ECONOMIC EVALUATION OF TRADITIONAL SHRIMP FARMING IN THE SOUTH WEST REGION OF BANGLADESH

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Declaration

Economic evaluation of traditional shrimp farming in the south west region of Bangladesh

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, 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 M. Sc. in Fisheries.

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Suman Kumar Roy
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Abstract

Traditional coastal shrimp farming is nearly a half-century old practice of the coastal people of Bangladesh. Generally traditional or extensive culture system is followed widely. In the south-west costal region i.e. Bagerhat, Khulna and Satkhira district shrimp culture is based on saline water. Main species cultured here is (*P. Monodon).* Main culture period is January to July/August. Farmers have flow of income from shrimp production over 8–9 months in a year. Farmers stock more or less 5 times in a year. Most of the farmer stock hatchery PL because of low cost. The items of cost are mainly establishment and repairing, fingerlings (seed), liming, fertilizer, feed, fuel, labor and rent. The other input costs including lime, cow dung, urea, TSP, Khail (oil cake) and feed etc. The fixed costs for the extensive farming systems have been calculated as Tk. 19172.61 per ha while the variable costs is Tk. 86048.09 per ha per year. Average production per ha per year is calculated in for the year 2006 was 226.67 kg per ha per year and average income was tk. 164352.37 per ha. Average net return calculated was Tk. 59131.67 per ha. The benefit-cost ratio is 1:1.68 and the breakeven yield per ha per year is 258.83 kg per ha. Still now the shrimp sector has the opportunity to develop and if the production can be increased and quality can be ensured foreign earnings will increase within a very short period of time. Joint collaboration of private, Government and NGO sector is essential in this case of technology development and implementation, supply of finance and better management practice. Farmers have a chance to increase the profitability 3 to 5 times by improving culture system and introducing better management practices.

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List of Abbreviations and non-English Words

ATDP-II	Agro-based Industries and Technology Development Project, Phase-II
BFRI	Bangladesh Fisheries Research Institute
BMP	Better Management Practices
BSFF	Bangladesh Shrimp and Fish Foundation
DDP	Delta Development Project
DFID	Department for International Development
DOF	Department of Fisheries
GOB	Government of Bangladesh
ha	Hectare
NGO	Non-Government Organization
SSOQ	Shrimp Quality Support Project
TSP	Triple Super Phosphate
USAID	United States Agency for International Development
WSSV	White spot syndrome virus
TSV	Taura syndrome virus
YHV	Yellow head virus

CHAPTER ONE

INTRODUCTION

Chapter 1

Introduction

Shrimp cultivation has a long and largely quiet history in Bangladesh since its introduction the early 1970's. However its rapid growth over the last two decades has resulted in growing controversy. While its supporters see it as a valuable means of generating foreign exchange that makes good use of Bangladesh's comparative advantage, its detractors point to environmental damage, social disruption and domestic inequalities that result from efforts to service the demand for shrimp in Western consumers (Dutta, 2006).

The impact of shrimp farming has now become emotive, often with a corresponding lack of objectiveness. In order to contribute to the debate in a more scientific manner, a number of studies relating specifically to the shrimp sector have been conducted by BCAS and staff from the FFP shrimp cell 7. These studies have generated extensive amounts of information, but were not intended to specifically examine the costs and benefits of shrimp farming in detail and this study was therefore commissioned to address these issues in more detail. The study has used the extensive amounts of literature already available, data from the shrimp sector studies already undertaken by BCAS and the FFP, information provided by relevant Ministries, and results from a limited amount of additional field work (Dutta, 2006).

1.1. Background of the study

In the zone coastal of Bangladesh, the rivers discharge an enormous quantity of fresh water and maintain a level of salinity both on land and in sea that favours the rapid growth of a wide variety of vegetation and aquatic life. The coastal region, especially the southwestern portion (Satkhira, Khulna and Bagerhat), is one of the most promising areas for shrimp cultivation for two major reasons (MOFL, 1997; Karim and Shah, 2001) first, its fresh- and saltwater resources are abundant in almost all seasons; second, the world's largest continuous mangrove forest, the Sundarbans, provides a food source and nursery for the offshore fishery.

Agriculture is also a major sector of Bangladesh's economy and the coastal area of Bangladesh is very fertile for growing rice. Increase in salinity intrusion and increase in soil salinity will have serious negative impacts on agriculture. The presently

practiced rice varieties may not be able to withstand increased salinity. The food production does not seem to have a better future in the event of a climate change (Ali, 2001).

The shrimp species cultured in Asian countries belong to the family Penaeidae; genera *Penaeus* and *Metapenaeus*. Among the dozen species of these genera, *Penaeus monodon*, *P. japonicus*, *P. merguiensis*, *P. indicus*, *P. orientalis* and *Metapenaeus ensis* are the important ones. However there are more than 26 shrimp species, 10 are commercially important (Alam S.M.N 2004). The main cultivated species are Tiger shrimp *(Penaeus monodon)* in barckishwater ghers. The traditional or extensive shrimp production system is referred to as the "*Bheri*" or pond method which is known as "*ghers*" (farms). Usually the *ghers* are connected to rivers and canals through channels and sluice-gates allowing farmers to manage the flow of brackish or tidal water in to their ghers (Dutta, 2006).

Known as tiger or jumbo tiger shrimp, *P. monodon* is the most common or well known species in Southeast Asian countries. In ponds, fry of 3 cm in length have been grown to a size of 75 to 100 g in five months at the stocking density of 5000 per hectare(Alam S.M.N 2004). In 1974 Forsters was able to grow them to 25 g in 16 weeks in a tank stocked at 15/m^2 (Kungvankij P., 1984). Kungvankij (1976) grew them to 42 g in 210 days in earthen pond. Liao (1977) grew them to 35 g in three months in tanks stocked at 15/m^2. It is euryhaline and grows well in salinity range of 15–30 ppt. Presently, the major source of fry for stocking still comes from the wild but the supply is sparse. Although several hatcheries have been established notably in the Philippines, Taiwan and Thailand, fry production is not steady due to the dependence on spawners caught from the wild which is difficult to obtain in sufficient numbers (Alam S.M.N 2004).

The total fish production in Bangladesh in 1996 was 1.264 million MT, contributing 5% in GDP and 16.67% in the gross value of agricultural products. Total export earnings from the fisheries sector amounted to 13,400 million TK in 1996 of which 11,000 million TK came from shrimp. It has been estimated that more than 380,000 people are directly or indirectly involved in the shrimp culture industry. This industry provides direct employment opportunities to some 350,000 people and employment to approximately 25,000 - 30,000 people involved in provision of equipment, lime,

fertilizer and feed suppliers and infrastructure developers. In addition to shrimp culturists, direct employment opportunities include shrimp fry collectors, nursery operators, fry transporters and depot operators (Siriwardena, 1997).

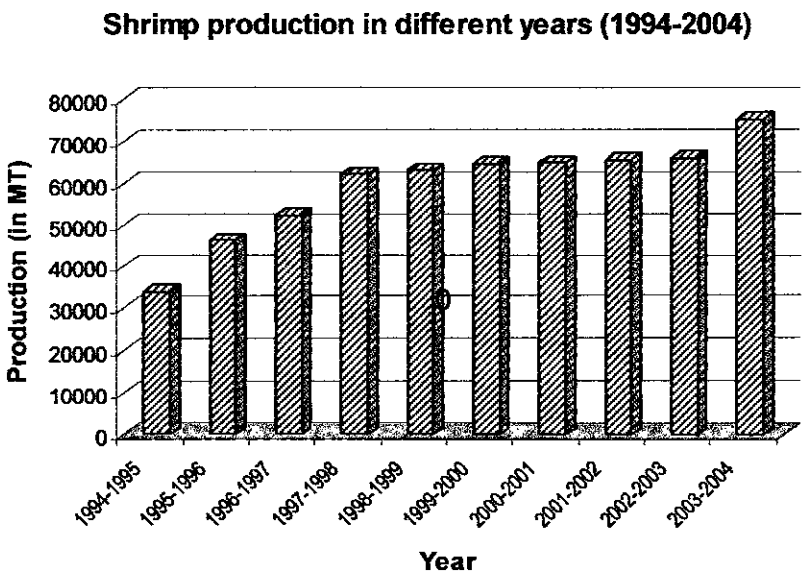

Figure 1. Annual Shrimp Production in Bangladesh (1994-2004)

Source: DOF Fishery Statistical Yearbook of Bangladesh, 1999-2000.

The main growing season is from January to July/August during the wet season when salinity levels are high enough to support shrimp growth. Farmers are usually stock shrimp fry in January although some farmer stock shrimp fry in November and December. Shrimp fry are trapped inside the gher by bamboo barriers that are placed at the exits. The trapped shrimp fry are allowed to grow in the growing period from March to June. During the growing period, farmers sometime change the water as required using the tidal cycles (Dutta, 2006).

In traditional system *Bagda* farms are mostly rice fields converted into shrimp ponds. More than 70 percent of producers cultivate shrimp using traditional farming practices. Farmers typically do not evaluate seed quality, they stock largely without any understanding of optimal density, and pond preparation, and fertilization or feeding is rare and often inconsistent (ATDP II, 2005). Ponds are also varying in size from 0.4 to 200 ha with irregular shapes, mostly a peripheral ditch or canal of 4-10 m. wide and 40-80 cm. deep. The pond bottom may not be properly leveled. Ponds are normally filled with gravity flow water during the high tide period with natural seeds and left for 60-90 days, without additional fry stocking and feeding (ATDP II, 2005).

Traditional shrimp farms use a one-phase or two-phase production process. In the two-phase process, juvenile shrimp are first stocked in nursery ponds before being transferred, several weeks later, to grow-out ponds. In the one-phase process nursery ponds are eliminated. In Bangladesh only one crop is produced, the main reason being the lack of saline water during part of the year. This form of production developed in the coastal area because there had adequate water salinity year-round and largely stable temperatures, an abundance of shrimp fry (post-larvae), and readily available and cheap labor.

In the early stages of development shrimp fry (along with other unwanted species) were trapped inside temporary coastal embankments erected by local farmers. In the early 1960s, this practice died out when the Coastal Embankment Projects in collaboration with the Government constructed a large number of coastal embankments (*Polders*) to protect agricultural land in the coastal areas from tidal waves and saline water intrusion. Since the 1970s, strong international market demand and high prices for product have encouraged farmers to resume shrimp farming within the embanked areas. During this period, farmers switched from traditional methods to selective stocking of shrimp fry. Initially shrimp farming was restricted to the peripheral land between flood embankments and the main river systems. However, large profits and poor land-use planning led to its rapid and uncontrolled expansion, particularly in the south west, into land that was primarily used for rice cultivation (Karim, 1986).

