introducing nurseries has the potential to increase the total availability of shrimp fry and provide employment opportunities— although some technical expertise and limited capital investment are required. Shrimp farming is a capital intensive venture. Credit infrastructures are insufficient for the small farmers in the country. The rich arathdars, commission agents, hatchery owners and farmers enjoy the loan from institutional banks. Other people have to depend on informal institutions e.g. moneylenders, friends and relatives. Presently, the wild and hatchery reared fries are abounding to shrimp farmers through a chain of intermediary fry traders, fry arathdars and commission agents. Few works have been done on wild *P. monodon* fry transportation and management. There is no report on wild and hatchery reared fry marketing system in Bangladesh. Therefore, the present study is to observe the marketing system of *P. monodon* fry, distribution chain, price determination and their ultimate impact on our shrimp industry. The fry-collectors working the sea beach of Cox's Bazar have become major suppliers to the industry. The shrimp fry-collectors are predominantly landless peasants, illiterate and with few employment alternatives. Women and children are much involved in seed-collection in some areas, are numerically dominant. *Penaeus monodon* fry marketing systems in Bangladesh based on the existing one and economic evaluation of marketing activities. In Bangladesh, *P. monodon* fry marketing of the wild and hatchery reared ones is almost exclusively handled by private entrepreneurs. The Government of Bangladesh has no command on this issue except the banning of wild fry catching. Santiago (2002), reported that the development of improved trading, transport, handling and storage methods of fry can increase the shrimp production of Bangladesh. The market chain from fry catchers or fry producers to shrimp farmers passes through a number of intermediaries: faria, fry traders, fry commission agents and retailers. The existing marketing system is buyer-driven chains where producers that is shrimp hatchery owners have little ability to influence the price, on the other hand, wild fry catchers or small fry dependent on the dominant buyers or larger arathdars. The fry value chain is complex, different intermediaries of each node of the chain is an important actor to determine the fry value.

1.2. Problem of the Study

This sector is in various problems. The main problem is poor production. It is caused for lack of timely available good quality seeds. The hatcheries fry is weak and low quality. There is no proven nursery technology for shrimp fry nursing in Bangladesh. The nursery owner has no proper knowledge on the fry nursing. There is no modern equipment of nursery. The marketing system is not development in the study area.

1.3. Hypothesis Setting

Shrimp fry nursery management is not common in Bangladesh. Some shrimp fry nursery is established in Satkhira. Nursery fry is not strong and not grows disease resistance power. But there is no modern technology in the nursery. Marketing channel of shrimp fry is not well developed.

1.4. Objectives of the study

- To observe the fry rearing systems in different nursery at surveyed areas.
- To analyses the economic benefits of nursery systems.
- To analysis the different trading systems of shrimp fry.

Chapter-2

Review of Literature

Mazid (1995) suggested the establishment of a shrimp hatchery village for Bagda (*penaeous monodon*) shrimp which would be specially designed for small farmers with a production capacity of 150,000–200,000 post larvae/unit/season.

Karim 1995; Rahman and Pal 1995 estimated that requirement for the 130,000 h of shrimp farms is 2.6–3.0 billion post larvae and the difference is made up from wild fry. In 1995, there was only one bagda hatchery (out of 10 shrimp hatcheries; DOF 1995) in Bangladesh producing between 20–30 million post larvae. Realizing this, DOF provided plans for construction of about 30 private-sector hatcheries (Selim 1994) 12 of which were under construction in 1995 (Haque 1995)

Folke *et al.* 1998; Kautsky *et al.* 2000. reported that the wild shrimp post larvae (seed) that are stocked in grow-out ponds are either allowed to enter traditional ponds with incoming tidal waters or caught by seed fishers and subsequently stocked in ponds. Shrimp post larvae can also be produced in hatcheries, which depend upon continual inputs of wild-caught brood stock. The brood stock can be separated into immature brooders, allowed to maturate in captivity, and already gravid female spawners.

Gain (1998) reported on environmental concerns caused by shrimp in Bangladesh. The book mentions that the coastal environment, which has already suffered tremendously due to embankments built from 1962 to 1972, was exposed to more risk through unplanned and unscientific shrimp cultivation. The rapid expansion of shrimp farming has drastically reduced the stock of indigenous fish varieties and destroyed many mangrove flora and fauna.

Ghafur *et. al* (1999) expressed grave concerns about environmental degradation and suggested that shrimp cultivation should be limited to the high salinity zones and part of medium salinity zones, where shrimp cultivation is economically more profitable.

Islam *et. al* (1999) studied the impacts of shrimp farming on soil and water quality in some selected areas and the results of the study demonstrated some adverse impact of shrimp farming on soil properties by increasing soil salinity levels (upto 500%) in non-saline area that hampered crop cultivation seriously. Water bodies were also found contaminated with high salinity (upto 22 ppt) that does not favour growth of many fresh water organisms.

Manju (2000) felt that in shrimp cultivation, the issue of natural equilibrium is not only absent in the production practices, but also absent in the perception of different classes of People engaged in shrimp farming in Bangladesh. The study solicited people's views regarding their environmental problems due to extensive shrimp farming in their localities. The local people identified two most important problems i.e., depletion of fisheries resources and reduction of plants and trees that affect their lives, livelihood and environment. The shrimp farmers mostly rely on wild shrimp stock because there are only nine hatcheries in Bangladesh, all with limited capacity for shrimp fry production. Furthermore, only one of these hatcheries, located in the south-eastern zone, produces bagda (P. monodon) fry—the preferred shrimp species (Karim 1995).

For every single bagda fry collected from the natural habitat, up to 99 other species of shrimp and finfish could be destroyed (Selim 1994). For instance, the shrimps belonging to the genus *Penaeus* have a life cycle where they spawn at sea and, after a few weeks, the post larval shrimps settle in inshore and estuarine waters, which they use as nurseries during their critical early life stages (reviewed by Dall *et al.* 1990).

(Garcia 1985; Rönnbäck 1999) observed that the major factor influencing the productivity of penaeid shrimp fisheries is the survival during the pre recruitment stages, when the larvae of many species use mangrove environments.

Both de Freitas (1986) and Primavera (1998*b*) found that *Penaeus monodon* prefers mangroves as nursery grounds. Apart from shrimp post larvae and brood stock, mangrove ecosystems also provide feed inputs, water quality maintenance and control against natural disturbances like erosion, The tiger shrimp *(Penaeus monodon)* dominates Asian shrimp

culture production because of its fast growth and adaptability to the pond environment and artificial feed. Culture technology has developed rapidly over the past decade-and-a-half and, in those countries with open economies, shrimp culture production has expanded at a tremendous rate. For example, Thailand's output of tiger shrimp went from 110 tin 1985 to 150,000 tin 1992.

Rosenberry (1992) reported that Indonesian production has grown similarly, from 12,000 t in 1985 to 130,000 t in 1992 Although about 108,000 ha are devoted to shrimp culture in Bangladesh, the yield is only of the order 200 kg/ha (Anon 1993). The culture is mainly 'extensive', which accounts for the low productivity. There is, at the same time, substantial waste in the seed-collecting and distribution system. High mortality occurs from the time the tiger shrimp seed is landed till it reaches the farmer. Raj and Hall (1993) estimated that mortality all the way up the market chain is 20-30 per cent in West Bengal.

Hussain (1994); Karim (1995) reported that there is the mortality due to the primitive pond and water management practices of the farmers. Mazid (1994); Ahmed (1996) obserded that an improved extensive method is a slight modification of the traditional extensive method, whereby farmers apply a few components of shrimp farming technologies. This method is, perhaps, specific to shrimp aquaculture in Bangladesh and Vietnam. An annual yield of 250–1,000 kg of shrimp can be obtained. Until the early 1990s, brackish water shrimp culture in Bangladesh was mainly based on traditional extensive systems. According to the Marine Fisheries Department (Choudhury, 1997), the total number of shrimp farms in 1992–1993 was 6540 with an average pond area of 16.5 ha (total pond area: 108,300 ha).

