PRODUCTIVITY AND RESOURCE USE EFFICIENCY OF BAGDA SHRIMP FARMING IN SOME SELECTED AREAS OF BAGERHAT DISTRICT IN BANGLADESH

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CERTIFICATE

This is to certify that thesis entitled, "PRODUCTIVITY AND RESOURCE USE EFFICIENCY OF SHRIMP (*Penaeus monodon*) FARMING IN SELECTED AREAS OF BAGERHAT DISTRICT IN BANGLADESH" **submitted to the Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of** MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS, **embodies the result of a piece of bona fide research work carried out by** REZOYANA KABIR RASHA **bearing Registration No.** 08-02711 **under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.**

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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PRODUCTIVITY AND RESOURCE USE EFFICIENCY OF BAGDA SHRIMP FARMING IN SOME SELECTED AREAS OF BAGERHAT DISTRICT IN BANGLADESH

ABSTRACT

Fisheries sector in Bangladesh has been playing a vital role in the economy of Bangladesh from the time immemorial. The contribution of agricultural sector to Gross Domestic Product (GDP) is about 16.33 percent in the FY 2013-14 of which fisheries sub-sector contributes about 22.61 percent to the broad agricultural sector Gross Domestic Product. The overall objectives of the present study were to examine socio-demographic profile of shrimp producing farmers, to assess profitability and resource use efficiency of shrimp farming. Bagerhat district was selected for the study on the basis of extensive cultivation of shrimp. Simple random sampling technique had been used for collecting data from 105 sample farmers through interview schedule. After analyzing the data, per hectare gross return, net return, and gross margin were found to be Tk. 364222.00, Tk. 215931.00 & Tk. 260095.00 respectively. Total costs of shrimp production were calculated at Tk. 148291.00 per hectare. Benefit Cost Ratio (BCR) was found to be 2.46 for shrimp farming. Thus it was found that shrimp farming was highly profitable. Production function analysis suggested that, among the variables included in the model, cost of shrimp fry, cost of feed, cost of fertilizer, cost of human labor, and cost of water management had a positive and significant effect on the gross return of shrimp production, except for cost of lime had a negative and insignificant effect on the gross return of shrimp farming. Multicollinearity test indicated that there was no severe correlation among the explanatory variables. Efficiency analysis indicated that most of the farmers inefficiently used their inputs. This study also identified some of the problems and constraints associated with shrimp farming. These were categorized into economic, technical and social problems. Problems faced by the farmers were ranked on the basis of corresponding percentages. The problems and constraints, of course, are interrelated with one another and hence, need to be removed comprehensively through an integrated programme for the overall development of shrimp (bagda) farming.

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ABBREVIATIONS AND ACRONYMS

BARC : Bangladesh Agricultural Research Council

BB : Bangladesh Bank

BBS : Bangladesh Bureau of Statistic

BCR : Benefit Cost Ratio

BER : Bangladesh Economic Review

DAE : Department of Agricultural Extension

DoF : Department of Fisheries

EU : European Union

et al. : and others (at elli)

FFP : Fourth Fisheries Project

FRI : Fisheries Research Institute

GDP : Gross Domestic Product

GNP : Gross National Product

GR : Gross Return

ha : Hectare

HSC : Higher Secondary Certificate

IOC : Interest on Operating Capital

JSC : Junior School Certificate

kg : Kilogram

MFC : Marginal Factor Cost

MPP : Marginal Physical Product

MT : Metric Ton

MVP : Marginal Value Product

MV : Modern Varieties

NGOs : Non Government Organizations

No. : Number

OC : Operating Capital

PL : Post Larva

PSC : Primary School Certificate

SPSS : Statistical Package for Social Sciences

SSC : Secondary School Certificate

sq. km : Square Kilometer

TC : Total Cost

TFC : Total Fixed Cost

Tk. : Taka

TVC : Total Fixed Cost

USA : United States of America

UFO : Upazila Fisheries Officer

CHAPTER 1
INTRODUCTION

1.1 Background of the Study

Agriculture is the mainstay of the economy of Bangladesh. The economic development is inextricably linked with the performance of this sector. The country has a vast delta with a population of 155.80 million encompassing an area of 147,570 sq km (BER, 2015). About 76.75 percent of total population of this country lives in rural areas (BBS, 2013b). Agriculture provides employment to nearly about 47.33 percent of its total labor forces (BER, 2015). Agriculture occupies a key position in the overall economic sphere of the country in terms of its contribution to Gross Domestic Product (GDP). Figure 1.1 represents the sectoral share of Gross Domestic Product at constant prices (Base Year: 2005-06). Broad agriculture sector which includes crops, livestock, fisheries and forestry contributes 16.33 percent to the Gross Domestic Product (GDP) as a whole in the FY 2013-14 (BER, 2015). An impact of climate change on agriculture has been keeping continuous pressure on food grain production. The high population growth with declining death rate together with low growth in agricultural productivity and natural hazards adversely affect the living standards of the people in the country.

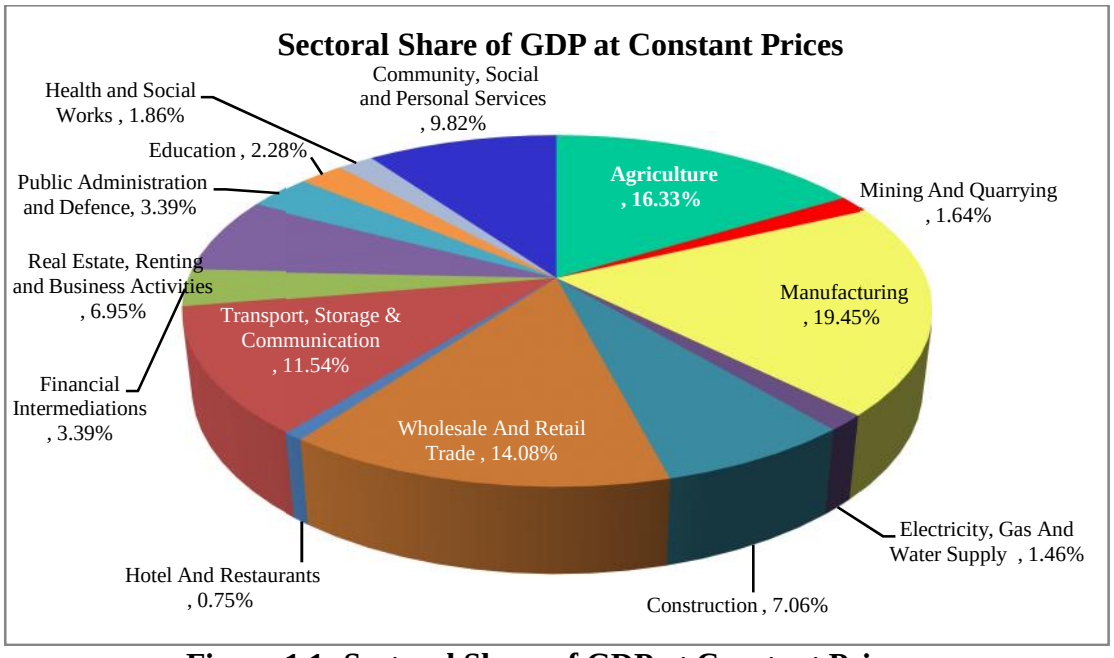

Figure 1.1: Sectoral Share of GDP at Constant Prices.

Source: BER, 2015.

In an agro-based country like Bangladesh, fisheries sub-sector is one of the most important and promising sub-sectors having vital contribution towards her economic development. The contribution of fisheries sub-sector in Gross Domestic Product was 3.68 percent in FY 2012-13 and 3.69 percent in FY 2013 -14. In 2013-14, fisheries sub-sector contributed about 22.61 percent to the broad agricultural sector Gross Domestic Product (BER, 2015) (Figure 1.2). This sector plays a significant role in meeting the protein demand, earning foreign exchange and socio-economic development of the rural poor by reducing poverty through employment generation.