Shrimp farming is Bangladesh began to expand rapidly during the mid 1980s (Alauddin and Hamid, 1996). The government of Bangladesh recognized shrimp farming as an industry under the Second Five-Year Plan (1980–85) and adopted measures necessary for increased shrimp production (Haque 1994). Shrimp farming area also has increased from 64000 ha in 1989-1990 to 170000 ha in 2003, with the number of shrimp farms increasing from 10300 in 1998 to 40000 in 2003 (DoF 2002; Nuruzzaman and Muniruzzaman 2003) and earned about US$ 322 million during 2000-2001 exporting fish and shrimp 80% of which was from the export of shrimp alone (DoF 2001).

1.2. Problem Statement

Shrimp aquaculture expanded significantly during the 1980s and now represents a multi-billion dollar a year industry. In 2002, the global shrimp farming industry produced an estimated 1.6 million metric tons of shrimp, and production is projected to increase at a rate of 12-15% per year over the next several years (Rosenberry 2003). Although farmed shrimp now represent about 50% of the global penaeid shrimp supply, farmers have suffered significant economic losses over the last decade, largely from viral diseases that have plagued the industry. In Asia, mortalities of cultured shrimp due to White spot syndrome virus (WSSV) and Yellow head virus (YHV) have resulted in significant economic losses (Flegel and Alday-Sanz 1998), and Taura syndrome virus (TSV) is now spreading throughout this region (Rosenberry, 2000).

Increased water temperature and salinity may not be suitable for many species. Sea level rise, by reducing the fresh water fishing area, will cause reduction in fish production. Pond culture in the coastal area will be affected by intrusion of salt water into ponds. Shrimp farming in the coastal area is a lucrative business. Increase in salinity is likely to jeopardize the shrimp farming. For the last few decades, more attention is being given to sea fish and brackish water fisheries. But due to horizontal growth of brackish water shrimp farming in the coastal region of Bangladesh this sector will feel a greater problem very soon (Ali, 2001).

In Bangladesh the traditional shrimp farmers use their huge potentiality for the better production but due to proper scientific technology, management, accessories facilities the farmers do not get actual benefit. The farmers use various cost such as feed cost, seed cost, fertilizer cost, labour cost and others accessories cost bur get less return. That is also a great problem of the traditional shrimp farmers of our country.

Most of the shrimp culture being practiced is by the extensive and improved extensive methods, known as *gher* culture. In the *gher*, the sluice gates are opened from February to April to allow the entry of saline water. It is estimated that about 250,000 ha of land has good potential for coastal aquaculture (Ahmed, 1995). Of that, about 180,000 ha are suitable for shrimp culture (Khan and Hossain, 1996). Coastal aquaculture increased from 20,000 ha in 1994/1995 to 135,000 ha in 1996/1997, and production from 4000 to 35,000 metric tons in the same period (MOFL, 1997). The

rapid expansion of shrimp farm development during the last decade, along with the adoption of extensive and improved extensive culture techniques, has caused growing concern as to its adverse effect on the coastal environment and damage to the traditional agricultural systems.

The economics of shrimp cultivation is investigated in some detail, looking at the returns in different are as and for *gher* managers from different land holding classes, and the distribution of the net returns from these activities. It then evaluates the possible impacts of shrimp cultivation within the wider community by making comparisons between villages with and without shrimp cultivation: first, through the consideration of perceptions of change within a large number of villages; and then, on a more limited scale, through more detailed analyses of incomes.

The existing literature on shrimp in Bangladesh mainly focuses on shrimp farming areas rather than on the industry as a whole or farm production system. A few researches are conducted on production system but it partially represents the system evaluation. Another general problem of reviewing the literature on economics of shrimp production is that the available literature does not describe costs and benefits on traditional farming system basis. In most cases, the costs are aggregated and these are not shown as input cost, establishment cost and cost for construction and equipment. Considering the problem this study is designed for conducting a systematic evaluation of performance of the traditional shrimp culture system.

A number of studies on traditional shrimp farming show production, cost and benefits in an inconsistent manner. This study will follow a well developed procedure to assess this information in a more accurate way.

1.3. Objective of the Study

The main objective of this study was to evaluate the economic return from traditional shrimp farming system practiced in the region. The specific objectives were-

- To assess some aspects of socio-economic profile of the traditional shrimp farmers.
- To estimate production rate, and costs, net returns and profitability from traditional shrimp farming.

CHAPTER TWO

REVIEW OF LITERATURE

Chapter 2

Literature Review

2.1 Literature Cited on Traditional Shrimp Culture System

In the performance evaluation of traditional shrimp farming in the south western region of Bangladesh Dutta (2006) stated that the south-west costal region is based on saline water. The main species cultured here is *P. Monodon.* He reported the culture period is January to July/August and most of the farmer stock hatchery PL because of being low cost. The items of cost are mainly establishment and repairing, fingerlings (seed), liming, fertilizer, feed, fuel, labor and rent. The other input costs including lime, cow dung, urea, TSP, *Khail* (oil cake) and feed etc. The fixed costs for the extensive farming systems estimated at Tk. 24976.86 per ha while the variable costs is Tk. 58024.90 per ha per year. He calculated average production per ha per year is calculated in for the year 2005 is 257.67 kg per ha per year and average income was Tk. 85934.32 per ha per year. Average net return calculated is Tk. 2932.56 per ha per year. The benefit-cost ratio is 1:1.04 and the breakeven yield per ha per year is 257.67 kg per ha per year. Farmers have a chance to increase the profitability 3 to 5 times by improving culture system and introducing better management practices.

Islam *et al.* (2005) found that coastal shrimp (*Penaeus monodon*) aquaculture in Bangladesh is mostly practiced in a special type of field/pond situated by the side of a river -- called a Gher – that is used to cultivate rice in winter and shrimp in summer. Ghers of different sizes are managed in different ways. The mean harvest weight of shrimp was similar in all Ghers, but survival rates were higher in the small (50%) and medium (37%) ones than in the large (18%) ones. The high mortality in the large units led to a production that was lower than one-half of that in the small Ghers (about 80 and 200 kg/ha, respectively). The importance of different items varied with Gher size. In the small Ghers, there are relatively high investments on inputs and labor. This expenditure results in lower shrimp mortality and higher production, which in turn results in gross returns that are larger than the total costs – hence, a positive and high net return. In large Ghers, the fixed costs are larger than in the small ones simply because of the size of the pond. Variable costs include higher investments in post larvae and labor than in small Ghers, and lower inputs applied only at pond

preparation. This results in higher shrimp mortality and lower production, which in turn results in gross returns that are smaller than the total costs – hence, a negative or low net return.

ATDP II (2005) estimates low productivity in traditional shrimp culture, ranging from 250 to 350 kg per hectare per year in the south western region of Bangladesh. Despite the low levels of inputs, costs per hectare are not insignificant and include rent or imputed rent as well as labor costs. Traditional methods incur estimated costs of almost 60,500 BDT per hectare per year. Average returns range from between 14,500 and 44,500 BDT per hectare.

Islam *et al.* (2003) studied the impacts of shrimp farming on the socioeconomic and environmental conditions in the coastal regions of Bangladesh, traditional shrimp farming system in Paikgacha per hectare total cost, gross income and net return were Tk. 47,779, 125,005 and 77,226, respectively and per hectare production of shrimp was relatively higher (275 kg). In Shamnagar of Satkhira offered gross income of Tk. 125,005 per ha and net return of Tk. 77,226 per ha. But gross income (Tk. 107,235 per ha) and net return (Tk. 62,300 per ha) from alternate shrimp-rice farming were relatively low.

While comparing the economics of shrimp farming in Asian countries, Ling et al (2001) reported the production rate from traditional farming system in Bangladesh at 216 kg/ha. They estimated the fixed costs for the extensive farming systems at US$ 1.34/Kg including overhead (US$ 0.99) and depreciation (US$ 0.35) costs. They also estimated the variable costs (US$ 2.73/Kg) including seed, feed, labor, power etc. The seed cost alone was estimated at 43.5% of the variable cost. The total cost, farm gate price and net return were estimated at US$ 4.07, 6.90 and 2.83 per kg respectively.

Shah *et al.* (2001) reported the net benefit in *P. monodon* farming at US$ 1.0/Kg from Bangladesh while it was US$ 2.0/Kg in other Asian countries (Thomas *et al.*, 2001; Ling *et al.*, 2001).

Thomas *et al.* (2001) in their recent study examines the distribution of costs and benefits of shrimp farming. The principal cost for production was for shrimp fry (at

about US$ 273 per ha.) followed by labor cost for maintenance and construction, guarding, pond cleaning, harvesting and preliminary processing of shrimp (US$ 91 per ha.). The other input costs including lime, cow dung, urea, TSP, *Khail* (oil cake) and feed etc. was very low i.e., US$ 18 per ha. The total cost per ha per year was US$ 700. The averages gross return/benefit from shrimp farm per ha for all categories were US$ 1041 which ranges between US$ 1000 to US$ 1145. The net income was US$ 2.6 per kg. The total production of tiger shrimp (Bagda) in 2000-2001 was 32,424 metric tones in Bangladesh.

Nuruzzaman *et al.* (2001) also reported higher yields of shrimp and higher profits in smaller Ghers relative to large Ghers in several regions of Bangladesh. They attributed their results to small ponds being better manageable. Their corresponding yields in small (1-2.5 ha) and large Ghers (>25 ha) were 189 kg/ha per year and 122 kg/ha per year in Khulna district, 221 kg/ha per year and 74 kg/ha per year in Bagerhat district.

Shah *et al.* (2000) shows that per ha/year production of Bagda (*Peanous monodon*) had been 129.58 kg. The average cost per acre/year was Tk. 15360. The items of cost included establishment and repairing, fingerlings (seed), liming, fertilizer, feed, fuel, labor and rent. The shares of fingerlings, rent and labor were 60%, 22% and 12% respectively. The rest 6% cost was for feed and fertilizing. The total annual farm income from shrimp and other fish was US$ 307 per acre/year excluding crop value. The annual gross income from black tiger shrimp was US$ 5.8 (BDT 348) only per kg. The net benefit from shrimp has been about US$ 0.80 (BDT 48) per kg only.

According to BFRI (1999) average production per hectare was 178.59 kg, total return was Tk. 98500 and cost per ha was 36000. Net benefit was 62500. Corresponding cost benefit ratio was 1:2.73. The Department of Fisheries estimates that in the year 2003 there are approximately 203,071 hectares of coastal shrimp farms producing an average of 75,167 metric tons of shrimp annually and an average of 370 kg/ha/year. Earning in excess of US$360 million annually and accounting for 4.9 percent of exports in 2004.

Uddin (1998) and Ling *et al.* (2001), reported per hectare net returns for traditional shrimp culture of Tk 35,600 and Tk 35,500 respectively per year which are very close

to those of the present findings of 37000 tk/ha. Rahman *et al.* (2001) recorded an annual income from shrimp farming of 40200 Tk/ha, which is higher than the present findings.

In Bangladesh most of the farmer (> 90%) practice traditional or extensive shrimp culture systems, which is characterized by a large-sized *Gher* from 0.4 to 200 ha, water depth of 60 cm, low stocking density, no feeding and fertilization and poor management of water quality with irregular in shape and bottom topography. Average pond size in this shrimp culture method is 1.3 ha. Farmers' generally stock wild and hatchery fry at a density of 3.5 per square meter. Traditional farming depends of natural feed and a few farmers use fertilizer occasionally (ATDP II 2005).