Hussain (1994) estimated that 70% of the total area under cultivation was 'extensive' culture (100–200 kg shrimp ha 1), 25% was 'semi intensive' culture (500–1000 kg shrimp ha_ 1) and 5% of the area was 'intensive' culture systems (1000–2000 kg shrimp ha_ 1). The total production in 2001 was 26,240 tons in a pond area of ca. 150,000 ha, i.e. an average production rate of 100–400 kg ha_ 1 year_ 1 (Md. Karim, personnel communications). Today, very few semi-intensive farms exist as a result of severe disease problems.

Raz and Hull, (1993) reported that fry faria bought fry either from fry catchers or from hatcheries throughout the year. In Khulna, fry faria were also engaged in buying and selling both shrimp and prawn fry, while in Cox's Bazar, the fry faria were almost exclusively trading in shrimp fry. Fry faria borrow money from fry arathdars or moneylenders that lock them into a contract to sell all fry to the lender. If they try to sell their products to other arathdars to get high price they are often facing verbal or physical abuse. Similar situation was observed in West Bengal, India where the fry catchers borrowed money (locally known as dadun) from the money lenders, (Raz and Hull, 1993).

Angell (1990) observed that nursery cage culture expands marketing opportunities in two ways: Undersized fry caught in August and September can be held until marketable size is reached. Hatchery PLs can be stocked and reared to marketable size. In fact, they can be nursed until the optimum size is reached. Excepting in 1990, prices for nursed juveniles ranged from Tk 800 to 1600, as demand increased markedly due to the growing popularity of shrimp farming. Prices did not differ between direct sales to farmers and to sales to *aratdars.* Culture is of central importance to the fisheries sector in Bangladesh. It grew from next to nothing in the early 1970s to contribute about 11% of total exports in the mid-1990s (DOF 1995).

DDP (1985) reported that traditional bheri/gher aquaculture had been practiced in the coastal areas of Bangladesh to grow shrimp and fish long before the introduction of current shrimp culture practices The total area under shrimp culture was expected to rise from 96,048 ha in 1990 to 135,000 ha in 2005. As of 1994, there were already about 130,000–138,000 ha of shrimp farms (DOF 1994; Rosenberry 1995), exceeding the projection for 2005. An estimate showed that production would be 89,000 t in 2005 (Marr Associates 1985) as opposed to production of 30,000 t in 1995 (Rosenberry 1995).

MPO(1987) observed that Satkhira District has the greatest potential for expansion of shrimp farming in the south-western region while potential for expansion in Cox's Bazaar District of the south-east seems also very high. An improved extensive method is a slight modification of the traditional extensive method, whereby farmers apply a few

components of shrimp farming technologies. This method is, perhaps, specific to shrimp aquaculture in Bangladesh and Vietnam. An annual yield of 250–1,000 kg of shrimp can be obtained (Mazid 1994; Ahmed 1996).

Kashem (1996) reported that the United States of America (USA), Japan and the European Union (EU) are the major destinations of exports. Foreign exchange earnings from Bangladesh's fisheries sector depend, in the main, on shrimp in 1995, hatcheries relied on the government research vessel, Anusandhani, which catches broodstock from the sea. Largely under-utilised public-sector hatcheries suffer from various management problems that limit their production (Khan 1995).

(Karim and Aftabuzzaman 1995) reported that stale feeds are supplied at the farm level, leading to adverse effects on shrimp farming . Consequently, most farmers rely on natural feed and their farms suffer from lower productivity.

CHAPTER THREE

MATERIALS AND METHODS

Chapter-3

Materials and Methods

3.1. Study area

The study was conducted on 30 nurseries in three upazila (Satkhira Sadar, Kaliganj and debhata) of Satkhira district.

3.2. Study period

The study was conducted by four months (April- July, 2010)

3.3. Field study

Prior to investigation a structured questionnaire was prepared. The questionnaire was prepared according to the objectives of the study. The questions were specific and free from any kind of bias. Then a corrected questionnaire was formed and again a survey was carried out in the study area. Finally a structured questionnaire was prepared through the entire survey was conducted.

3.4. Data collection

After finalizing the questionnaire, relevant data were collected by interviewing the nursery operators or managers. To collect the data visits were conducted in the study area for four weeks.

3.5. Collection of relevant materials

The relevant secondary information regarding the study was collected from different journals, articles, world fish DoF office at Boyra in Khulna, Seminar Library of Fisheries and Marine resource Technology Discipline, Khulna university.

3.6. Data analysis

After collection of relevant data and information, all data was classified and then it was analyzed according to the objectives by Ms Excel, SPSS software. The analyzed data was then presented in tables and graphs.

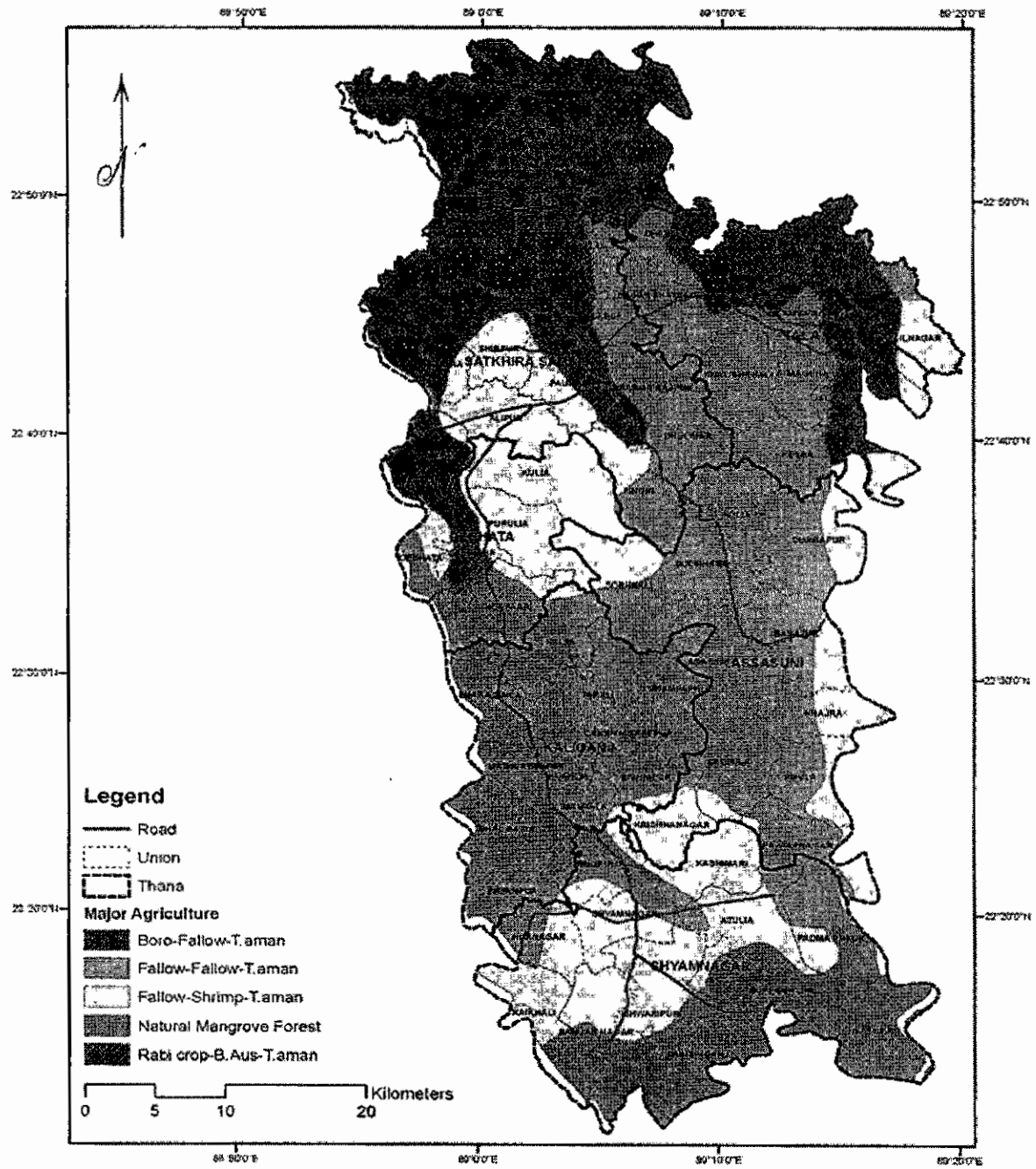

Fig: Map of the Satkhira District

CHAPTER FOUR

RESULTS

Chapte-4

Results

4.1. Number of ponds or tanks

The study was conducted in three Upazila (Satkhira Sadar, Debhata and Kaliganj) of Satkhira district. The survey was done in 30 nurseries where two types of nursery such as earthen ponds and concrete tanks were used to rear the fry of shrimp. There was a variation in number of tanks or earthen ponds in every Upazila. The information of tanks or ponds of 30 nurseries is given bellow.