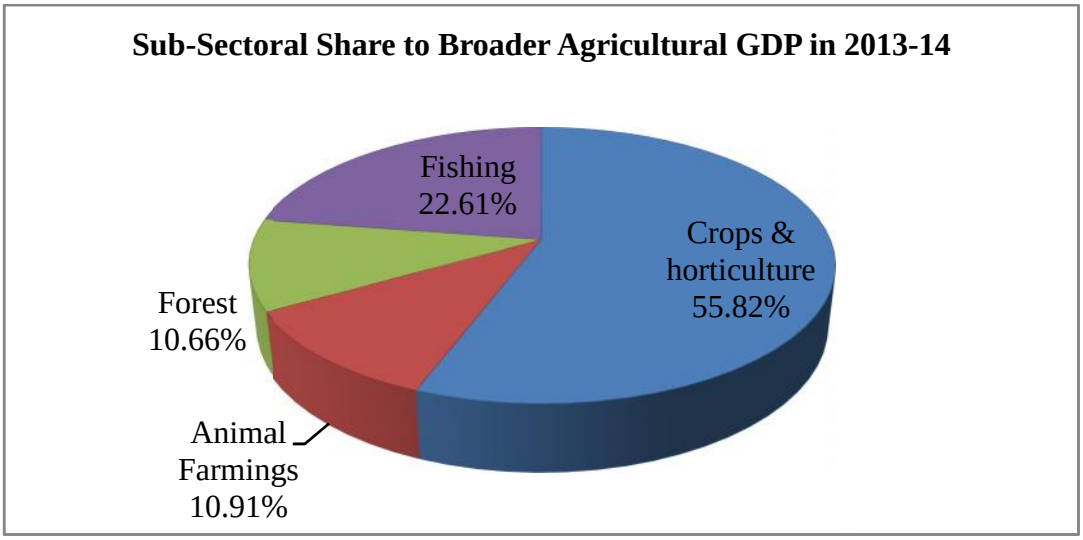

Figure 1.2: Sub-Sectoral Share of Broader Agricultural GDP in 2013-14.

Source: BER, 2015.

Shrimp farming and related activities contribute significantly to the national economy of Bangladesh. The main areas of contribution are export earning and employment generation through on and off-farm activities. Bangladesh has about 2.75 lakh hectares of coastal tidal land under brackish water culture (BER, 2015). The main cultured species is the tiger shrimp (locally known as *bagda* shrimp) of which the scientific name is *Penaeus monodon*. It is a marine shrimp and is cultivated in saline water. The next most important cultured species for export is the fresh water variety, locally called galda, scientifically

known as m*acrobrachium rosenbergii*. Bangladesh has the potential to increase production, raise productivity, upgrade processing facilities, and draw further land into shrimp cultivation.

In Bangladesh, brackish water shrimp farming is currently one of the most important sectors of the national economy. The brackish water shrimp is a highly valued product for international markets. Almost all shrimps are exported, particularly to the USA, Japan and Europe. Brackish water shrimp farming is mostly concentrated in southern Bangladesh mainly Satkhira, Cox's Bazar, Khulna and Bagerhat districts. In southern Bangladesh, thousands of farmers have converted their paddy fields to 'gher' to accommodate a profitable shrimp culture practice. 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: first, its fresh and salinewater 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. The mangrove forest provides a critical habitat for shrimp and other fish.

There is high demand for shrimp of Bangladesh in the world market. Bangladesh has stepped into a new era of industrial development. Technological innovation has been creating a greater impact on domestic economy. The increasing demand and steadily rising prices of shrimp encouraged its cultivation in the coastal belt of the country.

1.2 Importance of Fisheries Sector in the Economy of Bangladesh

In recent times, the world is facing the challenges of food crisis, population explosion, lack of shelter, employment, and the management of natural resources. But natural resources are contributing to the lion's share of the world's economy. Among all the natural resources, aquatic resources have been considered as a big source for meeting the protein deficits and vital for the economic development of the world economy.

Fish is one of the most valuable components of agricultural sector in Bangladesh and its production contributes to the livelihoods and employment of millions of

people. The importance of fisheries sector in Bangladesh on the growth and development of its economy cannot be exaggerated. The culture and consumption of fish therefore has important implications for national income and food security. Fisheries sector in Bangladesh has been playing a very vital role from the time immemorial. Bangladeshi people are popularly referred to as "Mache Bhate Bangali" or "fish and rice makes a Bengali". But in the past, due to our low population and optimum fish productions, special attention was not given to this sector. Now people in the rural areas are suffering seriously from deficits of foods, proteins and nutrition mainly due to over-population.

The fisheries sector is one of enormous importance to the economy of Bangladesh. This sector is now playing a very vital role in poverty alleviation, generating employment opportunities, producing animal proteins, earning foreign currency and increasing Gross Domestic Product (GDP) and Gross National Product (GNP). Fish provides 60 percent of animal protein consumption and about 1.2 million people are directly employed in this sector. Fishermen form one of the poorest segments of the population. In addition fisheries generate part-time employment for people through subsistence fishing, whose numbers peak in the flood seasons from June to October, and through related activities such as net manufacturing, processing, marketing, seed collection and distribution, and other ancillary activities. Considering the scarcity of pastureland in this country, fish is the next best alternative to substitute animal protein, which is very essential for human body.

At present the fisheries sector in Bangladesh represents as one of the most productive and dynamic sectors in the country. The growth rate of fisheries sub-sector to Gross Domestic Product has increased from 5.75 percent in 2005-06 to 6.49 percent in 2012-13 (BER, 2015). Yet, its growth and economic return is far less than actual potential. Given the importance of agriculture in the national economy and due to existence of vital linkage effects of agriculture is a crucial pre-condition accelerating overall economic growth of Bangladesh.

The fisheries sector is profitable even with minimum investment and time. Many fish farms and hatcheries were recently established with investment from the

government and the private sector. Bangladesh's fisheries sector is generally classified into two types: Inland (open-water fishery) and Marine fisheries. Fisheries sector broadly divided into four sub-sectors - inland capture, inland culture, mariculture (artisanal fisheries) and marine industrial fisheries. Inland fisheries comprise of capture and culture (closed-water fisheries) based fisheries. The capture component is composed of rivers and estuaries, the Sundarban mangrove forest, beel, Kaptai Lake, and flood-land etc. Inland culture fisheries, on the other hand, include ponds and ditches, baors, and coastal shrimp and fish farms. The total area of inland fisheries is about 46.99 lakh hectares (DoF, 2014). Bangladesh is one of the world's leading inland fisheries producers and has a huge water resource all over the country in the form of small ponds, ditches, lakes, canals, small and large rivers.

The ecology of the country is appropriate for the growth and production of the fisheries resources. Fish production in ponds, lakes, burrow pits, floodplains, oxbow lakes, and semi-closed water bodies are increasing day-by-day with the blessings of modern technology. Fish production has increased to 35.55 lakh MT in 2013-14, which was 25.63 lakh MT in 2007-08. Bangladesh is endowed with vast water bodies such as 39.25 lakh hectares of open water fisheries, 7.74 lakh hectares of culture fisheries and 0.48 sq. nautical miles of marine fisheries (Table 1.1). In 2013-14, total fish production was 35.55 lakh MT of which 55 percent production has been contributed by the culture fisheries, 28 percent by the open water fisheries and rest 17 percent by the marine water fisheries (Figure 1.3).