Alam and Phillips (2004) stated that the extensive culture systems characterized with low input use, leading to low productivity levels in southwestern region of Bangladesh. The different farm management practices were noticed among the different categories of farm ownership. The average farm size varied among individual (2.28 ha), group (4.59 ha), and outside lessee (19.56 ha). The production systems include multistock and multiharvest throughout the year. Inputs provided into the pond with an average depth of 0.7 m water were mainly limited to improper ratio of lime, cow-dung and fertilizer. All the categories maintained an average stocking density of 1.7 fry m^2 for *Penaeus monodon*. The outside lessee stocked less quantity and achieved higher survival rate than the other two categories. Due to disease prone each category achieved variable yield. The individual and group farmers preferred other shrimp and finfish in the shrimp farming systems to increase biomass and to avert the risk of diseases while the outside lessee concentrated on *P. monodon* culture. Poor disease control mechanism prevailed in the area.

The control of diseases (and pests) through the use of chemicals should be a last resort only after environmental conditions, nutrition and hygiene have been optimized (GESAMP, 1998). Chemicals used should be safe to the cultured crop, farm staff, environment and consumer. Farmers should avoid prophylactic treatment, apply effective and narrow spectrum anti-bacterial, adopt withdrawal periods and avoid discharge of effluents with toxic chemical levels into natural water bodies (GESAMP, 1998).

Farmers had flow of income from shrimp production over 8–9 (from January to July/August) months in a year. Usually higher production obtained in the month of November-February when salinity was higher but in the rainy season per unit production declined due to low salinity (Karim 2003).

Ling *et al.* (2001) described different physical feature of the farming system. According to him the average farm size is 16.6 ha, average stocking density is 1.5 PL/m^2, and more or less 1.2 crops per year are gained. But Karim and Stellwagen (1998) found that in traditional system shrimp ponds varying in size from 0.4 to 200 ha with irregular shapes, mostly a peripheral ditch or canal of 4-10 m. wide and 40-80 cm. deep. Stocking density in this type of culture is 0.5-5.0 pcs/m^2. The ponds are normally partially harvested.

According to BFRI, farmers use natural (80%) and hatchery (20%) PL. Average stocking density is below 1/m^2. Framers use a few lime and fertilizer but use no feed. They do not follow other technique for enhance growth or prevent disease too. Adult shrimp are harvested by cast net in every lunar cycle (BFRI 1999).

CHAPTER THREE

MATERIALS AND METHOD

Chapter 3

Materials and Method

3.1 Study Area:

The study was concentrated on the south western region of Bangladesh. The north side of Bagerhat and some part of Satkhira districts were covered for the study. Forty (40) traditional shrimp farm were surveyed from Bagerhat district and forty gher were surveyed from Satkhira district in different Upazillas. Six upazilla were surveyed in total (four from Bagerhat district and two from Satkhira district). And the selection process of the farm were random under this study.

3.2 Data Source

The data collection for this report included a series of key informant interviews using a structured questionnaire with gher owners or with fish farmers to elicit information about wages, prices, profits, productivity, variable cost, fixed cost, training information and also the disease information.

Secondary information is taken from different aquaculture related journals and research articles. Data are also collected from different internet sources.

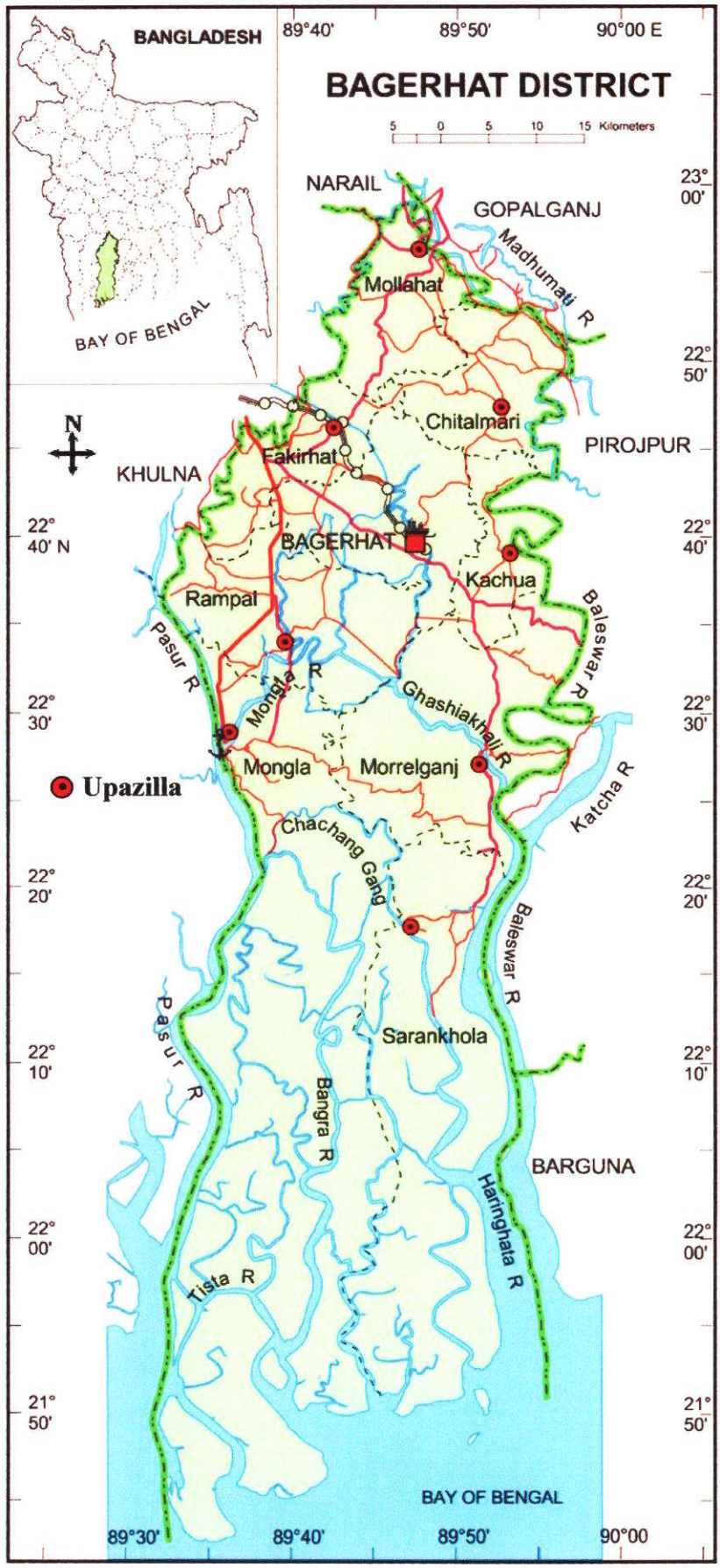

Figure 2. Map of Bagerhat District.

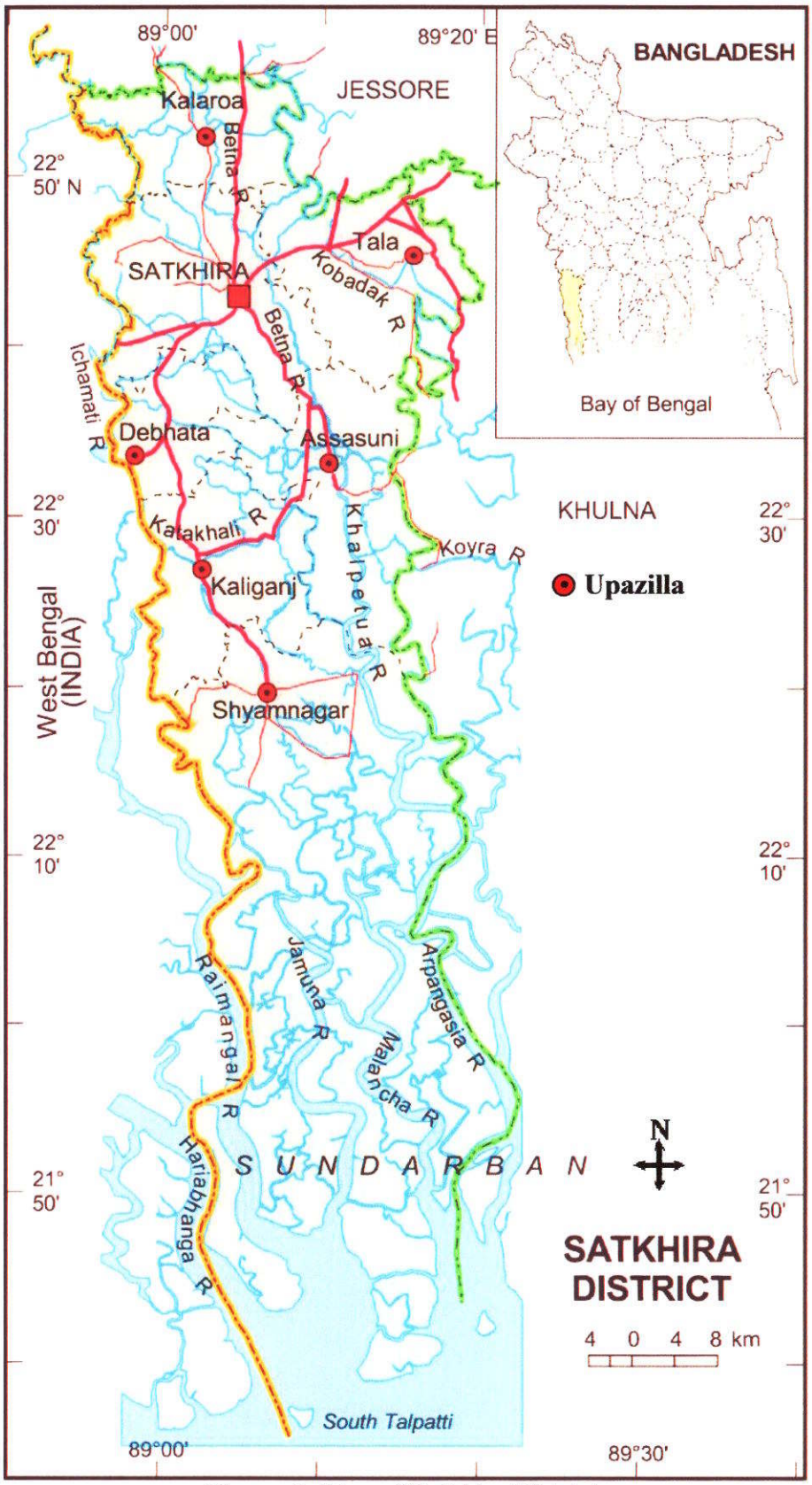

Figure 3. Map of Satkhira District.

3.3 Tools and Technique Used

Through the survey questionnaire eighty (80) traditional shrimp farmers and their traditional gher were surveyed. The farmers were selected randomly from Bagerhat and Satkhira districts. Sample of the survey of the study are shown in table 1.