Table1: Number of tanks or ponds of shrimp fry nursery

Study Upazila	No. of nursery	No. of concrete tank	No. of earthen pond
Satkhira Sadar	5	40	15
Debhata	15	100	30
Kaliganj	10	30	10

4.2. Size, shape and depth of ponds or tanks

The survey on concrete tanks and earthen ponds were varied according to their size and shape in every Upazila. It is given in table 2.

Table 2: Size of tanks or ponds used for shrimp fry rearing

Name of Upazila	Types of nursery	Size of tanks (6-8 sq. m.)	Shape	Depth (m.)
Debhata	*Concrete tank*	6-8	*Rectangular*	1.5-2
	Earthen pond	12-14	*Irregular*	2-3
Satkhira Sadar	*Concrete tank*	7-8	*Rectangular*	1.5-2.5
	Earthen pond	16-20	*Rectangular*	2.5-3
Kaliganj	*Concrete tank*	8-10	*Rectangular*	2-3
	Earthen pond	18-20	*Irregular*	2.5-3.5

4.3. Ponds or tanks preparation

It was found that nursing was done in both earthen ponds and concrete tanks in every Upazila. It was also observed that concrete tanks were prepared in the same way. Similarly all the earthen ponds were also prepared in the same way in every Upazila.

The operators performed a short preparation of the ponds or tanks. When the nursing was done in earthen ponds, the pond was sun dried, removal of the weeds and predatory fishes and excessive mud from the pond bottom, if there was any. After good drying, pond was bleached with bleaching powder. When the concrete tanks were used in the nursery generally wheel powder and jet was used to wash the tanks. The dike of the pond was also repaired if necessary. The pond was also fenced with nylon weir mesh to protect if from any predator to get into; the inlet and outlet of the pond were also closed with net. The pond was also covered with special net with bamboo stand to protect the Pl from excessive sun light.

The brackish water for filling the tanks or ponds was collected from the nearby river or creeks and it was settled in a reserve tank. The water was filtered using sand, stone and coal etc. Some nursery used certain chemicals like formalin, chlorine-33, EDTA etc. for purifying the water. After preparation the tanks or ponds, water was filled into those tanks. Any fertilizer was not used in both earthen ponds and concrete tanks.

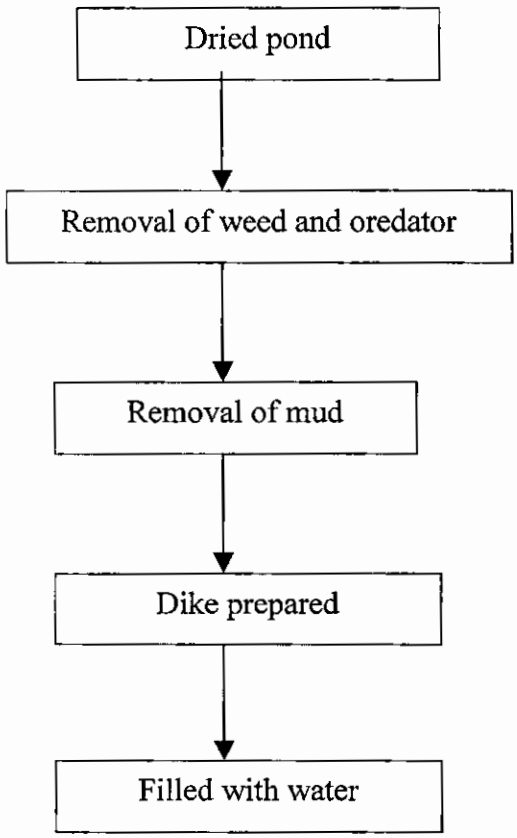

Figure 1: Preparation of earthen ponds

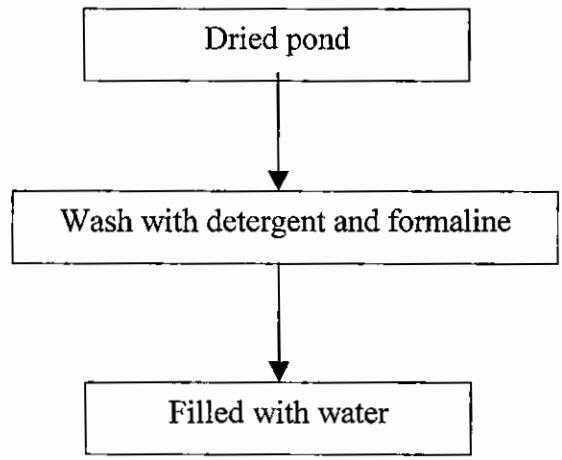

Figure 2: Preparation of concrete tanks

4.4. Sources of fry

Fry were collected from both hatchery and river. About 85% fry were collected from hatchery. The rest 15% were collected from wild sources (river, estuarine, etc). It is given Fig. 3

The wild fry was collected from the Sundarbans and the nearby rivers. About 90% wild fry were collected from the Sundarbans. Among the hatchery fries, 90% fry collected Cox's Bazar and the rest 10% collected from the different hatcheries of Satkhira.

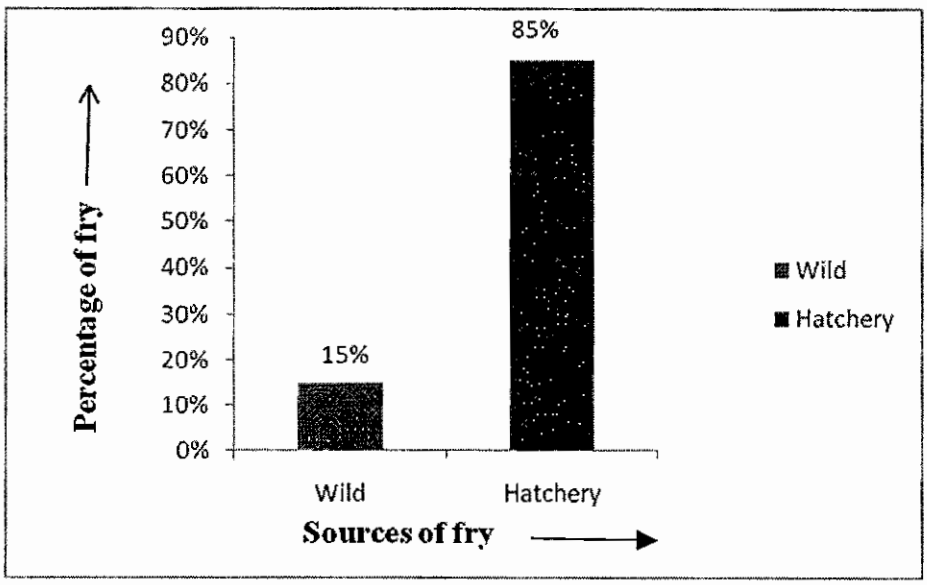

Figure 3: Sources of fry for nursing in Satkhira

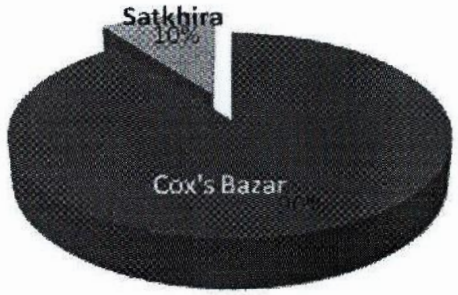

Figure 4: Sources of hatchery fry for nursing in Satkhira

4.5. Price of fry

Profit of nurseries depends on price of fry. So it is very important. The price of hatchery fry was 150-700 Tk./1000 fry and the wild fry was 800-1300 Tk. /1000 fry in different seasons. It is shown table 3.