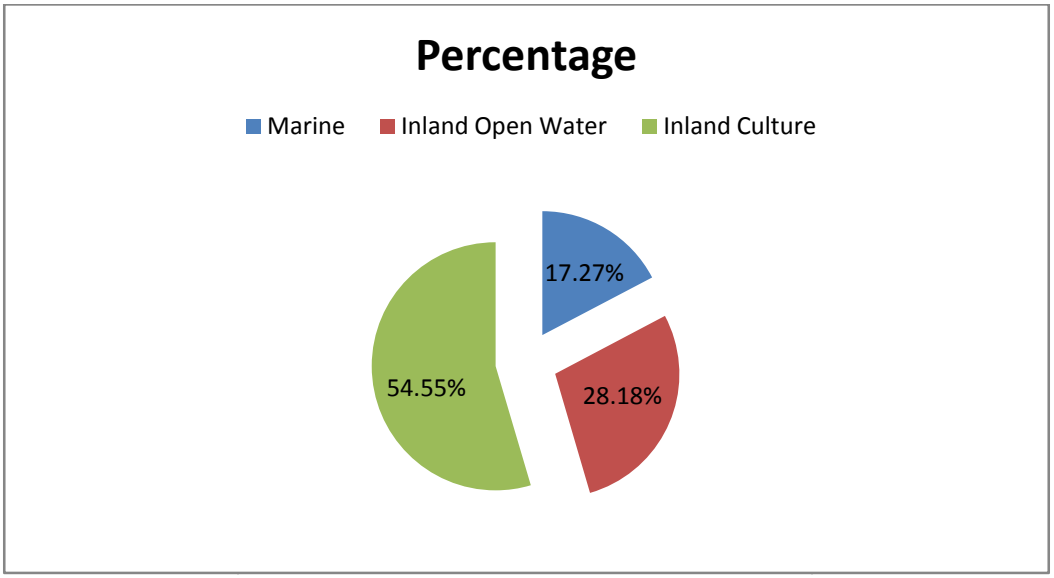

Figure 1.3: Fish Production in Different Resources 2013-14.

Source: BER, 2015.

The total inland fisherires area is about 46.99 lakh hectares which includes culture fisheries 7.74 lakh hectares and open water fisheries 39.25 lakh hectares (Figure 1.4).

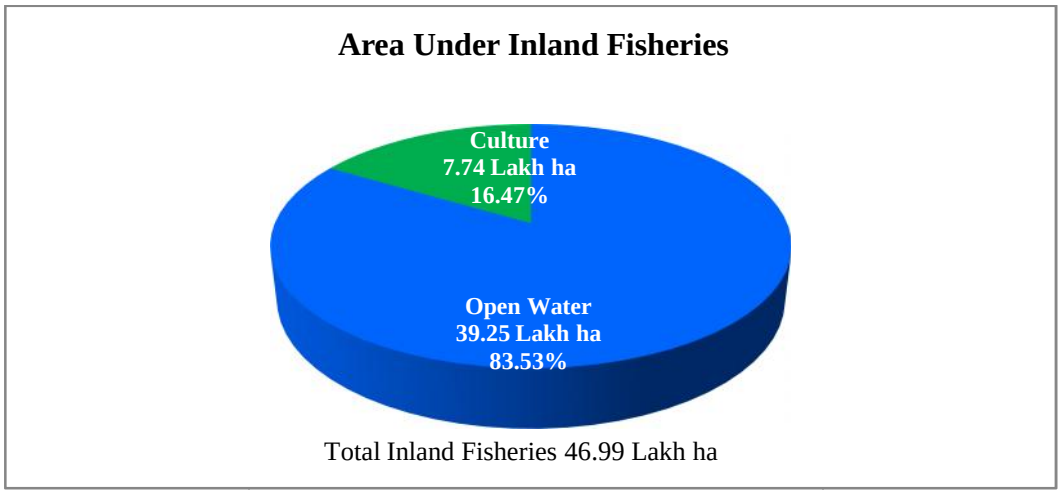

Figure 1.4: Area under Inland Fisheries.

Source: BER, 2015.

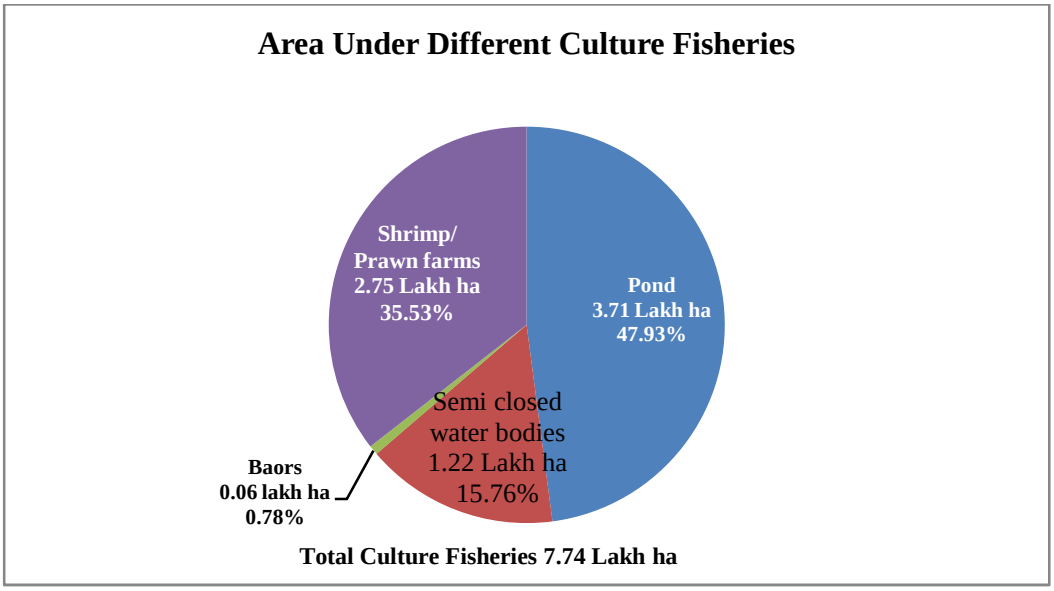

Figure 1.5: Area under Different Culture Fisheries.

Source: BER, 2015.

The total area under different culture fisheries is about 7.74 lakh hectares which includes 2.75 lakh hectares of shrimp/prawn farms, 47.93 lakh hectares of pond, 1.22 lakh hectares of semi closed water bodies and 0.06 lakh hectares of baors (Figure 1.5).

Table 1.1: Fish Production Trends in Different Resources (in lakh MT)

Sector	Area (Lakh ha)	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13	2013 - 14 (Target)
1.Inland								
(a) Open Water								
(i) River & Estuaries	8.54	1.37	1.69	1.35	1.45	1.46	1.47	
(ii) Sundarban	1.78	0.18	0.2	0.18	0.22	0.22	0. 16	
(iii) Beel	1.14	0.78	0.93	0.64	0.82	0.85	0.89	

(iv) Kaptai lake	0.69	0.08	0.09	0.07	0.09	0.09	0.09	
(v) Flood plain	27.11	8.19	6.17	7.51	7.97	6.96	7.01	
Sub - Total (Open Water)	39.25	10.6	9.08	9.75	10.55	9.57	9.61	9.69
(b) Culture								
(i) Pond	3.71	8.66	10.27	12.98	12.2	13.42	14.4 7	
(ii) Semi closed water bodies	1.22	--	--	--	0.51	1.82	2.01	
(iii) Baors	0.06	0.05	0.06	0.05	0.05	0.05 2	0.06	
(iv) Shrimp/Prawn farms	2.75	1.35	1.49	1.23	1.85	1.96	2.06	
Sub - Total (Culture)	7. 7 4	10.06	11.82	14.26	14.6	17.26	18.6	19.79
Total (Inland)	46.99	20.66	20.9	24.02	25.15	26.83	28.21	29.48
JJ2. Marine Fisheries	0.48 sq. nautical mile							
(a) Industrial		0.34	0.48	0.45	0.42	0. 73	0. 73	0. 75
(b) Artisanal		4.63	5.63	4.52	5.05	5.05	5.16	5.32
Total (Marine)		4.97	6.11	4.97	5.46	5.78	5.89	6.07
Country Total		25.63	27.01	28.99	30.62	32.62	34.1	35.55

Source: BER, 2015.

It is evident that inland aquaculture and inland open water fisheries are the two dominant sub-sectors, which together accounted for over 83 percent of the total fish production in Bangladesh. Hence, development of these two sub-sectors is vital in the context of making a major impact on the fish production and economic development of the people of this country, mainly the poor and marginal fishers.

Fisheries sector of Bangladesh is highly diverse in resources and species. There are about 795 native species of fish and shrimp in the fresh and marine waters. Besides that, there are 10 species of pearl bearing bivalves, 12 species of edible tortoise and turtle, 15 species of crab and 3 species of lobster. Species wise annual fish production is shown in Figure 1.6 (See Table A-1).