Table 1. No. of farms and area of the shrimp culture of the study area

District	No. of farms	Area (ha)
Bagerhat	40	28
Satkhira	40	35.43
Total	80	63.43

Data were entered and analyzed using MS-Excel. Socioeconomic profile of the farmers examined were age and schooling years of the farmers, percentage of farmer received training and training days, total land owned by the farmers and total pond area owned. Total cost is divided in two categories- fixed cost (Rental value, pond excavation, repair cost, equipment and accessories cost- shed, harvest equipments etc.) and variable cost (seed, feed, labor- permanent, hire, input- chemicals, lime, bleaching, fertilizers, other costs- icing cost, transport cost, harvest cost, interest cost etc.). Rental value was calculated for one year. And other fixed costs were also calculated for one year also. While calculating the equipment cost, the economic life and the equipment shared between how many farms was considered. All calculation (harvest, cost, income) was done on a per hectare per year basis. For simplification of the calculation this study follows Karim *et al.* (2005).

Gross margin is calculated by subtracting the variable cost from the gross income. Net benefit was calculated as gross income minus gross (Fixed and Variable cost) cost. Benefit cost ratio and break-even yield for traditional shrimp farming were also estimated.

CHAPTER FOUR

R E S U L T S

Chapter 4

Result

4.1 Socioeconomic Profile of the Farmers

Of the total farmers surveyed on average farmers were 34.14 years old and had 9 years of formal education. Among 80 farmers only 5% farmers received formal training on shrimp and fish culture and average duration of formal training was 12 days, while the minimum and maximum period of training were 4 days and 30 days respectively. Department of Fisheries and different non-government organizations such as Eon group, Quality fish feed etc. provided the training.

Table 2. Overall socio-economic profile of the farmers (n= 80).

Socio-economic variable	Mean	Min	Max
Average age of the farmers (years)	34.14	18	50
Level of education (years of schooling)	9	0	16
Percent of farmers received training on shrimp/fish farming	5	-	-
Average days of training received	12	4	30

Besides the above mentioned criteria, in socio-economic statistics there are also included some sequences. Such as occupational status of the farmers, land use pattern of the farmers, household income pattern of farmers, year wise income distribution of the farmers, demographic information of the farmers, status of family size with respect to age, status of income with total land and farm areas.

4.1.1. Occupational Status of the Farmers

The main income sources of the farmers are divided into various categories. Among 80 farmers the main occupation of the respondents was shrimp culture (about 69%). Rest of them possessed agriculture (9.5%) and business (9.5%). A very few of them were student, service holder and housewife. Detail results are given in Figure 4.

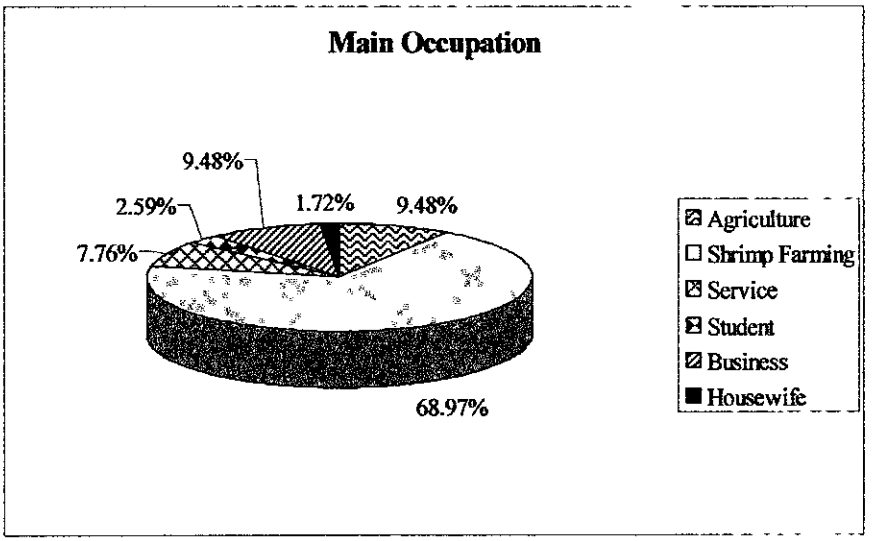

Figure 4. Main occupation of the Traditional shrimp farmers.

4.1.2 Household Income Pattern of Farmers

Above 90 percent of the household income was derived from fisheries and agriculture related activities (Figure 4). Income from Bagda shrimp represented 49 percent of the total household income and 78 percent of the total fish income. Other household income comes from *golda*, whitefish, other shrimp and crabs, poultry and crops. The actual scenario is simplified in the following figure (figure 5).

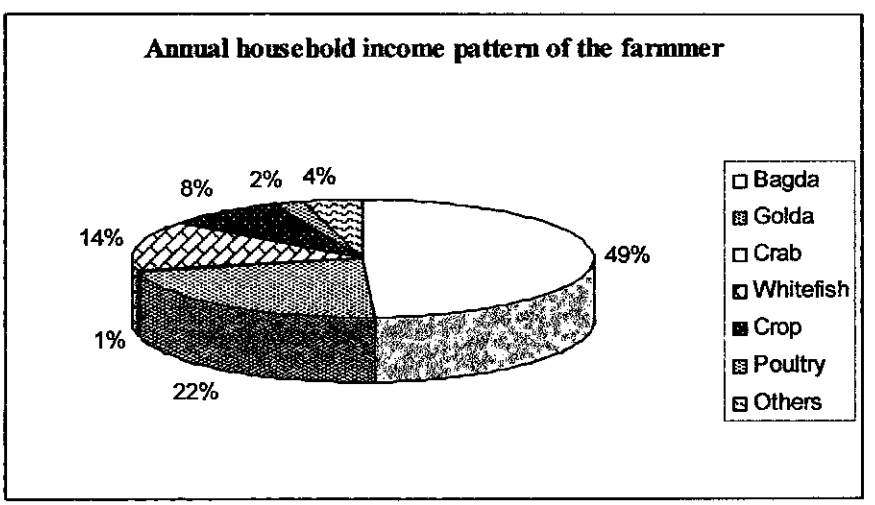

Figure 5. Annual household income pattern of the farmer.

4.1.3 Year Wise Income Distribution of the Farmers

In the Bagerhat district the income fluctuation of the farmers were very high and about 48% farmer's year wise income was in the range Tk. 100001-500000 in the year of 2006. Whereas, in Satkhira district, about 63% shrimp farmers earned 100001-500000 Tk. in the year 2006. Here table 3 shows the year wise income pattern of the farmers.

Table 3. Total income distribution (District wise).

District	Income	Frequency	Percent	Cumulative Percent
Bagerhat	≤100000	9	22.5	22.5
	100001-500000	19	47.5	70.0
	500001-1000000	8	20.0	90.0
	1000001-1500000	3	7.5	97.5
	> 2000000	1	2.5	100.0
	Total	40	100.0	-
Satkhira	≤100000	15	37.5	37.5
	100001-500000	25	62.5	100.0
	Total	40	100.0	-

4.1.4 Demographic Information of the Farmers

In the Bagerhat district on average the family size of the farmers were 5.5, the average age of the farmer was 33 years. The male and female ratio is 120:100 here. On the contrary, in Satkhira district the family size of the farmer was 5 and the average age of the farmer was 35 years. Here the male and female ratio is 122:100. The actual scenario is shown in the following table (Table 4).

Table 4. Demographic information of the shrimp farmers.

Name of the district	Bagerhat	Satkhira	Total information
No of respondents	40	40	80
Average family size (person)	6	5	5.5
Average age (in year)	33	35	34
Average schooling (year)	9	8	9
Total no of male	103	82	185
Total no of female	86	67	153
Male and female ratio	120:100	122:100	120:100
Child Male	15	25	40
Child female	17	23	40
Child Male/ child female	88:100	108:100	100:100

4.1.5 Status of Family Size With Respect to Age

Of the total farmers in the Bagerhat and Satkhira districts combined, the medium sized family (4 to 6 person) was higher level than the others (48%). Some family also contained the above 10 members around (9%). In the cross status, the shrimp farmers with the age variation 26 to 45 year found in higher percentage (76%) the Bagerhat and Satkhira districts combined. In the following table (Table 5) the status of family size in respect to age is shown.

Table 5. Status of family size in respect to age.

Family size (no)	Age of the farmers (yr)								Total	
	15-25		26-35		36-45		≥46			
	f	% f	f	% f	F	% f	f	% f	f	% f
1-3	5	6	9	11	7	9	1	1	22	27
4-6	6	8	13	16	16	20	3	4	38	48
7-9	2	3	5	6	5	6	1	1	13	16
≥10	1	1	4	5	2	3	0	0	7	9
Total	14	18	31	38	30	38	5	6	80	100

4.1.6 Land Use Pattern of the Farmers

Farmers owned on average 1.84 ha of land. Average land under aquaculture was 1.84 ha. Among this 0.01 ha was rented in and 0.03 ha was rented out and 1.06 ha was leased in and 0.74 ha was leased out. Table 6 represents details of land using pattern of traditional farmers.

Table 6. Overall Land ownership Pattern of the farmers.

Category	No. of Demonstrations Pond	Land Under Aquaculture	Owned (ha)	Rented in (ha)	Rented out (ha)	Leased In (ha)	Leased Out (ha)
Total	80	146.86	147.37	0.65	2.73	84.679	59.303
Average pond size (ha)	0.79	1.84	1.84	0.01	0.03	1.06	0.74
SD	0.61	3.49	2.72	0.07	0.17	2.60	2.53

4.2 Shrimp Culture and Production Information

Among the eighty farms, farmers owned on an average of 0.38 ha rented or leased area of their farm. Average farm size was 0.79 ha with an average depth of 71.95 cm. Farms were on an average of 10 years old. Table 06 shows details of farm information.

Table 7. Basic information of the traditional farms.

N=80	Area (Ha)	Av. Depth (cm)	Farm status		Age of pond (years)
			Owned (ha)	Rented (ha)	
Total	63.43	-	33.37	30.06	-
Average	0.79	71.95	0.42	0.38	10
SD	0.61	26.64	0.40	1.16	7.8

4.2.1 Source of Post Larvae (PL)

Among the total farmers, around 50% traditional farmer stocked hatchery post larvae (PL). On the other hand 12.93% farmers stocked wild PL and 36.20% farmer stocked both hatchery and wild PL in their pond. Hatchery PL cost (Tk 180 – Tk 550) was lower than PL collected from the wild (Tk. 200 – Tk 800).

4.2.2 Production Information of the Demonstrated Farm

This study showed the average shrimp production was 226.67 (±190.54) kg/ha/year from the traditional farms in the south west region of Bangladesh.

The average *bagda* production in the Bagerhat district was around 308 kg/hectare with a standard deviation 239.44, while maximum and minimum production found 1131 kg/hectare and 40 kg/hectare respectively. The *golda* production of the district was 236 kg/hectare and white fish production was around 268 kg/hectare. There were different types of white fish cultured in the region and also some undesirable species grow in the farms. In some *ghers* the *golda* species (*Macrobrachium rosenbergii*) was not cultured.