Table 3: purchasing price of different types of fry

Upazilla	Types of fry	Price Tk/1000 fry
Debhata	Hatchery	150-700
	Wild	1000-1200
Kaliganj	Hatchery	200-600
	Wild	1200-1300
Satkhira Sadar	Hatchery	200-650
	Wild	800-1000

4.6. Transportation of fry

The principal sources of fry used in culture farms of Satkhira were the hatcheries of Cox's Bazar. Fry of Cox's Bazar hatchery was transported by Biman from Cox's Bazar up to Jessore airport. From Jessore, the fry were carried by truck directly to the different nurseries or agent office in Satkhira. The nursery operators after purchasing the fry from the traders and agents office carried them to the nursery premises by means of truck, bus, pick-up van and rickshaw etc. Some nursery owners had their own truck to transport of fry from Cox's Bazar. It was gathered that fry was loaded at 200/L when they were carried by road truck and it was at 1000/L when they were transported by air cargo. The fry were placed in polythene bag inflated with oxygen and which was finally placed in a single Styrofoam box.

4.7. Mortality due to transportations

The density of fry in carrier bag and duration of transportation were very important factors to keep the fry healthy. It was reported that the rate of mortality during transportation was low; however, sometimes there occurred of mortality when the transportation time taken was long.

Table 4: Mortality of fry due to transportation systems

Transport system	Mortality rate (%)
Biman	2
Truck, van, bus, etc.	3-5

4.8. Duration of nursing of fry

Duration of nursing period of fry in concrete tanks and earthen ponds were different. In every nursery of concrete tank, the duration of nursing period was same in every Upazila and in every earthen pond nursery; it was also same in every study area. The duration of nursing was ranged from 3-14 days.

Table 5: Duration of nursing in the study area

Types of nursery	Duration of nursing (days)
Concrete tanks	3-8
Earthen ponds	4-10

The nursery rearing of fry done by the operators was quite short. About 80% nurseries, the fry were reared for 3-5 days. While 15% nurseries, the fry were reared them for 5-7 days. About 5% nurseries, the fry were reared for 7-10 days. It is shown in figure.

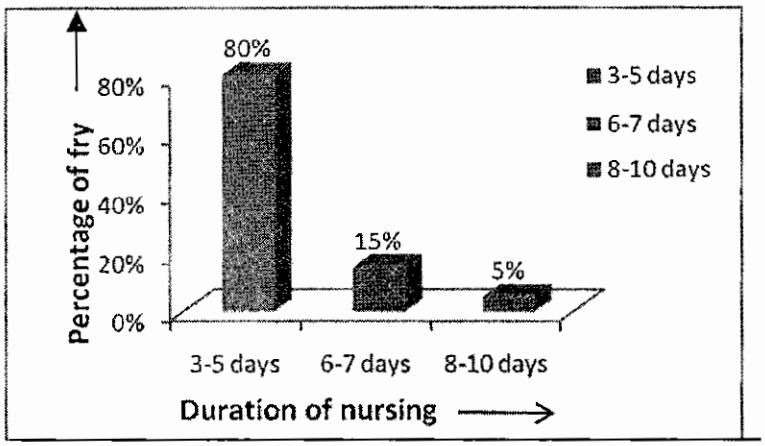

Figure 5: Duration of nursing only in concrete tank

Stocking density was varied from earthen pond and concrete tank. But the stocking density in every concrete tank was same in every Upazila and it was same in every earthen pond. The fry collected from different sources were primarily stocked in doubled cloth hapa at higher density for one day .Then they were transported to the earthen nursery ponds or concrete tanks. It is shown in table 6

Table 6: Stocking density of fry in different nursery systems in Satkhira

Upazila	Types of nursery	Number of nursery	Min. stocking density (sq/ m.)	Max. stocking density (sq/m)	Average stocking density (sq/m)	Standard Deviation
Shatkhira Sadar	*Concrete tank*	6	8000	8500	8283	183
	Earthen	4	7000	8000	8633	314
Debhata	*Concrete tank*	6	8500	9200	8683	314
	Earthen	4	7000	8500	7875	629
Kaliganj	*Concrete tank*	6	8500	8800	8566	136
	Earthen	4	7000	9000	7750	957

4.10. Number of cycle for nursing fry

It was reported that the operators run the system for 6-7 month in a year and complete up to 20-25 cycles every year; each cycle was run 5-7 days.

4.11. Water quality parameters

Although water quality parameter was very important for fry, it was measured only in 5% earthen nursery and 30% in concrete tanks nursery. The temperature was surveyed area was 28-34°C.

Table 7: Water quality parameter of shrimp fry nursery ponds or tanks

Name of Upazila	Parameter	Minimum	Maximum	Average	Standard deviation
Debhata	*pH*	7.5	8.5	8	0.408
	Salinity	8	9	8.63	0.478
	D.O	8	9	8.50	0.408
Kaliganj	*pH*	7	8.5	7.75	0.707
	Salinity	7	10	8.50	1.29
	D.O	8	9	8.13	0.85
Satkhira Sadar	*pH*	7	10	8.50	1.29
	Salinity	11	12	11.25	0.957
	D.O	7	12	7.87	0.853

4.12. Artificial feeding

About 70% farmer did not use feed in earthen ponds whereas all of the farmers of concrete tank were used feed in every Upazila. The nursery operators used different kinds of feed such as flake feed, *Artemia*. During investigation it was found that about 70% of the nursery operators used mainly *Artemia* and flake feed. 10% and 20% operators used either *Dafnia* feed or *Artemia* + mixed feed. The feeds were available in the market in packet or boxes. The feeding rate of mixed feed was 1-1.5 spoon (10-15gm)/tank/day. The feeding was given 1-3 hour interval in a day. The percentage of the operating applying different feed category in the ponds is shown in fig-6

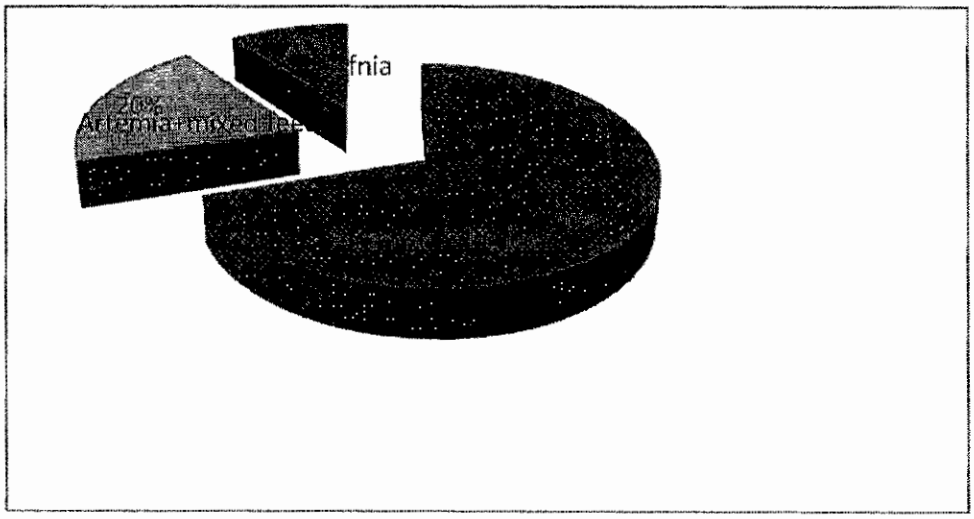

Figure 6: Percentage of nursery used of artificial feed

4.13. Survival rate of the fry

Survival rate was different in all kinds of nursery in every Upazila. In earthen pond it was (70-80) % and in concrete tank nursery was (90-98) % in every Upazila. Quality of management of a nursery was evidenced by the survival rate of the fry and in fact it was the single most criterion of judgment for standard of practice in managing of a nursery. It was found during investigation that survivability of the fry in different nursery varied considerably and was described to the over all improper management. The figure shows the survivability range of the fry in different nurseries in percentage.

Table 8: Survival rate of shrimp fry in different Upazila

Name of Upazila	Types of nursery	Minimum (%)	Maximum (%)	Average (%)	Standard deviation (%)
Debhata	*Concrete tank*	90	95	94	2.22
	Earthen	85	90	87	2.2
Kaliganj	*Concrete tank*	94	98	96	1.7
	Earthen	84	90	87	2.58
Satkhira Sadar	*Concrete tank*	90	96	93	2.58
	Earthen	88	91	89	1.29

4.14. Use of modern equipment in different nursery

Most of the nursery operators in the study area did not use modern equipments. They were not in the position to maintain the water quality parameters at optimum level. It was found that 60% of the nursery had aerator, 45 % of the nursery used generator, 30% used pH meter and D.O meter, 50% had used water pump, 50% used refracto meter and 35% of the nurseries had transportation vehicles.