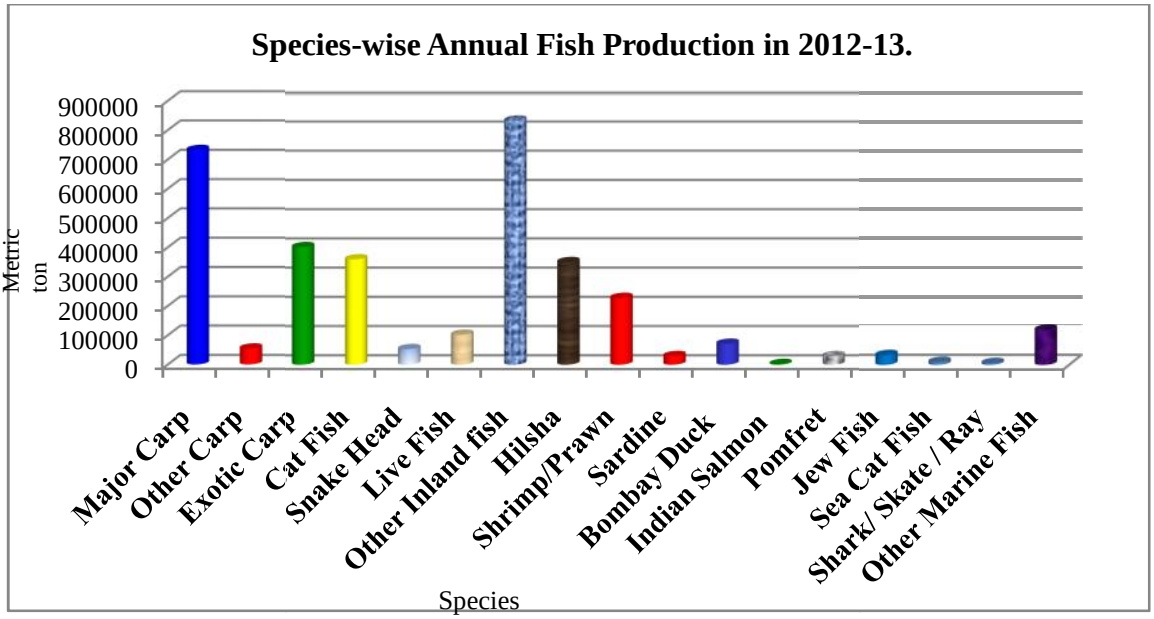

Figure 1.6: Species Wise Annual Fish Production in 2012-13.

Source: DoF, 2014.

Export earnings in 2013-14 stood at Tk. 178554.60 crore as against Tk. 159110.80 crore in the preceding year of which fsih, shrimps and prawns alone contributed about Tk. 4097.00 crore. Export earnings for 2013-14 increases Tk. 517 crore over the previous year for fish, shrimps and prawns (Table 1.2).

Table 1.2: Comparative Position of Export Receipts From Major Commodities During the Last Four Years (Tk. in crore)

Sl. No.	Commodity group	2010-11		2011-12		2012-13		2013-14	
		Amount	percent of A	Amount	percent of A	Amount	percent of A	Amount	percent of A
1	Readymade garments	96440	77.1	146627	78.4	128269	80.6	146627	82.1
2	Jute manufactures	4777	3.8	5317	3.4	5988	3.8	5317	3
3	Fish, shrimps and prawns	4149	3.3	4097	3.1	3580	2.2	4097	2.3
4	Leather and leather manufactures	3367	2.7	6864	2.8	5399	3.4	6864	3.8
5	Home Textile	3251	2.6	3862	2.4	3316	2.1	3862	2.2
6	Raw jute	1977	1.6	948	1.2	1681	1.1	948	0.5
7	Petroleum and petroleum products	852	0.7	5350	0.6	825	0.5	5350	3
8	Terry Towel	607	0.5	106	0.6	193	0.1	106	0.1
9	Bicycle	340	0.3	377	0.3	462	0.3	377	0.2
10	Pharmaceutical products	272	0.2	508	0.3	466	0.3	508	0.3
11	Handicraft	33	0	58	0	52	0	58	0
12	Tea	19	0	16	0	18	0	16	0
13	Fertilizer	181	0.1	1	0.1	1	0	1	0
14	Others	8740	7	4425	6.8	8862	5.6	4425	2.5
	A. Sub-total	125006	100	178555	100	159111	100	178555	100
	B. Exports of EPZ	20002	0	34820	0	30549	0	34820	0
	Grand total:(A+B)	14500	0	21337	0	18966	0	21337	0

		8		5		0		5	

Source: BB, 2015.

1.3 Importance of Shrimp in the Economy of Bangladesh

Shrimp farming plays a significant role in the economy of Bangladesh. Processed shrimp comprises one of the important export commodities of the country. Due to its tremendous potential, the area under shrimp farming has been increasing rapidly every year in Bangladesh.

In Bangladesh, shrimp industry is the second largest foreign currency earner after the garment industry. Expansion and spread of brackish water shrimp farming over the coastal areas during the decades of seventies and eighties as a result of the high demand in international market and its high prices in the world. Then shrimp farming become a major activity in the coastal belt of Bangladesh. Bagda shrimp cultivation has great potential in some areas of Bangladesh. Shrimp culture started in Bangladesh in the coastal district of Satkhira in 1960s. Gradually, its culture expanded to the coastal belts of Khulna, Bagerhat, Cox's Bazar and Chittagong and now the area under shrimp culture has increased from 64,246 hectares in 1984-85 to 275,274 hectares in 2013 (DoF, 2002 & 2014).

However, shrimp culture is an old practice in the coastal areas in Khulna, Satkhira, Bagerhat and Cox's Bazar districts. In the past, people trapped tidal water in low lying inter tidal lands by constructing small dike and harvested shrimp and finfish after 3-4 months. There was no stocking of fry under this system and only wild seeds of shrimp and fish carried by tidal water were allowed to grow without any form of management. Shrimp species harvested from the country are mainly black tiger shrimp (Bagda), brown shrimp (Horina), Indian white shrimp (Chaka) and giant freshwater shrimp (Galda). After the independence of the country, interest in shrimp production grew with rising price and demand in international markets. Shrimp farms were establishing in peripheral lands near the mouth of coastal rivers where inundation of saline water is possible. From the late 1970s to early 1980s, shrimp culture system expanded steadily. The industry grew rapidly to the mid 1990s. There

was rapid growth of other allied activities including establishment of processing plants, ice plants and shrimp depots (Rahman and Hossain, 2009).

Shrimp as a fisheries commodity represents a great importance in the international trade. It is a popular food item consumed throughout the globe, although once it was considered as a luxury foodstuff by many people. Developed nations such as USA, Japan and European countries are the major importers of shrimp products, whereas, developing nations, especially South-East countries, act as main shrimp suppliers of the world.

About 80 percent of the tiger shrimp comes from the south western region of Bangladesh i.e. greater Khulna region. The biology of these two species is mostly associated with the salinity of the environment. Khulna region is geographically situated in the mixed climatic condition between fresh, brackish and marine environment. Marine shrimp and fresh water prawn are both suitable culture in this ground. The rapid expansion of shrimp farming over last decade and its contribution to foreign earnings has been quite remarkable. In 2012-13 the total foreign earnings from shrimp export were Tk. 3376.20 crore by exporting 50333.00 MT shrimp (Figure 1.7 & Figure 1.8).