In the Satkhira districts the average *bagda* production was around 145 kg/hectare with a standard deviation 50.33, while maximum and minimum production found 271 kg/hectare and 43 kg/hectare respectively. The average *golda* production of the district was 25 kg/hectare and white fish production was around 172 kg/hectare. There were also different types of white fish cultured here and also some undesirable species grow in the farms. In Satkhira district *golda* species was cultured only in the rainy season. And in some cases, the species was not cultured due to high salinity. The actual figure is shown in the following table (Table 8).

Table 8. District wise production information.

District	Production	Mean	Std. Deviation	Minimum	Maximum
Bagerhat	Bagda production	308.32	239.44	30.95	1131.25
	Golda production	236.43	360.90	0	1837.08
	White fish production	217.69	268.10	0	1190.48
Satkhira	Bagda production	145.02	50.33	43.01	270.57
	Golda production	25.49	29.80	0	118.28
	White fish production	171.50	119.65	0	392.86

4.2.3 Percentage of Return from the Demonstrated Farm

In the Bagerhat district of the total income from the demonstrated farm 53% earning came from *bagda* farming and 32% and 15% earning came from *galda* and white fish farming respectively. On the other hand, in the Satkhira districts around 68% incomes came from *bagda* farming. A very poor percentage (12%) came from *golda* farming due to high salinity. And white fish production is 20% in that region.

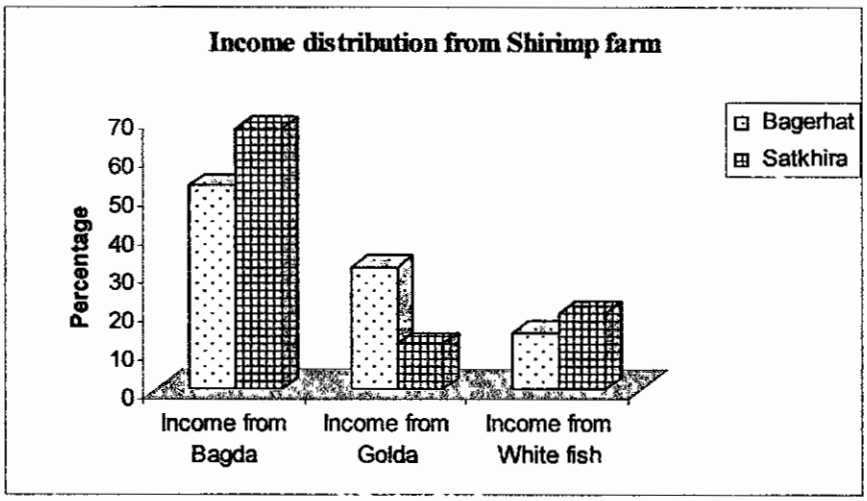

Figure 6. Income distribution from demonstrated farm.

4.3 Economics of Traditional Shrimp Farming

In the economic analysis of the traditional shrimp farming the area of fixed cost (Tk/ha/year), Variable Cost (Tk/ha/year), gross cost, yield (kg/ha/year), average unit price (Tk/Kg), gross return (Tk/ha/year), gross margin, net return, benefit –cost ratio, break-even yield (kg/ha/year) and the no. of farm obtaining negative net return was estimated.

4.3.1 Fixed Cost for Shrimp Farm

Average fixed cost per hectare per year was Tk. 19172.61 (±14938.63). Calculated fixed cost includes average rental value of leased value, average pond excavation/re-excavation cost and equipment cost.

Table 9. Particulars of fixed cost of traditional shrimp farm (Per ha per year).

N=80	Rental Value (Tk.)	Excavation/ Re-excavation (Tk.)	Equipments/ Accessories (Tk.)	Total (Tk.)
Total	1109445.66	288423	135939.58	1533808.66
Average	13868.07	3605	1699.24	19173
SD	15335.03	3413.93	1704.87	-

4.3.2 Variable Cost

Variable cost involves non durable item cost (blue net, wood/bamboo/sticks/branches of trees, harvest trap etc.) fertilizer cost (organic and inorganic), chemical cost, feed cost, seed cost, labour cost, fuel cost and other miscellaneous cost (electric value, pump rent etc). Average variable cost per hectare per year was Tk. 86048.09 (±71650.94). Average production cost in the present study found as Tk. 105220.70 per hectare per year.

Table 10. Particulars of variable cost of traditional shrimp farm (Per ha per year).

Particular features	Total cost (Tk.)	Average (Tk.)	SD
Non durable item cost	417176.29	5214.70	7243.40
Organic fertilizer cost	85504.36	1068.80	1578.81
Inorganic fertilizer cost	89892.80	1123.66	1138.43
Chemical cost	106562.47	1332.03	2714.81
Feed cost	1386161.91	17327.02	25990.30
Seed cost	3622714.60	45283.93	29110.00
Fuel cost	103884.79	1298.56	3432.71
Labour cost	1002064.59	12525.81	20315.03
Other cost	69885.63	873.57	1628.18
Total	6883847.44	86048.09	-

4.3.3 Cost and Return Information per Hectare of Traditional Farming System

Gross average income was 164352.37 (±170783.53) Tk/ha/year with a gross cost of Tk. 105220.70 (±72853.84) /ha/year. Therefore gross margin was Tk. 78304.27 (±123573.43) and net return was Tk. 59131.67 (±124237.01) per ha per year. The benefit cost ratio found 1.68 and the break even yield 258.83 Kg/ha/year. Due to diseases or other environmental causes 19 farm got the negative net return in the study. In the following table total information of Cost and return are accumulated.

Table 11. Cost and return information per hectare of traditional farming system.

No.	Particulars	Average	SD
A	Fixed Cost (Tk/ha/year)	19172.61	14938.63
B	Variable Cost (Tk/ha/year)	86048.09	71650.94
C	Gross Cost (A+B)	105220.70	72853.84
D	Yield (kg/ha/year)	226.67	190.54
E	Average Unit Price (Tk/Kg)	425.37	56.19
F	Gross Return (Tk/ha/year)	164352.37	170783.53
G	Gross Margin (F-B)	78304.27	123573.43
H	Net Return (F-C)	59131.67	124237.01
I	Benefit –Cost Ratio (F/C)	1.68	1.05
J	Break-even yield (C/E) (kg/ha/year)	258.83	-
K	No. of Farm obtaining negative net return	19	-

Of the total sample there was a strong correlation found between percentage of loss and the Shrimp size and the value is 0.8.

Table 12. Pearson Correlations between shrimp size and Percentage of loss.

		Percentage of loss	Animal size
Percentage of loss	Pearson Correlation	1	0.795(**)
	Sig. (2-tailed)	.	0
	N	80	80
Animal size	Pearson Correlation	0.795(**)	1
	Sig. (2-tailed)	0	.
	N	80	80

** Correlation is significant at the 0.01 level (2-tailed).

4.4 Diseases Information

In the southern region most of the shrimp farm was affected due to white spot disease virus. In the total demonstrated farm, around 64% shrimp farm is affected due to white spot disease virus and rests of the *ghers* (around 36%) become unaffected.

4.4.1 Diseases Occurrence

In Bagerhat district in the season 2006 around 45% shrimp farmers stocked shrimp fry in the pond one to three times in a season and affected each stock due to white spot syndrome virus. But farmers of that region got some return from their farm. Because, in most cases the losses due to the virus activity were not extreme (around 50% to 60%). On the contrary, in Satkhira district the stocking frequency of the shrimp farmer was higher (more than 80% farmers stocked over seven times in an individuals farm) and the losses due to the virus activity were extreme. In the following table (table 13) it is shown clearly.

Table 13. Disease occurrences & Stocking information.

Districts			Stocking frequency			Total (in %)
			1-3 Times	4-6 Times	More than 7 Times	
Bagerhat	Infection due to WSSV	1-3 Times	45.0%	25.0%	5.0%	75.0%
		4-6 Times		20.0%	5.0%	25.0%
	Total		45.0%	45.0%	10.0%	100.0%
Satkhira	Infection due to WSSV	1-3 Times		19.4%	58.1%	77.4%
		4-6 Times			16.1%	16.1%
		>7 Times			6.5%	6.5%
N= 80	Total			19.4%	80.6%	100.0%

4.4.2 Disease Distribution and Parentage of Loss Due to Diseases

In Bagerhat district around 50% traditional shrimp farm become affected due to white spot disease virus. Of the affected farm about 10% farm hampered 60% loss due to this viral disease. In Satkhira region, white spot diseases appear very randomly and more than 77% farm affected due to white spot disease. Around 17% farm damage 80% and 15% farm damaged 90% loss due to due to this viral disease of he affected farms in the Satkhira districts. There is another disease in the Satkhira region, which is not yet identified by the farmers. The farmers informed it to the fisheries office of Satkhira district but necessary steps is not taken yet.

Table 14. Disease distribution and parentage of loss due to diseases.

Disease Type		Bagerhat	Satkhira
White spot disease	Damaged due to WSSV	Farm affected due to WSSV (%)	
	50 % loss	7.5%	2.5%
	55 % loss	7.5%	2.5%
	60 % loss	10.0%	2.5%
	65 % loss	2.5%	5.0%
	70 % loss	7.5%	10.0%
	80 % loss	7.5%	17.5%
	85 % loss	5.0%	12.5%
	90 % loss	2.5%	15.0%
	95 % loss	0 %	7.5%
	99 % loss	0 %	2.5%
Not identified		0%	5.0%
No disease		50%	17.5%
	Total	100	100

CHAPTER FIVE

DISCUSSION

Chapter 5

Discussion

5.1 Socioeconomic Profile of the Farmers

A large number of the people of the region were involved in shrimp farming or shrimp oriented business of the south western region of Bangladesh. Some people involved in the shrimp farm as labour due to meet their daily needs. Due to the poverty of the rural people they involved in the business and shrimp farming. And as a result most of them cannot complete their primary or high school education. There is another factor of less education or illiteracy may the consciousness of the rural people. Most of the farmers were non-trained because; they do not get enough facilities for training.

5.1.1 Occupational Status of the Farmers

Due to favorable environmental condition, shrimp farming has been developed as the key/major occupation to most of the respondents. As a result, land use pattern in the region has been shifted from agriculture to shrimp farm.

Dutta (2006) reported that 65% farmers had shrimp culture as main occupation; the rest 13% and 7.5% had agriculture and small business respectively in the SW region of Bangladesh. The variation of this finding from the present study (69%) would be due to sampling method or increase of farmers in shrimp cultivation.

5.1.2 Household Income Pattern of Farmers:

The rural area of Bangladesh is based on agriculture and fisheries. So the maximum income of the rural people comes from the agricultural sector as well as fisheries.

Dutta (2006) stated that 86 percent of the household income was derived from fisheries related activities and income from Bagda shrimp represented 67 percent of the total household income in the south west region of Bangladesh. And there are also some income source such as *golda* farming, whitefish, other shrimp and crabs and crops etc.