Table 9: Modern equipment available in different nurseries

Types of equipment	Percentage of Concrete tank nursery	Percentage of earthen tank nursery
Aerator	60	20
Generator	45	10
Water pump	50	30
pH+D.O meter	30	5
Refractor meter	50	5
Truck,pick-up,van etc	35	5

4.15. Ownership of the nursery operation

Question was asked as to the management ownership of the nursery and it was found that the systems were under both single and multiple ownership was, however in the common area: only 5% of the ventures were being managed under multiple ownership. The percentage of ownership categories of nurseries is shown in figure.

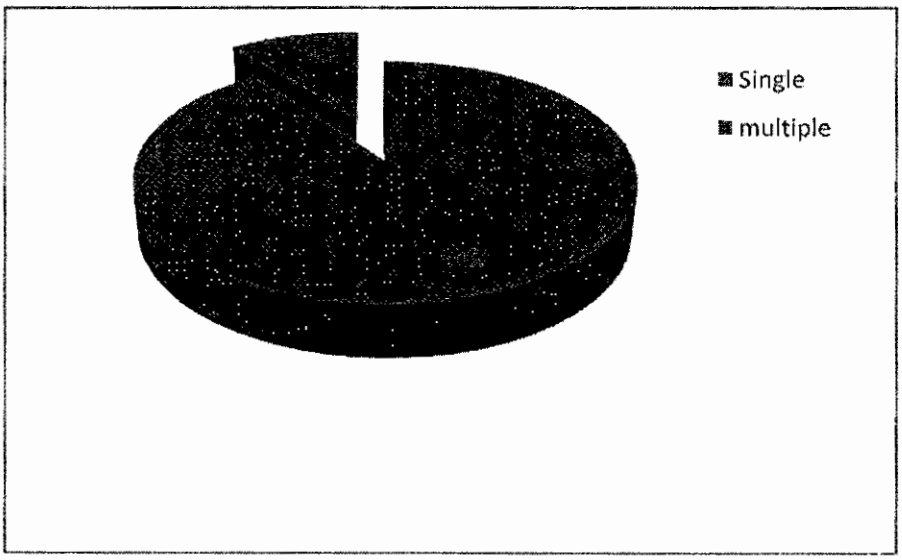

Figure 7: Pattern of owner ship of different nurseries

4.16. Technical knowledge of the nursery operator

Technical knowledge of the nursery operator was found very poor. Some of the nurseries had technician but most of them had no institutional knowledge. They had no formal training on the subject. They were doing on the job on the basis of their empirical knowledge that they achieved through observation. They were instances of failure of diagnosis diseases and as a result often mortality occurred in the nursery with consequent loss in venture.

4.17. Harvesting of fry

When the fry stocking became 3-8 days, it harvested to sell it. When the fry was sold partially, then it was harvested by netting. In case of total harvesting, the water was drained by pipe then it was harvested using net.

4.18. Price of fry

Depending upon the market situation in the study area as whole, the price of fry was seen to fluctuate during the culture season in every Upazila. The price range during stocking and selling are shown in the table.

Table 10: price of hatchery fry in different seasons

Price category	Season	Price (taka/thousand fry) during stocking	Price (taka/thousand fry) during selling
Highest	***Feb-July***	400-700	450-750
Lowest	***Oct-Nov***	150-200	200-250
Medium	***Aug-sep***	200-250	250-300

Table 11: price of wild fry in different seasons

Price category	Season	Price (taka/thousand fry) during stocking	Price (taka/thousand fry) during selling
Highest	***Feb-July***	1200-1300	1250-1300
Lowest	***Oct-Nov***	600-800	650-850
Medium	***Aug-sep***	800-900	850-950

4.19. Management problems

In the study area there is some problems associate with the nursery operation which hindered the real progress in this sector. Such as

- Most of the nursery owner had no transport vehicle. So, the transport cost became high.
- Sometimes it takes long time for transportation that caused oxygen depletion in the carrier bags and mortality rate become very high.
- Unstable market price was a serious problem in the study area.
- In some cases some problems observed such as disease, improper management, more labor cost.
- Lack of good quality fry and water.

4.20. Marketing Channels

Shrimp hatcheries produced *P. monodon* fry from mother shrimps under controlled condition. Most of the shrimp hatcheries were located in the Cox's Bazar region and the fries were transported by air or road to the south-west regions. About 85% of the hatchery-produced fries were transported to the Satkhira and Khulna region by airfreight.

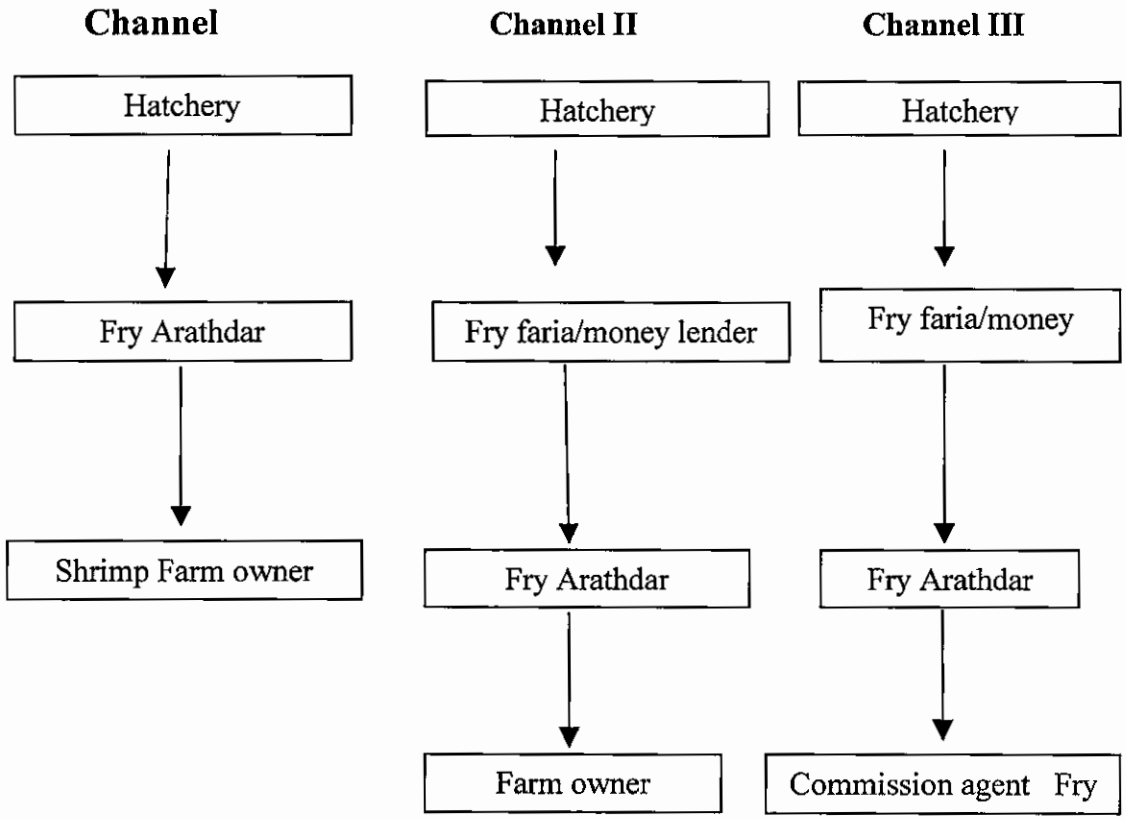

Figure 8. Different marketing channels of hatchery fry of *P. monodon*

4.21. Description of the Marketing Channels

4.21.1. Fry Catching

Fry catching took place widely throughout Bangladesh. There were 12 districts and about 40 thanas where shrimp fry catching took place. We estimate that there were currently around 518,130 fry catchers involved in shrimp fry catching during the peak season. Most of the fry catchers reside along the beaches or river and many had migrated from other parts of the country. Generally, both men and women work in fry catching with women comprising approximately 40 percent of the workforce. Children frequently accompany fry catchers and participate in catching and sorting activities. During the peak season women and girls participate more visible in fry catching. However, throughout the year women and girls sort the shrimp fry collectors sift the surf for fingerling. They transfer their catches to earthenware or metal bowls which were often carried back to the villages where the fry were sorted and counted by women and children using white enameled plates. The transporting and sorting process undoubtedly results in a very large wastage of fry of both penaeid shrimps and other commercially important species including fish. The shrimp fry then passed through a chain of middlemen before reaching the shrimp farmers.