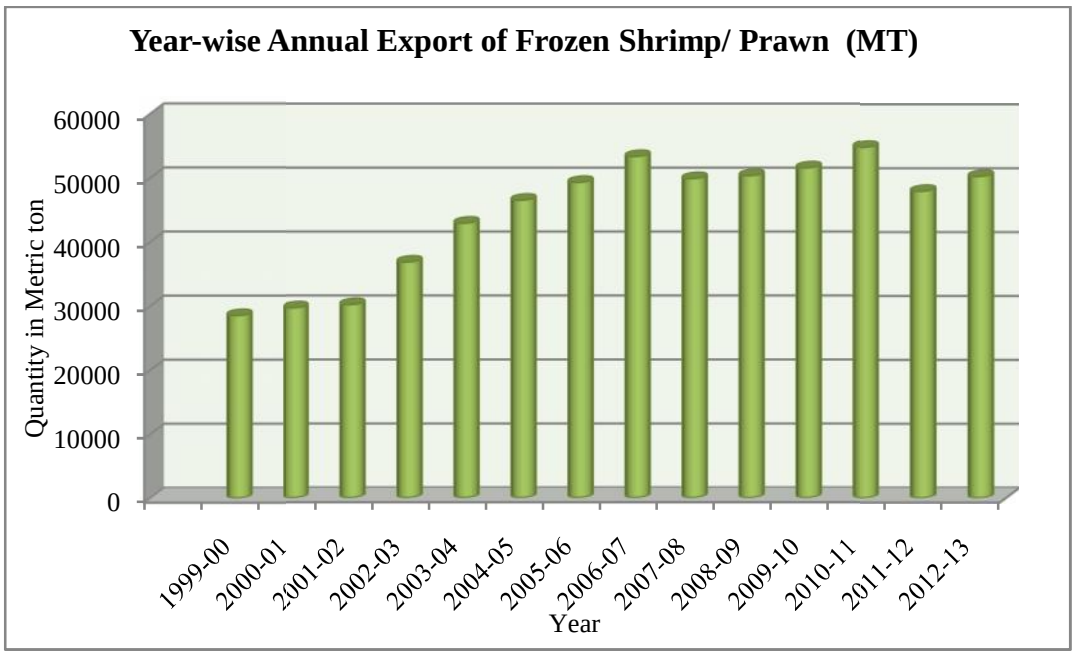

Figure 1.7: Year-wise Annual Export of Frozen Shrimp/Prawn (MT).

Source: DoF, 2014.

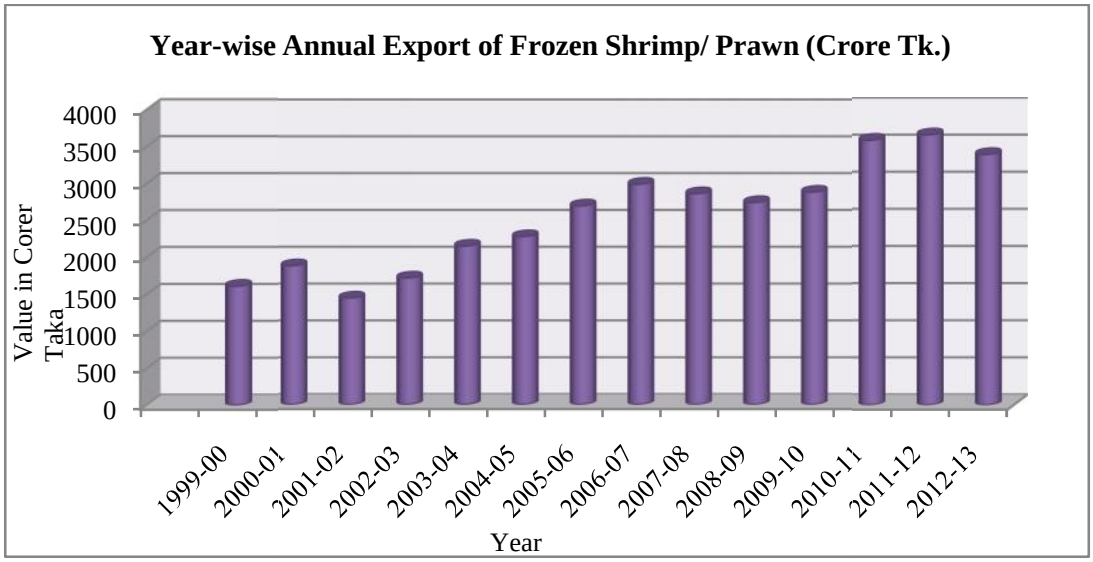

Figure 1.8: Year-wise Annual Export of Frozen Shrimp/Prawn (Crore Tk.).

Source: DoF, 2014.

Bangladesh earned 2359.94 crore Tk. and 716.30 crore Tk. by exporting 37274.39 MT bagda shrimp and 6678.94 MT galda shrimp in the year 2012-13 (Figure 1.9 & 1.10).

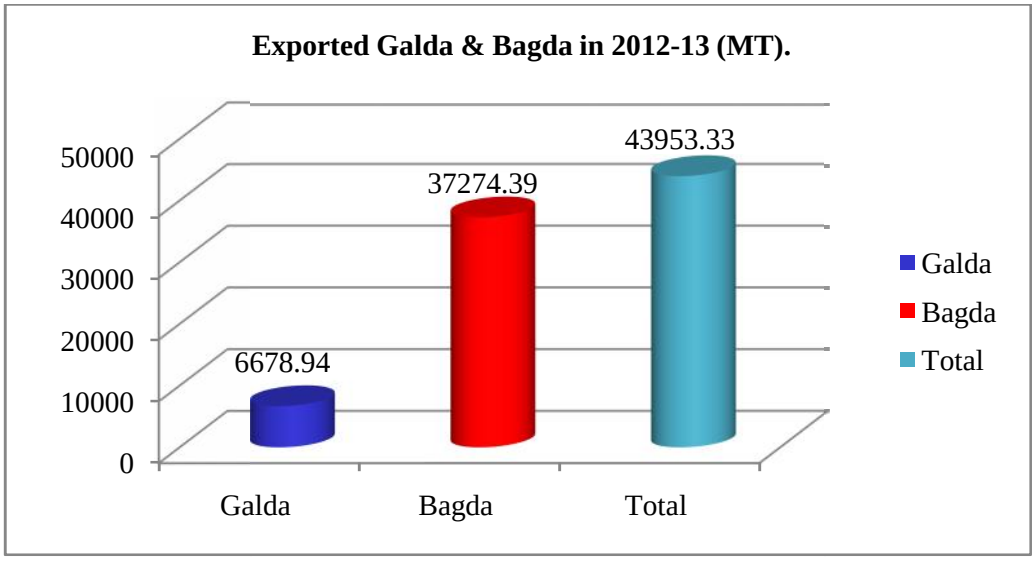

Figure 1.9: Exported Galda & Bagda in 2012-13 (MT).

Source: DoF, 2014.

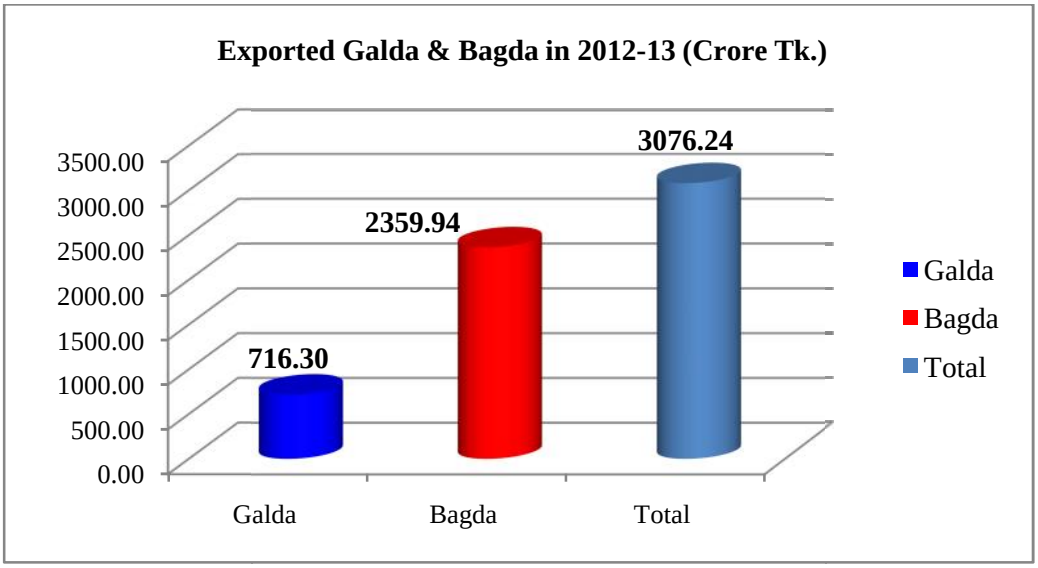

Figure 1.10: Exported Galda & Bagda in 2012-13 (Crore Tk.).