5.1.3 Year Wise Income Distribution of the Farmers:

Among the two districts the income of the shrimp farmers in Bagerhat district was higher than the Satkhira districts and the year wise income range was wide. In the Bagerhat district most of the respondents got benefited with their shrimp farm. Here virus or other destructive activities or losses occurred in a minimum context in the year 2006. But this situation may vary from year to year and also from region to region.

In the range at Tk. 100001-500000 (year of 2006) there were about 48% farmers in the Bagerhat district but around 3 % farmer's income more than 2000000 in the year 2006. Whereas, in Satkhira district, about 63% shrimp farmers earn 100001-500000 Tk. in that year. This presented finding may due to the sampling method.

5.1.4 Demographic Information of the Farmers

The family size and the male-female ratio are varied from region to region and also from family to family. The average family size is moderate or medium (5 to 6 members in a family) both in Bagerhat (5 members) and Satkhira district (6 members). In the sampling area most of family was single family so that the findings of the family size (moderate) may due to the single family. Also in the region, presently the family planning activities of Government and Non Government Organizations is increases and the consciousness of the general people increased.

The male female ratio of the farmers in their family was around same in the stated district. In the findings, it found that most of the farmers were middle aged. In the shrimp farming the risk factor always hampered the farmers in the context of Bangladesh and moderate aged people can take the risk and handle it more easily than the others. So that it may a cause.

5.1.5 Status of Family Size With Respect to Age

The medium sized family (4 to 6 person) found in higher (48%) level in the region. Presently, most of the families are single type in the both Bagerhat and Satkhira districts. And among the shrimp farmers, middle aged farmers ranges from age 26 to 45 years were very high (about 76%). In the shrimp farming the risk factor always hampered the farmers in the context of Bangladesh and moderate aged people can take the risk and handle it more easily than the others. Furthermore young people

were also engaged themselves in the shrimp farming. Because, it was already proved that shrimp farming is a profitable occupation and one can engaged oneself in that occupation staying in the local area. And the village people have a strong fascination to stay in their local village or area.

5.1.6 Land Use Pattern of the Farmers

The land use pattern is varied from region to region. It's also depends on the economic status, social status and as well as family background of the farmers and what they get from their inherent.

Development Project shows that there is an uneven distribution of land ownership in the coastal regions of Bangladesh, with a significant proportion of land in the hands of large landowners. Over the past decade, the land holdings of marginal and small farmers have declined, while large and very large farmers have acquired more land.

In 1996 Khan stated that, 50% of the rural population was functionally landless and landlessness was on the rise. A study conducted by the Alauddin and Tisdell (1996) and he identified the five types of land ownership pattern (Own land using their own or domestic labor, Rented land using hired labor, Multiple owners, Small number of owners and local people and Outsider).

5.2 Shrimp Culture and Production Information

In the result it was found that farmers owned on an average of 0.38 ha rented or leased area of their farm while the average farm size was 0.79 ha with an average depth of 71.95 cm. In the region most of the farmers used leased or rented area for shrimp farming (fully or partially). A very few farmer used their owned land for shrimp culture. Farms were on an average of 10 years old i.e. farmers were involved in shrimp farming largely from last ten years.

5.2.1 Source of Post Larvae (PL)

In the findings of extensive or traditional method of shrimp farming, it was found that around 50% traditional farmer use hatchery post larvae (PL). Hatchery PL are available to the village farmers and also the price is normally low (Tk 180 – Tk 550) than the wild or PCR tested PL. Some farmers (around 13%) still stocked post larvae from wild. Because they still get better production from the wild PL with their endogenous knowledge. According to that farmers the survivability of the wild PL

high than the others. Farmers also stocked both hatchery and wild PL in their pond (around 36%) because they have not the technological knowledge.

Farmers make continues stocking all round the season in case of traditional farming in the region. So the stocking density in the traditional farming is not properly maintained.

Islam *et al.* (2005) found that the stocking density was 21,900 PL/ha per cycle in large-sized farms and was 20% lower in the medium- and small-sized ones (about 17,800 PL/ha per cycle). The mean final weight of shrimp in the different farms was similar. The highest shrimp survival rates – approximately 50% – were recorded in small farms and the lowest, 18%, was obtained in large ones. Despite the higher shrimp stocking rate in large farms, the high mortality occurring in these large units led to a significantly lower shrimp production that was less than one-half of that in the small farms (about 80 and 200 kg/ha, respectively). Survival and, consequently, production in the medium-sized farms were intermediate between that obtained for the small- and large-sized ones, and not significantly different from either.

5.2.2 Production Information of the Demonstrated Farm

While comparing the economics of shrimp farming in Asian countries, Ling et al. (2001) reported the production rate from traditional farming system in Bangladesh at 216 kg/ha but Dutta (2006) stated that average production per hectare was 247.67 kg per hectare for the year 2005, in the performance evaluation of traditional shrimp farming in the south western region of Bangladesh.

ATDP II (2005) estimated low productivity in traditional shrimp culture, ranging from 250 to 350 kg per hectare per year in the south western region of Bangladesh, which is higher than average production of 209 kg (Karim *et. al.* 2005). Shah et al (2000) reported much lower production (129kg/ha/year) and so do Ling et al (2001) (216 kg/ha/year).

Nuruzzaman *et al.* (2001) also reported higher yields of shrimp and higher profits in smaller Farms relative to large Farms in several regions of Bangladesh. Their corresponding yields in small (1-2.5 ha) and large Farms (>25 ha) were 189 kg/ha per year and 122 kg/ha per year in Khulna district, 221 kg/ha per year and 74 kg/ha per year in Bagerhat district.

In the study average *bagda* production from Bagerhat district was around 308 kg per hectare with a standard deviation 239.44. In the Satkhira districts the average *bagda* production was around 145 kg with a standard deviation 50.33 and the overall production was 226.67 kg/ha/year. Which is higher than the estimation of Ling *et al.* (2001), average production of 209 kg (Karim *et. al.* 2005), Shah *et. al.*, the production rate129kg/ha/year in 2000 but lower than the production rate of ATDP II (250 to 350 kg per) in 2005 and the production rate 247.67 kg per hectare of Dutta (2006). The variation may occur due to the sampling procedure. And also the production rate varied from year to year and also from region to region.

5.2.3 Percentage of Return from the Demonstrated Farm

In the study it was found that the maximum income of the farmers comes from bagda shrimp farming. The main cultivable species in the south western region is *P. monodon*, locally called bagda shrimp. The salinity of the coastal belt and the suitable environmental condition favour farmer to culture bagda shrimp in their farm and they get benifitted from the bagda shrimp culture.

In the Bagerhat district of the total income from the demonstrated farm 53% comes from *bagda* farming and 32% *galda*. In the rainy season the salinity level become low in the Bagerhat district. So most of the traditional farmers make mixed culture (galda-bagda) in their farm. On the other hand, in the Satkhira districts around 68% income comes from *bagda* farming. A very poor percentage (12%) comes from *golda* farming due to high salinity. And white fish production was found in both Bagerhat and Satkhira district.

5.3 Economics of Traditional Shrimp Farming

Gross cost is simply the addition of fixed cost and the variable cost. Gross margin can be calculated by deducting variable cost from gross return. Net Return can be calculated by deducting gross cost from gross return. Benefit –Cost Ratio can be calculated by dividing gross return by gross cost. Break-even yield can be calculated by dividing gross cost by average unit price.

Mathematically,

Gross Cost = Fixed Cost + Variable Cost

Gross Margin = Gross Return- Variable Cost

Net Return = Gross Return- Gross Cost

Benefit –Cost Ratio = Gross Return/Gross Cost

Break-even yield = Gross Cost/Average Unit Price

5.3.1 Fixed Cost for Shrimp Farm

Fixed cost involves the fixed costing for shrimp farm for a large period of time. It is invested for long time basis in the farm purpose. Fixed cost Rental value, excavation or re-excavation cost, equipment cost which can run for several year/period.

Dutta, A. (2006) stated that in the traditional shrimp culture in south west coastal region of Bangladesh the average fixed cost per hectare per year was estimated at Tk. 24976.86. On the other side, Islam *et. al* (2003) reported fixed cost of Tk. 15502 per hectare per year for traditional shrimp farming while assessed the impacts of shrimp farming on the socioeconomic and environmental conditions in the coastal regions of Bangladesh.

While comparing the economics of shrimp farming in Asian countries, Ling et al. (2001) estimated the fixed costs for the extensive farming systems at US$ 1.34/Kg including overhead (US$ 0.99) and depreciation (US$ 0.35) costs.

Thomas *et al.* (2001)

Average fixed cost found Tk. 19172.61 per hectare per year. This is higher than most of the previous findings. The reason may be the cost increasing of the rental value, excavation and re-excavation and equipment cost also.

5.3.2 Variable Cost

Ling et al. (2001) estimated the variable costs (US$ 2.73/Kg) including seed, feed, labor, power etc. The seed cost alone was estimated at 43.5% of the variable cost. The total cost, farm gate price and net return were estimated at US$ 4.07, 6.90 and 2.83 per kg respectively, while Dutta (2006) reported the variable costs is Tk. 58024.90 per ha per year in his study. Karim et. el. (2005) reported the variable cost 75618 Tk per hectare per year and than BFRI (1999), Tk. 36000 for that year.

Dutta (2006) found the variable costs Tk. 58024.90 per ha per year in his performance evaluation of traditional shrimp farming in the south western region of Bangladesh.

The input costs includes lime, cow dung, urea, TSP, Khail (oil cake) and feed etc. was very low i.e., US$ 18 per ha (Thomas *et al.*, 2001)

Average variable cost found Tk. 86048.09 per hectare per year. This is higher than most of the previous findings. The reason may be the cost increasing of the related products such as feed cost, seed cost etc.

5.3.3 Cost and Return Information per Hectare of Traditional Farming System

According to BFRI in 2003 gross margin was Tk. 62500/ha/year. Islam *et. al.*, in 2003 found gross margin of Tk. 77226/ha/year. Break-even yield for the farmer was 264.03 kg per hectare per year. Benefit cost ratio was 1:0.97. Present findings is higher than Karim *et.al.*, 2005 where net return was found as Tk 1434.04/ha/year. But cost benefit ratio is 1:1.02 and breakeven yield is 205.47 kg/ha/year.

Islam *et al.* (2003) studied the impacts of shrimp farming on the socioeconomic and environmental conditions in the coastal regions of Bangladesh, traditional shrimp farming system in Paikgacha and estimated per hectare total cost, gross income and net return were Tk. 47,779, 125,005 and 77,226, respectively.

While studying the economics of *bagda* shrimp (*penaeus monodon*) farming in coastal areas of Bangladesh, Shah *et al.* (2001) reported the net benefit in *P. monodon* farming at US$ 1.0/Kg from Bangladesh while it was US$ 2.0/Kg in other Asian countries, which also support the findings of Thomas *et al.* (2001), in their study of costs and benefits of bagda shrimp farming in Bangladesh and Ling *et al.*, (2001) in their comparative economics of shrimp farming in Asia.