4.21.2. Hatcheries

Hatcheries produce fry from mother shrimp under controlled conditions. The hatchery obtains the mother shrimp from farmers and marine fishermen. Bagda hatcheries need pipes and infrastructure to bring seawater inside the hatchery and to return it for disposal. For breeding purposes, the mother shrimp was kept in a dark quarantined room at a controlled temperature. Cleanliness and quiet are emphasized as critical factors for successful breeding. Consequently, access to the main breeding room was limited and only the key care-taker was allowed to get in this room to perform essential work.

4.21.3. Fry Faria

Fry faria bought fry either from fry catchers or from hatcheries. Fry faria bought fry throughout the year. The peak season for buying fry was five months long from "Baishakh" (April) to "Bhadrah" (August). During this period the faria conduct business every day and buying and selling twice a day. During off season in the months of "Poush" (December) and "Magh" (January) they could faced significant financial distress and frequently resorted to loans from the fry Aratdar which locked them into a contract to sell all fry to the lender. If they tried to sell to other Aratdar they frequently faced verbal or physical abuse. Most of the fry faria reported that they preferred to buy wild fry as these fry were perceived to be stronger and more resilient than fry from the hatcheries. This preference was reflected in prices where wild fry were valued at comparatively higher prices.

4.21.4. Fry Aratdar

Fry aratdar also purchased fry that comes from hatcheries or from natural sources. Many fry aratdar bought directly from fry faria, aggregating the volumes of fry. Fry were transported by the fry aratdar to the commission agents in other regions by air or road. Some fry aratdar were also farmers who own or manage ghers.

4.21.5. Fry Commission Agent

Shrimp fry was collected from Cox's Bazar, Chittagong, and Khulna and transported to Khulna where most of the gher (farms) were located. Typically, Commission Agents received the fry and sold them to the farmers. The Commission Agents hold the fry for short periods of time. Large containers, usually plastic drums and aluminum pots, are used to carry and served the fry. Shrimp fry were transported by air and road and no food was provided during either transportation, storage and trading. The Commission Agents were generally medium to large-scale entrepreneurs. Fry commission agents sold wild fry at higher price than hatchery fry. Buyers willingly pay this premium since they believed that the wild fry had higher survival rates. They claim that they lost 10 to 12 thousands of fry on an average per one lakh (100,000) fry. The mortality rate depended on both the quality of net used in catching the fry and the type of management during transportation.

Nurseries are where the fry were adapted to the production environment. Technical expertise and infrastructure were required for the operation of a nursery. In the nursery, the fry was kept under controlled conditions and was nourished through regular feeding at three hour intervals. The fry gradually adapted to the temperature and pH level of the water where it would be grown. The fry arrived at the nursery at a temperature of 12 ° centigrade. The water temperature was gradually increased to the temperature of the water available in the locality. The pH level was adjusted with lime to a level that matches the local environment. If necessary, the salinity of the water was gradually changed to ensure proper adaptation for the fry. In addition, an uninterrupted supply of oxygen was provided at every stage of nursing. Fry stayed in a nursery for about 3 days and are then sold at a higher price than fry that had not been acclimatized in this manner. Nurseries typically operate only during the shrimp production season. Workers at nurseries claim that their nourished fry had significantly higher survival rates (up to 100% in some cases) and a few nurseries offer a pay-back guarantee if fry die. Nursery culture was a new value addition option in the shrimp value chain that may help to improve survival rates of hatchery produced fry. Introducing nurseries had the potential to increase the total availability of shrimp fry and provide employment opportunities— although some technical expertise and limited capital investment were required.

4.22. Cost benefit analysis of the nurseries

Every nursery owner bought about (2.02-21.50) billion and sold about 2-20 billion. Buying price Of hatchery fry of Per thousand fry was 150-700 Tk. and selling price was 200-750 Tk. and buying price Of wild fry of per thousand was 800-1000 Tk. and selling price was 850-900 Tk. There were many types of cost such as the purchasing of fry feed, chemicals, cost for preparation of tank or ponds, transportation and labour etc.

Table 12: Cost- benefit analysis shrimp in different Upazila in Satkhira

Upazilla	Numer of nursey	Cost Tk/sq.m./thousand fry	Income Tk/sq.m./ thousand fry	Net profit Tk/sq.m./ thousand fry	Avarage Tk/sq.m./ thousand fry
Debhata	1	200	220	20	29.17
	2	250	275	25	
	3	350	380	30	
	4	600	630	30	
	5	700	740	40	
	6	1000	1030	30	
Satkhira Sadar	1	800	820	20	28.33
	2	750	780	30	
	3	550	585	35	
	4	650	690	40	
	5	780	800	20	
	6	675	700	25	
Kaliganj	1	1000	1020	20	39.17
	2	620	650	35	
	3	450	490	40	
	4	540	580	40	
	5	600	650	50	
	6	1050	1100	50	

CHAPTER FIVE

DISCUSSION

Chapter-5

Discussion

Bangladesh has great potential for shrimp farming. Shrimp alone contributed about 84% of total export earnings from fishery product (Islam *et al.,* 2003). The shrimp culture industry of Bangladesh depends on catches of the wild fry of tiger shrimp. So the huge numbers of by-catch like eggs, larvae and juveniles of non-target fish and shrimp during *P. monodon* fry collection are discarded in the land after sorting of target fry (A. Taufik, pers. comm., 1998). Thereby, the coastal biodiversity has been decreased day by day. Among the many concerns about fry catching is the potential loss of other biodiversity in the fry are sifted from the surf. As a result the Government banned the catching wild fry. On the other hand, the wild fry cannot meet demand of more fry. So the farmers was becoming depends on the nursery. In the present study efforts were made to survey the present status of the nurseries and the role that they play in the development of shrimp culture in the areas of Satkhira. Seventy percent of the shrimp produced in the country was grown in greater Khulna where as almost all of the hatcheries were established in Cox's Bazaar area (EPB and DOF, 2004). For these problems, it is essential to establish hatcheries to produce shrimp fry which is needed nursing. It is claimed that hatchery produced fry is weak and low quality. Because most of the fry were slow growth rate, poor survival rate and poor disease resistance power. For these problems fry was needed to nurse in the nursery to solve those problems. Considering the demands and importance of shrimp fry of its culture, the present study was carried out to observe the nursing & trading system fry in the most demanding area (Satkhira). From the present study it is found that there are two types of sources (wild& hatchery). The main sources of fry are hatchery. (Hussain 1994; Karim 1995) reported that the shrimp farmers mostly rely on

wild shrimp stock because there are only nine hatcheries in Bangladesh, only one of hatchery , located in the south-eastern zone, produces bagda (*P. monodon*), the preferred shrimp species (Karim 1995). The existing shrimp seed production capacity of commercial hatcheries is nowhere near the total requirement for Bangladesh's increasing shrimp hatchery. From study it was found that about 85% fry were collected from hatchery. The rest 15% were collected from wild sources (river, estuarine, etc). Aftabuddin *et. al* (2009) reported that the arathdars sell approximately 85% of shrimp fries to the shrimp. farmers of Satkhira and Khulna, and the remaining 15% are sold in different parts of Cox's Bazar including Moheskhali, Chakoria and Mathertek area. It is the same result comparing of my study.

It was found from the study that the age of 12-14 days fry were stocked at the rate of 8000-9000 fry/sq m .The collected fry from different sources were primarily stocked in doubled cloth hapa at higher-density for one day .Then they were transported to the earthen nursery ponds or concrete tanks. (Harlingen Shrimp (Farms, Ltd., Los Fresnos, Texas) showed that four to five day old post larvae (PL 4–5) were produced at the TAES facility and were stocked in four raceways (4050 PL/sq. m.). My surveyed result is different due to management systems and technology.