Source: DoF, 2014.

1.4 Area and Production of Shrimp

Commercial shrimp production depends mainly on producing giant tiger shrimp or bagda shrimp and fresh water galda shrimp. In total 52,000 hectare of land was used for shrimp production in 1983 and at present it has increased to 2,75,274 hectare and shrimp production also increased to 1,33,818 MT.

- Total shrimp farm area- 2, 75, 274 hectare
- Yearly shrimp production - 1, 33, 88 MT
- Per hectare shrimp production – 486 kg.
- Per hectare production (Total shrimp & fish) - 449 kg
- No. of bagda hatcheries - 60.
- Bagda fry production (Post Larva) - 923.92 crores.
- No. of galda hatcheires – 21 (5 are Government Organizaion)
- Galda fry production (Post Larva) – 3.31 crores.

Source: DoF, 2014.

Table 1.3 shows the annual production of shrimp/prawn farm in the 2012-13 in different division of Bangladesh including- Dhaka, Khulna, Barisal, Rangpur, Rajshahi, Chittagong and shylhet division.

Table1.3: Annual Production of Shrimp/Prawn Farm in 2012-13

Division	Area (Ha)			Shrimp/ Prawn Production (MT)				Fish Production (MT)	Total Production (MT)
	Bagda	Galda	Total	Bagda	Galda	Other shrimp / prawn	Total shrimp/ prawn		
Dhaka	0	1443	1443	0	501	3	504	688	1192
Khulna	156525	59381	215906	52906	40633	20157	113696	61354	175050
Barisal	7342	3124	10466	2642	2084	425	5151	2425	7576
Rangpur	0	14	14	0	5	0	6	4	9
Rajshahi	0	12	12	0	5	0	5	5	10
Chittagong	46186	1244	47430	13400	483	572	14455	0	22395
Sylhet	0	3	3	0	1	0	1	1	2
Total	210053	65221	275274	68948	43713	21157	133818	72417	206235
percent	76.31	23.69	100	33.43	21.2	10.26	64.89	35.11	100

Source: DoF, 2014.

1.5 Justification of the Study

Shrimp farming plays a vital role on changing our farmer's living standard and achieves self sufficiency in income. Shrimp farming plays just like cool air in hot weather for shrimp farmers. Shrimp farming is mainly based on the southern region of Bangladesh. This region is very important for fisheries production and most of the people are related with shrimp farming. Shrimp farming should receive an attention in order to earn huge amount of foreign currency for the increasing population of Bangladesh. Presently government and non-government organizations are extending scientific method of shrimp production. There exit wide variations in the yield of shrimp under different cultural and management practices of shrimp farming. The management practices and input use are likely to be influenced by socio-economic factors such as farmer's age, education, occupation, resource base and access to information. In order to increase the production of shrimp farming to the maximum possible extent, it was necessary to identify the factors behind the yield variations so that policy interventions might be made accordingly.

This study will generate baseline information on socio-demographic characteristics of shrimp farmers, level of input use and its pricing, cost and returns, factors affecting productivity of shrimp farms, resource use efficiency, consequences and problems associated with shrimp farming. The present study was conducted in 2 villages of Bagerhat sadar upazila under Bagerhat district. This study was expected to add some valuable information to the existing body of knowledge regarding shrimp farming particularly with respect to the area under study. This study provides appropriate suggestion and policy recommendations which might help the development agencies and policy makers of the country for improving the livelihood of coastal people.

1.6 Objectives of the Study

The specific objectives of the study are as follows-

a) To identify the socio-demographic profile of the respondents.
b) To calculate the profitability of shrimp farming.
c) To assess the resource use efficiency of shrimp farming.
d) To address the problems and suggest some policy recommendations for the improvement of shrimp farming.

1.7 Outline of the Study

This thesis contains a total of ten chapters which have been organized in the following sequence. Chapter 1 includes introduction. The review of literature is presented in Chapter 2. Methodology of the relevant study is discussed in Chapter 3. Chapter 4 provides the information about the study area. Chapter 5 contains the socio-demographic profile of the shrimp producing farmers. Chapter 6 deals with the costs and returns of shrimp farming. Chapter 7 describes the factors affecting returns of shrimp farming. Chapter 8 presents problems and constraints of shrimp farming. Finally, Chapter 9 represents the summary, conclusion and policy recommendations to increase shrimp production.

CHAPTER 2
REVIEW OF LITERATURE

2.1 Introduction

This chapter presents the review of relevant literature with a view to understand the method and cause-effect relationship of past and present research work on shrimp farming. This would help in narrowing down the problem correctly and in selecting the most appropriate technique of analysis. A large number of studies were conducted on production and marketing of shrimp in Bangladesh. But review of literature was not only limited to works done in Bangladesh but also was extended to other countries for having a broader view.

2.2 Shrimp Farming Related Studies

Biswas (1993) conducted research on "A comparative economic study on the production of transplanted aman with shrimp and without shrimp in Rampal thana under Bagerhat district". It was found from the study that the yield and net return of T. aman with shrimp was significantly lower than that of T. aman without shrimp. The yield of T. aman with shrimp was low mainly due to excessive intake of saline water into the field for shrimp cultivation. Besides, the ownership pattern also affected the yield of aman paddy. The study also found that the paddy farmers were not so much benefited if they would cultivate shrimp in their fields. But they were far away from the ability to produce the shrimp that involved high cost.

Das (1993) studied shrimp farmers by tenurial groups such as owner operator, owner-cum-tenant and tenant farmer from the district of Khulna and Bagerhat of Bangladesh to examine the socioeconomic characteristics, production profitability and problems of the selected farmers. He found that the highest production was obtained by owner operator (196 kg/ha) and the lowest production was obtained by owner-cum-tenant (151 kg/ha). He further showed that benefit cost ratio was the highest for owner operator (2.53). Functional analysis showed that application of more inputs would increase the farm income.

Uddin (1995) conducted "An economic study on shrimp farming in some selected areas of Khulna and Satkhira district". He found that most of the farmers in Satkhira district followed improved traditional method in shrimp farming which resulted in higher yield. Per hectare total cost of shrimp farming was Tk. 62613.26 in Satkhira district while it was Tk. 41815.69 in Khulna district. He also found that per hectare net income in Satkhira District was Tk. 78374.60 and in Khulna district it was Tk. 32447.49 which means that net income in Satkhira district was 2.41 times higher than that of Khulna district. In all respect shrimp farming in Satkhira district was more profitable compared to Khulna district.

Liao (1996) examined "The production economics of freshwater shrimp farming in southern Taiwan". Based on survey data, large farms were more profitable than small farms. It was found to be associated with lower production cost per hectare for large farms. A Cobb-Douglas production function was fitted to analyze the survey data. Farm size, capital and management were significant factors affecting production of freshwater shrimp. The adoption of improved practices resulted in higher yields. The estimated production function provides estimates of marginal value products for farm size, labor, capital and management.

Miah (2001) reported that per hectare production of shrimp (245 kg) was higher under alternative shrimp salt farming compared to the production of shrimp (207 kg) under alternate shrimp rice farming. He found that combined gross returns from producing shrimp and salt was Tk. 247165.00 substantially higher than that of combined returns from shrimp and rice production was Tk. 107235.00 under alternate shrimp rice farming system. In respect of socioeconomic consequences of shrimp farming, it was reported that about 90 percent farmers and other related people were economically and socially benefited due to shrimp farming. He also found that new employment opportunity had been created for both men and women. However, it was found from the study that shrimp farming had some negative effects on environment and agro-ecosystem, which had changed the biodiversity in the areas.