In the performance evaluation of traditional shrimp farming in the south western region of Bangladesh Dutta (2006) reported that average income was Tk. 85934.32 per ha per year, average net return calculated is Tk. 2932.56 per ha per year.

The benefit-cost ratio is 1:1.04 and the breakeven yield per ha per year is 257.67 kg per ha per year while the total cost per ha per year was US$ 700. The averages gross return/benefit from shrimp farm per ha for all categories were US$ 1041 which ranges between US$ 1000 to US$ 1145. The net income was US$ 2.6 per kg. The total production of tiger shrimp (*Bagda*) in 2000-2001 was 32,424 metric tones in Bangladesh (Thomas *et al.*, 2001).

5.4 Diseases Information

In the southern region most of the shrimp farm is affected due to white spot disease virus. In the total demonstrated farm, around 64% shrimp farm is affected due to white spot disease virus and rests of the farms (around 36%) become unaffected.

Diseases are simply a great disaster for shrimp farm. No any prevention method invented against disease especially white spot syndrome virus yet. But sometimes through some good management practice diseases problem can mitigate. In the traditional farming system, there seems very poor management practice and it may a reason for diseases or virus affection.

4.4.1 Diseases Occurrence

In Bagerhat district in the season 2006, according to farmer most of the stock was affected totally or partially due to WSSV but can not damage in extreme context, these may due to environmental cause or farmers can not identify WSSV. The partial mortality of the shrimp may occur due to the other causes (other diseases, poor survivility of the PL etc.). So that farmers got some return from their farm.

Whereas in Satkhira district the stocking frequency of the shrimp farmer was higher (more than 80% farmers stocked over seven times in an individuals farm) and the losses due to the virus activity were extreme. This may occurs due to frequently stoking practice in the same farm.

4.4.2 Disease Distribution and Parentage Of Loss Due To Diseases

In Bagerhat district around 50% traditional shrimp farm become affected due to white spot disease virus in the year 2006. Of the affected farm about 10% farm hampered 60% loss due to this viral disease. In Satkhira region, white spot diseases appear very randomly and more than 77% farm affected due to white spot disease. Around 17% farm damage 80% and 15% farm damaged 90% loss due to due to this viral disease of he affected farms. There is another disease in the Satkhira region, which is not yet identified by the farmers. The result may due to the geographical location. The size of the farm is another factor for virus affection. It was found that the farm size in Bagerhat district was comparatively small than the Satkhira districts. Another finding shows the loss due to virus or diseases is higher in Satkhira rather than Bagerhat. This may be due to continuous stoking is practiced in Satkhira region or the environmental cause or sampling method.

CHAPTER SIX

CONCLUSION

Chapter 6

Conclusion

Management practices in traditional system are poor which is characterized by very low inputs and higher stocking density. Therefore in spite of having much potential the shrimp industry in Bangladesh the yield is low and yet to reach the desired level of development. Occurrence of viral disease becomes a major problem in this decade for the shrimp industry. This study confirms this statement. Percentage of farms infected by the disease is higher and the amount of loss is also extreme. As a result farmers faced severe losses and amount of money that they lost was very high. Net return was obviously is not satisfactory. Though the farmers were able to harvest more than breakeven yield, still now the traditional culture system fails to perform at its best. So modification of culture system is very much essential in the coastal region of Bangladesh. Introduction of Better Management Practices (BMP) for environment friendly sustainable shrimp culture, regular training and demonstration of BMP at coastal Upazilla is needed in this aspect. . If farmer follows the better management practices and replace traditional culture system with modified, intensive or semi-intensive culture system there is a high chance to increase shrimp production by 3-5 times than what they are producing at the moment.

CHAPTER SEVEN

REFERENCES

Chapter 7

References

Agro-based Industries and Technology Development Project-Phase II (ATDP II), 2005. Shrimp Industry Study: Problems, Prospects and Intervention Agenda.

Ahmed, A.T.A., 1995 Impacts of shrimp culture on the coastal environment of Bangladesh. In: Proceedings of the National Workshop on Coastal Aquaculture and Environmental Management. Institute of Marine Sciences, 25–28 pp. 1995. Nuruddin Mahmood, University of Chittagong/UNESCO, Bangladesh, 77–84 pp.

Alam S.M.N. and Phillips M.J., 2004. Coastal Shrimp Aquaculture Systems in Southwestern Bangladesh, Asian Fisheries Science, Asian Fisheries Society, Manila, Philippines, 17: 175-189.

Alam S.M.N., 2002. Shrimp based farming systems in south-western coastal zone of Bangladesh. Master degree thesis, Integrated Tropical Coastal Zone Management, Asian Institute of Technology, Bangkok, Thailand, 102 pp.

Alauddin M. and Hamid M. A., 1996. Shrimp Culture in Bangladesh with Emphasis on Social and Economic Aspects, Department of Economics, University of Queensland, Australia, 53-60 pp.

Alauddin M., and Tisdell, C.A., 1996. Bangladesh's shrimp industry and sustainable development: resource-use conflict and the environment. Working Paper No. 1, Shrimp–Rice Farming Systems in Bangladesh Working Paper Series. Brisbane, Department of Economics, University of Queensland, Australia.

Ali A., 2001. Vulnerability of Bangladesh coastal region to climate change with adaptation options Bangladesh. *Space Research and Remote Sensing Organization (SPARRSO)*, Agargaon, Sher-e-Bangla Nagar, Dhaka 1207, Bangladesh.

DDP Delta Development Project, 1985. Shrimp culture in the semi-saline zone of the Delta: final report, Bangladesh–Netherlands Joint Program. The Hague, Delta Development Project, Technical Report No. 13.

Department of Fisheries (DOF), 1994. District-wise area and number of shrimp farms, Department of Fisheries Document Dhaka, Bangladesh.

Department of Fisheries (DOF), 2001. Fish Week Compendium, Department of Fisheries, Ministry of Fisheries and Livestock, Dhaka, Bangladesh.

Department of Fisheries (DOF), 2002. Shrimp aquaculture in Bangladesh: A vision for the future, Dhaka, Bangladesh.

Department of Fisheries (DOF), 2003. Balancing resource conservation with livelihood protection for shrimp fry collectors: an integrated approach to managing coastal resources, Dhaka, Bangladesh.

Dutta A., 2006. Performance evaluation of traditional shrimp farming in south-west coastal region of Bangladesh. Executive Masters of Business Administration (EMBA) thesis, Department of Business Administration, Khulna University, Khulna, Bangladesh, 24 pp.

Flegel T.W. and Alday-Sanz V., 1998. The crisis in Asian shrimp aquaculture: current status and future needs. Journal of Applied Ichthyology 14:269-273.

Food and Agricultural Organization (Fisheries Department), 1997. Aquaculture development, Food and Agricultural Organization Technical Guidelines for Responsible Fisheries. No. 5. Rome, Italy.

GESAMP 1998. Towards safe and effective use of chemicals in coastal aquaculture. Reports and Studies, Joint Group of Experts on the Scientific Aspects of Marine Pollution, in press.

Haque S. M., 1994. Annual report of Bangladesh Frozen Foods Exporters Associations (BFFEA), BFFEA Special Bulletin, Dhaka, Bangladesh.

Islam M. S., Milstein A., Wahab M. A., Kamal A. H. M. and Dewan S., 2005. Production and economic return of shrimp aquaculture in coastal ponds of different sizes and with different management regimes, Department of Fisheries Management, Bangladesh Agricultural University Mymensingh, Bangladesh; Aquaculture International, Springer 2005. DOI 10.1007/s10499-005-9000-7.

Islam M. S., Wahab M. A., Miah A. A. and Kamal A. H. M. M., 2003. Impacts of Shrimp Farming on the Socioeconomic and Environmental Conditions in the Coastal Regions of Bangladesh, Pakistan Journal of Biological Sciences, 6(24): 2058-2067.

Karim M. R., 2003. Present status and strategies for future development of shrimp culture in Bangladesh. In: Wahab M.A. (ed.), Environmental and Socioeconomic Impacts of Shrimp Farming in Bangladesh (Technical Proc. BAU-NORAD Workshop BRAC Centre, Dhaka, Bangladesh), Bangladesh Agricultural University, Mymensingh, Bangladesh.

Karim M., 1986. Brackish water shrimp culture demonstration in Bangladesh. Madras, Bay of Bengal Programme for Fisheries Development, FAO (Food and Agriculture Organization of the United Nations), Rome.

Karim M., and Aftabuzzaman M. A., 1995. Brackish and marine water aquaculture: potential, constraints and management needs for sustainable development, A paper presented at the National Workshop on Fisheries Resources, Development and Management, Dhaka, Bangladesh.

Karim M., and Stellwagen P., 1998. Shrimp Aquaculture, Fourth Fisheries Project, Preparatory Phase for National Fisheries Sector Development Program, Department of Fisheries, Dhaka, Bangladesh.

Karim R. T. and Saifuddin M. S., 2005. Financial Analysis of Shrimp Seal of Quality, United States Agency for International Development (USAID), Dhaka, Bangladesh.

Karim, M.R. and Shah, M.S., 2001. Brackish Water Shrimp Cultivation Restricts Coastal Agriculture, Khulna University Studies, Khulna, Bangladesh, 2(1), 123–134.

Khan M.G., 1996. Bangladesh: economy. In: The Far East and Australasia, London, Europa Publications.

Khan Y.S.A. and Hossain M.S., 1996. Impact of shrimp culture on the coastal environment of Bangladesh. International Journal of Ecology and Environmental Sciences 22(2), 145–158.

Kungvankij P., 1984. Overview of penaeid shrimp culture in Asia, Network of Aquaculture Centres in Asia Regional Lead Centre in the Philippines, Aquaculture Department, Iloilo, Philippines.

Kungvankij P. 1976. On the monoculture of jumbo tiger shrimp Penaeus monodon Fabricius, Phuket Mar, Fish Cont. No. 7. 14 p.

Liao I.C., 1977. A culture study on Grass Prawn, Penaeus monodon in Taiwan - the patterns, the problems and the prospects, Journal of the Fisheries Society of Taiwan Vol. 5, No. 2. 29 p.

Ling B.H., Shang Y.C. and Leung P.S., 2001. Comparative Economics of Shrimp Farming in Asia. In: Leung P.S. and Sharma K.K. (eds.), Economic and Management of Shrimp and Carp Farming in Asia, Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

Ministry of Fisheries and Livestock (MOFL), 1997. Fisheries resources development and management. Paper presented at the National Workshop, 29 October to 1 November 1997, MOFL, Dhaka, Bangladesh.

Nuruzzaman M. and Muniruzzaman M., 2003. Impacts of shrimp industry on coastal communities, Paper Presented in the Workshop on Present Status of Coastal and Marine Resources of Bangladesh and Future Potentials for Poverty Alleviation held in BRAC Auditorium, Mohakhali, Dhaka, Bangladesh.

Rahman A.A., Mallick D.L., Haque N. and Nishat A., 2002. Trends in Natural Resource Management in Bangladesh: Looking for Integration and a New Institutional Framework, A workshop Paper of BCAS and DFID, Dhaka, Bangladesh.