Feed was the essential factor for shrimp fry production and another factor which was important that was quality feed. The nursery operators used different kinds of feed such as mixed feed -1, 2, 3 in sized in different portion decided upon by their experience. During investigation it was found that nursery operators used mainly *Artemia, Dafnia* and mixed

feed (custard). (Persoone and Claus, 1980) reported that larval rearing diets are typically composed of different species of microalgae and newly hatched *Artemia* nauplii

According to (Jones *et al. (1979)*, to ensure high growth and survival rates, particle size and feed rates must be closely controlled, implying a need for increased frequency of feeding of an appropriate particle size. From the two results it is found that lacking of feeding management, feed cost becomes high.

For the Shrimp fry nursing water quality parameter was very important. From the study it was found pH 8-9, Salinity 8-11 ppt. (Samocha *et al.* (1998). Post larvae (PL) showed that were transferred into a 100-mL beaker filled with fresh 35 ppt artificial seawater using dissecting scope and a large-mouth eyedropper. From this beaker PL were transferred into a separate cone filled with 17 ppt artificial seawater supplemented with gentle aeration. This salinity is suitable for nursing in the study area. The salinity is different due to geographical condition.

From my study it was found that dissolve oxygen in the surveyed area was 7-9 mg/l According to Hall and Van Hamm (1998), dissolved oxygen concentrations need to be maintained "above 4 mg/l during the grow-out period if repeated bouts of metabolic stress to the prawns are to be avoided" (juvenile *P. monodon*). According to other reports, incidents of dissolved oxygen deficit in extensive systems in Khulna might have contributed to stressing conditions. In Indonesian tambaks, early morning dissolved oxygen concentrations between 3 and 5 mg/ 1 were considered favourable for growth without causing stress in *P. monodon* (Hariati *et al.*, 1996). Comparing of the two results it was found that the oxygen of my study area was better for shrimp fry production.

In the area temperature was 28-34°C. According to Chanratchakool *et al.* (1998), the feeding response may be reduced by 30–50% at temperatures higher than 32–33 °C. Stress inducing temperature levels, up to 38–39° C, were observed in three Gher .

From study it was found that the survivability of the fry was (90-98) %. Abtabuddin *et.al.*(2009) reported there was a claim that they lose 10 to 12 thousand fry on average per one lakh (100,000) wild fry. The mortality rate depends on both the quality of net used in catching the fry and the type of management during transportation. However, survival rate of wild fry are 70 - 80%. These agree with the report of Angell (1994), who also found 80% survival rate in wild fry. Samocha *et al.* (1998) and C.B. Robinsona, reported that survival of larvae ranged from 69.1% to 88.1% Better survivability in my study area was found for better management.

From my study it was found that the price of hatchery fry was 150-700 Tk. /1000 fry and the wild fry was 800-1300 Tk./1000 fry in different seasons. (Abtabuddin et .al, 2009) reported that fry commission agents sell wild fry at higher prices than hatchery reared fry. Buyers willingly pay this premium as they believe that the wild fry have higher survival rates.

It is found that technical knowledge of the nursery operator was found very poor. Some of the nurseries had technician but most of them had no institutional knowledge. They had no formal training on the subject. They were doing on the job on the basis of their empirical knowledge that they were achieved through observation. They were instances of failure of diagnosis diseases and as result often mortality occurs in the nursery with consequent loss in venture. Marketing system is not good.

CHAPTER SIX

CONCLUSION AND RECOMANDATIONS

Chapter-6

Conclusion and Recommendations

Bangladesh is a populous country. So the demand of shrimp products is increasing day by day. We earn many foreign exchanges every year from the fishery sector. Bangladesh is trying hard to increase the shrimp fry production as well as shrimp productions. To increase the productions we must increase the production of good quality fry. If the fry quality is not good more fry will be discarded and production will be low. But the technology in our country is not good and management systems are very poor. There are some factors that act as a barrier in nursery management at this region. Such as, lack of credit facility, lack of technical knowledge and modern equipment, hazardous transportation process of fry, lack of policy etc. So we will be sincere to improve technology and worked on nursing system to find out the problems and then we have to solve that. If it is possible to remove these problems of this sector, the survivability of the fry will increase and the production of shrimp will also increase. To solve the problems we have to be done-

- We should improve the management systems of the nursery to increase the production of fry.
- The Government should give special attention in providing proper training and credit support for the development of the sector.
- We have to improve modern culture techniques to get maximum productions.
- It is needed to establish more good quality nursery.
- It is needed to improve the transportation systems.
- We have to improve the training and credit facilities for nursery owners.

CHAPTER SEVEN

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Chapter-7

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APPENDICES

APPENDIX-A

Questionnaire

General information:

1) Name of the farmer:

2) Address of the farmer: ----------

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3) Number of pond: ----------

a) **No. of owned----------**

b) **No. of shared----------**

c) **No. of leased----------**

4) Cost of leasing pond----------Taka

5) Area of water: □--------(ha) □---------(m)

6) Duration of culture period: ----------

7) How long has been doing the business? ----------

8) Culture System: □ Mono □ Poly

9) If poly which species are cultured:

a)----------

b) ----------

c) ----------

d) ----------

10) Physical condition of the pond:

- **Condition of dyke--------**
- **Water colour----------**
- **Water depth----------**
- **Aquatic weed □ present □ Absent**
- **Types of bottom soil: □ Loamy □ sandy loam □ clay loam □ clay**

Pond preparation:

11) Do you remove aquatic weed from your pond? □ Yes □ No

If yes, cost of labor---------- Taka.

12) Do you repair the dike and canal of your ponds? □ Yes □ No

If yes, cost of labor---------- Taka.

13) Do you control predator and unwanted species? □ Yes □ No If yes, then how?

□ by drying the pond

□ by using poison & chemicals

□ by netting

14) If drying

- **When----------**
- **Duration----------**

Cost of Pond drying

a) **Machine rent cost----------Tk.**

b) **Fuel cost---------- Tk.**

c) **Labor cost---------- Tk.**

Total Tk.

15) Do you use lime after drying? □ Yes □ No If yes, then

Type	Dose (Kg/dec)	Buying cost (Tk.)	Labour cost (Tk.)	Transport ation cost(Tk.)	Total cost (Tk.)

16) Do you use fertilizer □ Yes □ No If yes

Type	Dose (Kg/dec)	Buying cost (Tk.)	Labour cost (Tk.)	Trans portati on cost (Tk.)	Total cost(Tk.)

17) Source of water-- □ Rain water □ Deep tubewell □ others If Deep tubewell then

a) Machine rent cost----------Tk.

b) Fuel cost---------- Tk.

c) Labor cost---------- Tk.

Total Tk.

18) Do you use poison for controlling predator and unwanted species?

□ Yes □ No If yes,

Type	Dose (Kg/dec)	Buying cost (Tk.)	Labour cost (Tk.)	Trans portati on cost (Tk.)	Total cost(Tk.)

19) Do you control predator and unwanted species by netting? If yes, then

a) Net rent cost----------Tk.

b) Labor cost---------- Tk.

Total Tk.

Stocking:

Species name	Stocking density (no./kg)	Stocking month	Size (cm)	Source	Cost (Tk./Kg)	Transportation cost (Tk.)	Labour cost (Tk.)	Total cost

20) Do you use any feed? □ Yes □ No if yes then

Type	Dose (Kg/dec)	Buying cost (Tk.)	Labour cost (Tk.)	Transportation cost (Tk.)	Total cost (Tk.)
Pelleted					
Rice bran					
Wheat bran					
Oil cake					
Mixed					
Others					

21) Do you check growth rate of your fish? □ Yes □ No if yes then

a) Duration----------

b) Net rent cost----------Tk.

c) Labor cost---------- Tk.

Total Tk.

21) Do you check growth rate of your fish? □ Yes □ No if yes then

a) Duration----------

b) Net rent cost----------Tk.

c) Labor cost---------- Tk.

Total Tk.

22) Feeding frequency----------per day

23) On what basis do you provide feed to your fish?

□ % of body weight □ Age of fish □ According to own desire

24) Feeding time: ----------

25) Do you maintain water quality of your pond? □ Yes □ No if yes then

a) Duration--------

b) Parameter that you maintain:

□ p^H

□ Alkalinity

□ DO

□ Turbidity

26) Please mention the cost for maintaining water quality (if necessary)----------Tk.