Parvin (2001) conducted a study on "Shrimp processing industry in Bangladesh: A market structure analysis". She stated that processed shrimps were distributed through two channels. There was no significant evidence of product differentiation in the industry but shortage of raw shrimps and lack of capital were the main barriers to entry for new firms. He also found the shortage of raw shrimps (100 percent), lack of institutional support (100 percent), lack of shipment facilities (45 percent), strike and political unrest (88 percent) and price instability (83 percent) were the important problems of shrimp processing firms.

Shah and Karim (2001) studied on Shrimp culture and changes of land use pattern in coastal belt of Bangladesh: A spatio-temporal analysis. They identified the causes and extent of changes of physical, socioeconomic and ecological pattern. A total of 3932 households were included covering ten thana of Khulna district in the survey. They showed that shrimp culture has created negative impacts on the physical, socioeconomic and environment of the areas as a whole. Some necessary guidelines had been provided for sustainable shrimp culture activities in the areas.

Miah *et al.* (2002) stated that shrimp farming and related activities helped the concerned people, directly and indirectly, to increase their household income which enables them to have more savings and investment, resulting in better livelihoods and socio-economic conditions. Shrimp industry was found to have the potential for absorbing the surplus labor force of the coastal areas. The study also revealed that existing unplanned shrimp culture had adversely affected the production of cereal crops and vegetables, trees and plantation, poultry and livestock, environment and agro-ecosystem, which had moderately changed biodiversity.

FFP (2003) study showed that untrained farmers, when they used inputs, generally used them in an undiscriminating wasteful manner. Following this findings, one of the Fourth Fisheries Project key messages to the farmers was that it was more effective and cheaper to use smaller quantities and balances between different types of inputs (e.g., using lime, urea or cattle manure, because

acidity discourages growth of phytoplankton even when nutrients are abundant).

Rahman (2003) conducted "An economic study of Galda shrimp farming in some selected areas of Jessore district". He found that under year-round galda shrimp farming, per hectare production was 550 kg, which was higher compared to the production of shrimp (440 kg) under alternate galda shrimp rice farming. The combined gross return Tk. 202500.00 from producing galda shrimp and finfish was substantially higher than that of combined returns Tk. 159800.00 from galda shrimp and rice production under alternate galdashrimp rice farming. He clearly indicated that year-round galda shrimp farming was highly profitable because farmers had to incur small amount of cost for producing galda. He also found that per hectare total cost was Tk. 78728.00 for producing galda and net return was Tk. 123772.00.

Islam *et al.* (2003) stated that the government of Bangladesh was concerned about the impact of shrimp farming. The government provided crucial support in the sector through accessing of land, leasing of 'khas' land to shrimp farmers and providing financial support in production and marketing of shrimp. Regarding negative impacts of shrimp culture, the government subsequently introduced some regulatory measures to mitigate some of the negative impacts. However, those measures were alleged to be inadequate and even not implemented to protect the negative socio-economic and environmental consequences.

Barmon and Osanami (2004) conducted a study on "Problems and prospects of shrimp and rice-prawn gher farming system in Bangladesh". The findings indicated that the shrimp-gher farming system had a negative impact on the environment, ecology, land degradation, livestock, and water quality; whereas the rice-prawn gher farming system was found to be friendlier to environment, ecology, and water quality and helpful to alleviate poverty. The rice-prawn gher farming system had significant impacts on land for modern varieties (MV) paddy production. The yield of modern varieties paddy production under rice-prawn gher farming system was almost the same as the yield in other parts of

Bangladesh where the farmers usually produce only year-round MV paddy. The rice-prawn gher farming system was found to provide a sufficient amount of rice, fish and vegetables to small, marginal and landless farmers that would not be possible under shrimp gher farming. Case studies and secondary data were used in the study. Primary data was not used for the study. So, in this regard the present study will provide better analysis for shrimp farming in Bangladesh.

Ito (2004) examined that changing agrarian institutions in southwestern Bangladesh where a large number of farmer, small and large, had switched from rice farming to export-oriented freshwater prawn farming within the last decade. The local economy boomed until ecological and managerial problems began to threaten the sustainability of the farming activities. At the same time, the impact of global competition was forcing the industry to adopt so-called global standards concerning food safety and sanitary conditions. These demand restructuring of the local supply chain at the bottom of which a significant number of small farmers were struggling to survive. It was argued that this restructuring was leading to small farmer's reduced access to financial capital and possible to changes in ownership pattern of freshwater prawn farms.

Nuruzzaman (2006) conducted a study on "The present status of shrimp at the stage of production and marketing: a study in Khulna district of Bangladesh". He found that the marine water shrimp and freshwater prawn was commercially cultured in Khulna district of Bangladesh. Thousands of farmers in this area had converted their paddy fields to shrimp and prawn farms to accommodate a profitable shrimp culture practice. However, now the production of shrimp and prawn are turn over all around the year. The shrimp/prawns supply chain from farmers to the international markets always pass through a number of middlemen: foria (field workers), prawn traders, agents and companies. He mainly used paired t-test for two sample mean and linear regression analysis for examining the relationship between production of shrimp and its stages of marketing. His study focused on marketing chain of shrimp farming but not on the other side like its profitability, socio-economic condition of the farmers and the impacts of shrimp cultivation on the income of the farmers. So, in that case

this study will provide a clear picture for the policy makers of the country for improving the livelihood of coastal people.

Reddy (2006) conducted a study on "Resource use efficiency of shrimp farming in India". This study was conducted to analyze resource use efficiency and resource productivity of shrimp farming for long-term sustainability. The medium farmers followed by large farmers emerged as the technologically advanced group, who meticulously adopted scientific culture management practices. The revival phase of shrimp culture from the recent setback was observed in the study. The resources that were efficiently utilized by the farmers include lime, organic manures and pond area. However, the material inputs, viz., feeds, stocking material, and fuel and electricity were excessively used. It was suggested that need-based training programmes and demonstrations should be conducted among farmers to encourage them to follow the recommended package of practices.

Islam *et al.* (2007) made an attempt to determine the gender role and empowerment of stakeholders involved in shrimp industry. They noted that after development of shrimp industry, involvement of women in income generating activities had increased but still male participation and involvement were dominant compared to women. There was significant difference of wage rate or salary between male and female in different sectors of shrimp industry where both male and female laborers were employed. For most of these cases, women workers had no bargaining power and the job market was controlled by the male character.

Uddin (2008) conducted a study on "safety standards in shrimp export from Bangladesh to the world's market". This study aimd to sketch out various activities of different stakeholders in the value chain from the production level to export market conformity with the food safety standards. The result revealed that shrimp farming found to be very much profitable and work environment was being improved. They were found to be trying to practice traceability. Some international organizations are working as third party certification agency. However, it was recommended to ensure traceability from the farm level to

shipment as well. It is also recommended to recover the illegally occupied government land and distribute those to the real shrimp farmers and processor to augment its production and export volume.

Rahman and Hossian (2013) conducted a study on "Present Status and Potentiality of Shrimp in Bangladesh". He found that Shrimp and prawn together represent the second largest exportable items contributing to foreign exchange earnings of Bangladesh. Shrimp farming was found to have significant impact on environment and economy. The productivity of shrimp was very low compare to the other shrimp producing countries of the world. One of the major causes of poor productivity was the extensive or traditional method of farming, whereas developed countries brought their farms under intensive or semi-intensive methods of farming. The farmers of the study area practiced galda-cum-rice pattern. The productivity of galda and T. Aman rice was found 505 kg/ha and 3497 kg/ha, respectively. About 72 percent famers of the study area were choose galda farming as the main occupation and shared 83.4 percent of their annual income whereas, rice shared 8.88 percent only. So, galda had significant importance to the socioeconomic and livelihood status of the farmers. Data on shrimp farm management practices were mainly analyzed using descriptive statistics such as mean, median and percent. Activity budget was used to analyze the profitability of shrimp/prawn farming. This study was not used the Cob-Douglas production function model which provides a clear explanation of the relationship between the input and output of shrimp farming. So, in this perspective this study will provide a clear explanation of the relationship between the input and output of shrimp farming based on the Cob-Douglas production function.