Rosenberry B., 2000 World Shrimp Farming 2000, San Diego, California, Shrimp News International.

Rosenberry B., 2003 World Shrimp Farming 2003, San Diego, California, Shrimp News International.

Shah W.A., Phillips M., Kamal S., Jahan I. and Sarker J., 2000. The Economics of Bagda Shrimp (Penaeus monodon) Farming in Coastal Areas of Bangladesh. In: Sen S. (ed.), Grassroots Voice, Volume-III, (Issues I & II), Bangladesh Resource Centre for Indigenous Knowledge, Dhaka, Bangladesh.

Siriwardena P.P.G.S.N., 1997. Disease prevention and health management in coastal shrimp culture, Technical cooperation programme, Food and Agriculture Organization of The United Nations, Bangkok.

Thomas M. A., Macfadyen G. and Chowdhury S., 2001. The costs and Benefits of Bagda Shrimp Farming in Bangladesh. Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh.

APPENDICES

Appendix- A

An Interview to Assess the Impact of Traditional Shrimp Farmer in 2006

General background of the farmer:

Farmer Name : .....

Village : .....

Union : .....

Upazilla : .....

District : .....

Technology : .....

1. Basic Information of the respondent:

a) Age: .....b) Schooling Years: ..... C) Family member (no.): .....

d) Family member distribution (no.): Adult: male.....female.....Child: male.....female.....

e) Experience in Shrimp Culture (Years) ..... No. of Pond under Shrimp Culture: .....Total area (ha) .....

f) Land size (ha): owned .....Rented In.....Rented out.....Leased In:.....Leased Out: .....

g) Total household income of the year 2006

..... (Tk)

g) Income generating activities of the household members (January '06 to December '06):

Income Source	Income (Tk)	Income Source	Income (Tk)
Bagda farming		Business	
Golda farming		Service	
Fish farming		Petty trading / Shop keeping	
Other shrimps and crabs farming		Money Lending	
Fish Processing		Others (specify...)	
Crop Farming			

Poultry/Duck farming			

2.1 Basic information of the demonstration pond

a) Pond size (ha): ..... Average depth (cm): ..... Age of the pond (years): .....

b) For how many years the pond has been using for shrimp culture: .....

c) Tenure status (single owned / joint owned / single leased / joint leased): .....

d) If multiple ownership (joint owned or joint leased), how many persons: .....

e) Dominant soil type (Clay/Sandy/loamy/Sandy loamy/Peat soil/others):.....

f) Sources of farm water (Groundwater/ river/canal/others).....

g) Average salinity (PPT) of intake water (Low salinity (0-5) /moderate salinity (6-12)/high salinity (>12): .....

2.2 Information of fixed costs for shrimp culture in the demonstrated pond:

a) Did you borrow money this year for shrimp culture in the demonstrated pond?
Yes = 1, No = 0 .....

b) If yes, how much money did you borrow this year for shrimp culture in the demonstrated pond?

c) Leased Value (Tk): ..... Land Tax (Tk) .....

d) Excavation year of pond ..... Cost (Tk) ..... Economic life (years).....

e) Excavation year of nursery..... Cost (Tk) ..... Economic life (years).....

f) Equipments (Durable: Economic life is more than one year) used in the demonstration pond:

Equipments or Accessories	Purchase Year	Purchase Value (TK)	Economic life (years)	Repairing Cost (Tk)	Shared between how many farms
Aerator					
Feeding Tray					
Cast net					
Water Quality Kit					
Boat					
Harvest trap					
Farm house, Guard shade					
Pump machine					

2.3 Information on operating costs for shrimp culture in the demonstrated pond:

a) Equipments (non-Durable: Economic life is less than one year) used in the demonstration pond:

Equipments or Accessories	Purchase Value (TK)	Shared between how many farms
Blue Net		
Bamboo and Wooden material (Stick/branch/pole, rope, tire, tube, polythene)		
Electric Equipment (Bulb, Battery, Torch etc.)		

b) Input Cost of shrimp culture

Input	Pond Preparation	Nursery	Grow out / Reservoir	Unit Cost
	Qty (Kg)	Qty (Kg)	Qty (Kg)	(Tk/Kg)
Organic Fertilizer				
Cow dung				
Molasses				
Yeast				
Rice bran				
Mustard Oil Cake				
Others				
In-organic Fertilizer				
Urea				
TSP				
MP				
DAP				
Others				
Chemical Fertilizer				
Lime				
Bleaching				
Dipterax				
Rotenone				
Dolomite				
Others				
Supplementary Feed				
Wheat bran				
Soya cake				
Pelleted Feed				

CP feed				
Saudi Bangla Feed				
Fresh				
Quality				
Titas				
Others				
Home made feed				
Miscellaneous				
Fuel				
Oil				
Electricity				
Others				

c) Labor used for shrimp culture

Labor Type	**No of Labor**	**Time spent**			**Total Salary Paid (Tk)**
		(Hour/Day)	**Day/Month**	**Month/Year**	
Hired Labor (Permanent)					
Hired Labor (Temporary)					
Family Labor					

d) Stocking Information

Species	**Date**	**Number**	**Weight (Kg)**	**Total Value (Tk)**	**Source**	**Nursing Period (Days)**
Bagda						

Golda						
Whitefish						

3 Information on harvesting from shrimp culture in the demonstrated pond:

a) Harvesting Information

Species	**Date**	**Number**	**Weight (Kg)**	**Total Value (Tk)**
Bagda				
Golda				

Whitefish				

c) Labor used for harvest:

Labor Type	No of Labor	Time spent			Total Salary Paid (Tk)
		(Hour/Day)	Day/Month	Month/Year	
Hired Labor (Permanent)					
Hired Labor (Temporary)					
Family Labor					

4. Training exposure of the respondents

a) Have you attended the training program organized by the project (Yes - 1 / No – 0)? .....

b) If the answer of Question 4 (a) is yes then please response the following question:

No. of training received from the project ..... and duration of training ..... (Days)

Please response about the quality of training? (Very Good -1; Good -2; Moderate – 3; Bad -4; Very Bad-5) ..... and mention the reason behind the answer

.....

.....

.....

c) If the answer of Question 4 (a) is no then please response the following question:

Why you didn't attend the training program organized by the project?

.....

.....

..... How did you gather knowledge on shrimp culture?

d) Have you attended any shrimp culture training organized by other project/institutions (Yes-1 / No-0)? ……

e) If the answer of Question 4 (d) is yes then please response the following question:

Name of the organization:

……

…….. duration of training

……

….. (Days)

f) Did you attend any other training program other than shrimp culture (Yes-1 / No-0)? ……

g) If yes, name of the training program …… organized by ……

5. Management of Farm/ Farming system:

5.1 Farm/water management in the nursery

a) Use of nursery (Yes -1 /No -0): ……Nursery type……

Stock frequency …… Nursery frequency ……

b) Measures to disinfect water (Yes -1 /No -0):……if Yes then how many times: …… and method used: (Bleaching / Rotenone / Dip Terex /Liming/Others ……

c) Measures to enhance natural productivity (Yes/No): …… If yes then how (jute bag/ branches/rice bran with molasses and yeast/inorganic fertilizer/others (name)……

d) Use of PCR tested PL (Yes -1 /No -0): …… if Yes then how many times: ……

e) Maintenance of PL nursing density (Yes -1 /No -0): …… If yes then how many times …… average stocking density in the nursery per sqm ……

f) Acclimatize of PL before stocking (Yes -1 /No -0): ……If yes then how many times ……

g) Maintenance of water level in the grow out pond (Yes -1 /No -0): ..... If yes then how.....
.....

h) How do you release your nursed PL to grow out: cutting the nursery / by counting / others.....
.....

5.3 Farm/water management in the grow out:

a) Maintain stocking density (Yes -1 /No -0): ..... If yes then how many times ..... average stocking density in the grow out pond per sqm
.....

b) Use of aeration (Yes -1 /No -0): ..... If yes then how many hours per day.....

c) Use of fertilizer to increase water productivity (Yes -1 /No -0): ..... If yes then how (jute bag/ branches/rice bran with molasses and yeast/inorganic fertilizer/others (name).....

d) How many kinds of algae occur in your pond ..... Beneficial algae (name)..... Harmful algae (name)
.....
.....

e) Do you Control aquatic algae and weed (Yes -1 /No -0): ..... If Yes then how (Mechanical / chemical / manual / biological / others)
.....

6. Disease occurrence and management:

a) Have you encountered shrimp viral disease in 2006 in this pond (Yes -1 /No -0):..... If yes then which disease.....and how did you detect the disease
.....
.....

b) How many times you stocked this year.....and how many times you faced WSSV in 2006.....

c) Usually after how many days of stocking the disease occurred ..... and how large are the animals during this period of time .....

.....

.....

d) Loss of shrimp stock due to disease.....

e) What are the main reasons you have experienced which are responsible for disease occurrence and why?

.....

.....

f) What steps did you take when your farm were infected by WSSV?

.....

.....

g) When shrimp farming was started in this pond .....and which year this farm was first infected by WSSV

.....

..

h) How many times WSSV occur in your shrimp pond till *2006*.....

7. What problems do you face during shrimp culture?

.....

.....

.....

Appendix-B

Information Table related to the study

Table 1. Typology of shrimp production of traditional system in Bangladesh.

Particulers	Traditional Culture System
Average pond size (ha)	1.3
Stocking density PL/m^2	3.5
Water management	Mostly tidal
Fry Sources	Wild and hatchery
Feeding	Natural feeding with occasional fertilization
Production (kg/ha/yr)	250-350
Cost (tk/ha)	*60500*
Cost (tk/kg)	242-173
Returns (tk/ha)	14500-44500

Source: ATDP II Cost Benefit Analysis, 2005.

Table 2. Annual profitability of shrimp farming in 2003.

Particulars	Shrimp Farming (Tk/ha)
Gross Income (GI)	125005
Total Fixed cost (TFC)	15502
Total Variable cost (TVC)	32277
Total Cost (TC=TFC+TVC)	47779
Gross margin (GM=GI-TVC)	92728
Net Margin (GI-TC)	77226

Source: Pakistan Journal of Biological Sciences 6 (24): 2058-2067, 2003.

Table 3. Cost benefit ratios of extensive shrimp culture system.

Items	Tradition shrimp farming
Dewatering	5%
Drying	Natural
Ploughing/tilling	-
Lime application	20%
Flashing	-
Seed source	
a. Natural	80%
b. Hatchery Produced	20%
Stocking rate	Below 1/m^2
Feed application	-
Aeration	-
Fertilization	20%
Disease treatment cost	
Water exchange	Natural
Harvesting nature	During lunar cycle (cast net)
Total cost involved Tk/ha/year)	Tk. 36,000
Total Av. production (kg/ha/year)	178.59
Total return in Taka	Tk. 98,500/-
Net benefit	Tk. 62500/-
Cost benefit ratio	1:2.73
Expected cost benefit ratio	1:3.56

Source: Annual Report 1997-98 and 1998-99, BFRI