27) Do you check growth rate of your fish? □ Yes □ No if yes then

a) Duration----------

b) Net rent cost----------Tk.

c) Labor cost---------- Tk.

Total Tk.

28) Is any disease occurs □ Yes □ No if yes, then what types of measures do you take?

-----29) If you use any drug or chemicals for controlling disease the

Type	Cost (Tk.)

Harvesting :

a) Harvesting size---------

b) Harvesting season----------

c) Gear used----------

d) Net rent cost----------Tk.

e) Labor cost---------- Tk.

Marketing:

30) What size of fish do you think suitable for marketing and why?

31) Where did you sale your fish?

□ Local market □ Upazila market □ District market □ Middle man □ Aratder

32) Marketing cost

a) Transportation cost----------Tk.

b) Labor cost---------- Tk.

Constrains and Problems:

33) What types of Problems do you face during culture?

□ Fry insuffiency

□ High price of inputs

□ Credit insuffiency

□ Low market demand

□ Transportation Problem

□ Marketing Problem

34) Do you take any step to solve the Problem mentioned above?

Cost benefits analysis:

Year	Expenditure	Production in (Kg)	Production in (Taka)	Benefit in (Taka)

35) How do you become interested to come in the business?

36) Do you have any training? ☐ Yes ☐ No if no then do you need any training?

37) Do you have any suggestion for increasing production?

Appendix - B

Table1: Water quality parameter of shrimp fry nursery ponds or tanks

Name of Upazila	Parameter	Number of pond	Sample	Average	Standard deviation
Debhata	*pH*	1	7.5	8	0.408
		2	8		
		3	8.5		
		4	8		
	Salinity	1	8	8.63	0.478
		2	9		
		3	8.5		
		4	9		
	D.O	1	8	8.50	0.408
		2	8.5		
		3	8.5		
		4	9		
Kaliganj	*pH*	1	8	8	0.707
		2	8.5		
		3	8.5		
		4	7		
	Salinity	1	7	8.50	1.29
		2	9		
		3	10		
		4	8		
	D.O	1	8	8.13	0.85
		2	9		
		3	7		
		4	8.5		
Satkhira Sadar	*pH*	1	9	8.50	1.29
		2	10		
		3	8		
		4	7		
	Salinity	1	12	11.25	0.957
		2	10		
		3	11		
		4	12		
	D.O	1	8	7.87	0.853
		2	9		
		3	7		
		4	7.5		

Table 2: Stocking density of fry in different nursery systems

Upazila	Types of nursery	Number of nursery	Stoking density (sq. m.)	Average	Standard Deviation
Shatkhira Sadar	*Concrete tank*	6	8000	8283	183
			8500		
			8200		
			8400		
			8200		
			8400		
	Earthen	4	7000	7375	479
			7500		
			8000		
			7000		
Debhata	*Concrete tank*	6	8500	8683	314
			8500		
			8800		
			8400		
			9200		
			8400		
	Earthen	4	7000	7875	629
			8000		
			8500		
			8000		
Kaliganj	*Concrete tank*	6	8500	8566	136
			8500		
			8800		
			8600		
			8400		
			8400		
	Earthen	4	7000	7750	957
			9000		
			8000		
			7000		

Table 3: Survival rate of shrimp fry in different Upazila

Name of Upazila	Types of nursery	Survival rate (%)	Average (%)	Standard deviation (%)
Debhata	*Concrete tank*	90	94	2.22
		95		
		92		
		94		
	Earthen	85	87	2.2
		86		
		88		
		90		
Kaliganj	*Concrete tank*	98	96	1.7
		96		
		97		
		94		
	Earthen	86	87	2.58
		88		
		90		
		84		
Satkhira Sadar	*Concrete tank*	90	93	2.58
		92		
		94		
		96		
	Earthen	89	83	1.29
		88		
		90		
		91		

Table 4: Cost-benefit analysis of shrimp fry in different Upazila in Satkhira

Upazila	Number of nursery	Cost Tk./sq. m./ thousand fry	Income Tk./sq. m./ thousand fry	Net profit Tk./sq. m./ thousand fry	Average Tk./sq. m./ thousand fry
Debhata	1	200	220	20	29.5
	2	250	275	25	
	3	350	380	30	
	4	450	480	30	
	5	600	630	30	
	6	700	740	40	
	7	1000	1030	30	
	8	800	830	30	
	9	540	580	40	
	10	650	670	20	
Satkhira Sadar	1	800	820	20	26.5
	2	750	780	30	
	3	550	585	35	
	4	650	690	40	
	5	780	800	20	
	6	675	700	25	
	7	570	590	20	
	8	525	550	25	
	9	240	265	25	
	10	370	395	25	
Kaliganj	1	1000	1020	20	34.5
	2	620	650	35	
	3	450	490	40	
	4	540	580	40	
	5	600	650	50	
	6	1050	1100	50	
	7	230	265	35	
	8	590	520	30	
	9	460	480	20	
	10	560	585	25	

PHOTO GALLARY

PHOTO GALLARY

Fig: Equipment of harvesting

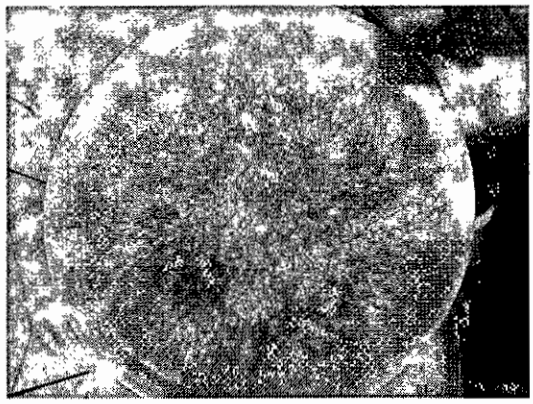

Fig: Fry of shrimp in bowl

Fig: Fry of shrimp in bowl

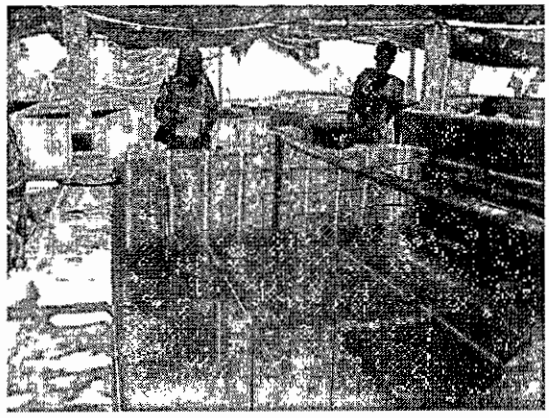

Fig: Nursing tank of fry

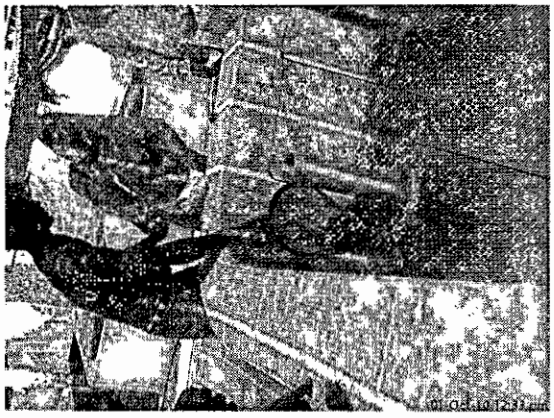

Fig: Harvesting of fry

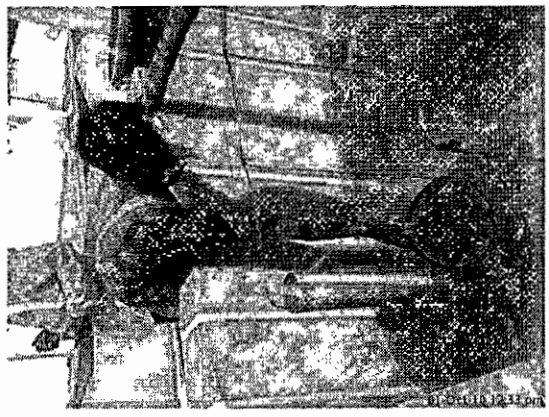

Fig: Harvesting of fry