2.3 Concluding Remarks

The above mentioned discussion and review indicate that most of the studies dealt with cost, return, profitability and productivity of shrimp. Some studies also determine the factors affecting the profitability. Maximum studies examined parameters, which influence production, more than a decade ago. Within this period changes might have taken place in production process, and owing to these changes, the validity of those factors needs to be looked into again. Side by side

the influence of other factors identified by the researchers of other countries is needed to study studied in the context of Bangladesh. Very limited integrated studies were conducted on productivity and resource use efficiency of shrimp farming in Bangladesh. Therefore, this study is expected to be conducted taking into account those aspects. The review of literature was helpful to re-design methodological aspects with a view to overcome the limitations of previous studies. From the above studies the researcher felt the need of conducting and analyzing the productivity and resource use efficiency of shrimp farming in Bangladesh within the current development context, which will help the policy makers to understand the current situation and take programmes to increase shrimp production and improving the livelihood of coastal people in Bangladesh. On the other hand, researcher believed that the findings of this study would provide useful updated information, which would help the policy makers and researcher for further investigations.

CHAPTER 3
METHODOLOGY

3.1 Introduction

This chapter presents a detailed sequential steps of research work for instance, selection of study areas, selection of study period, sources of data, processing of data and analytical techniques.

3.2 Selection of the Study Area

Bagerhat district was selected as one of the major shrimp farming area for this study (Figure 3.1). This district contributed more than 26 percent towards the country's shrimp/ prawn farming areas and 29 percent of shrimp/ prawn production in 2012-13 (DoF, 2014). For selection of the study area, a preliminary visit was made in the respective areas. Two villages namely, Sungandhi, and Korari of Rakhagachi union under Sadar upazila of Bagerhat district, which are the extensive shrimp producing areas were selected with the consultation of Department of Fisheries (DoF) personnel of the respective upazila and district.

The reasons for selecting this study area for the present study are given below:

- Comparatively higher concentration of shrimp farming.
- These villages had some identical characteristics like homogeneous soil type, topographical and climatic condition for producing shrimp.
- Easy accessibility and good communication facilities.
- Researcher's belief about getting well co-operation from the selected respondent and
- No such study was conducted in this area.

3.3 Sources of Data

Data required for the present study were collected from primary and secondary sources. Primary data were obtained from farmers and secondary data were

collected from various published sources. Secondary sources were Bangladesh Bureau of Statistics (BBS), Department of Fisheries (DoF), Bangladesh Bank (BB) and other related agencies in Bangladesh.

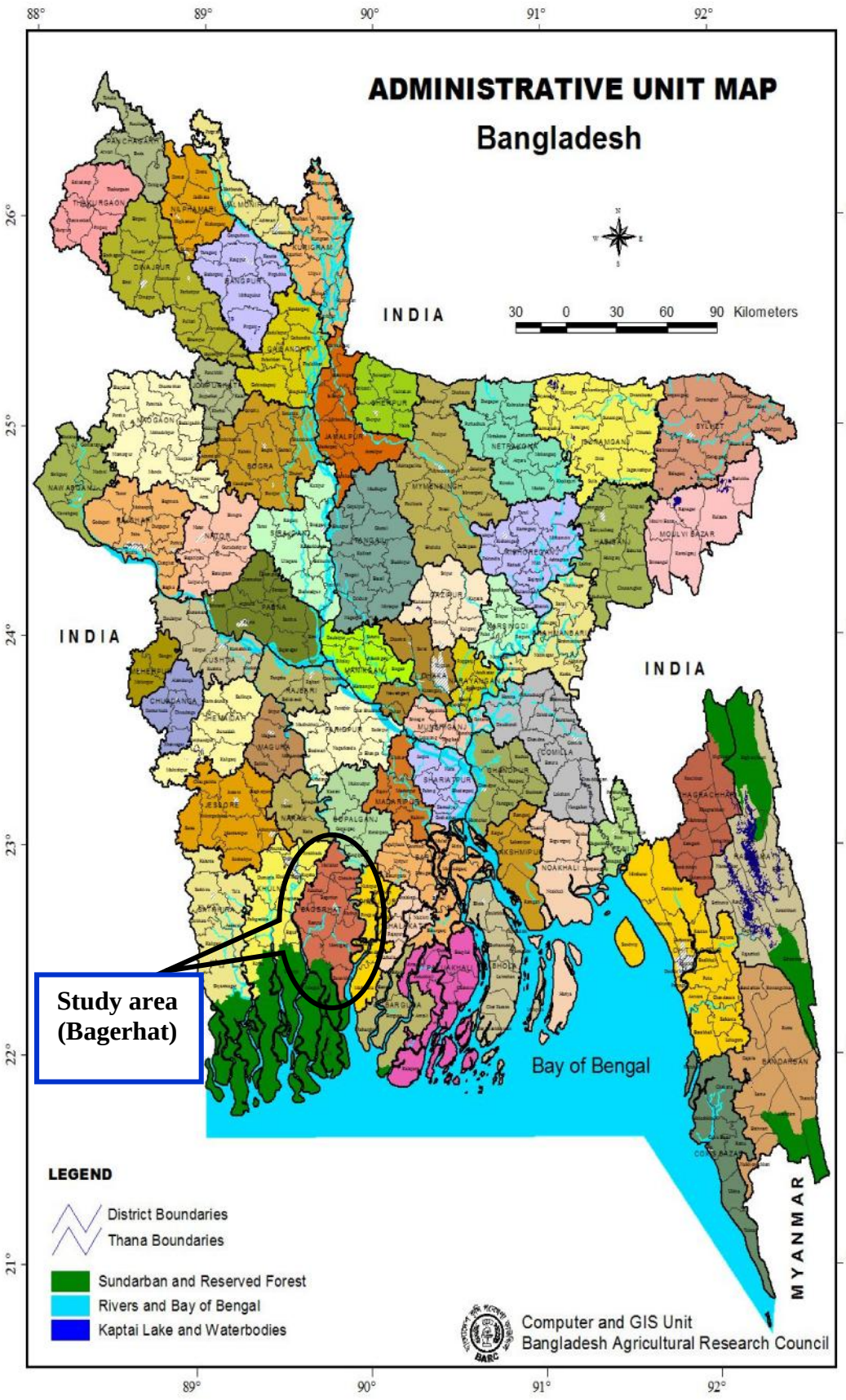

Figure 3.1: Map of Bangladesh

3.4 Selection of the Samples and Sampling Technique

Shrimp producing farmers were the respondent of primary sources of data for this study. Cultivators of shrimp were selected from the above selected areas as they represent the total farmers in terms of output and coverage. Survey method was followed to collect production related data while, simple random sampling technique was used to select the shrimp farmers. The list of shrimp farmers was prepared through a preliminary short survey with the help of Department of Fisheries (DoF) and Department of Agricultural Extension (DAE) personnel, after which they were selected by using random number table. A total of 105 year round shrimp farmers were selected from the selected villages.

3.5 Preparation of the Survey Schedule

Preparation of survey schedules is of crucial importance in this study. A comprehensive survey schedule was prepared to collect necessary information from the concerned respondent in such a way that all relevant information needed for shrimp (bagda) farming could be easily obtained within the shortest possible time. The interview schedule was pretested for judging their suitability. After pre testing, the schedule was finalized.

3.6 Collection of Data

To satisfy the objectives of the study, necessary data were collected by visiting each farm personally and by interviewing them with the help of a pretested interview schedule. Usually most of the respondent does not keep records of their activities. Hence it is very difficult to collect actual data and the researcher has to rely on the memory of the respondent. Before going to an actual interview, a brief introduction of the aims and objectives of the study was given to each respondent. The question was asked systematically in a very simple manner and the information was recorded on the interview schedule. When each interview was over the interview schedule was checked and verified to be sure that information to each of the items had been properly recorded. In order to minimize errors, data were collected in local units. These were subsequently converted into appropriate standard unit.

Data collection period was 1st April to 31st May, 2014. In order to obtain reliable data the researcher initially visited for several times to introduces himself with the people of the study areas during the season. Secondary data were collected through literature and different publications from BBS, BER, DoF, and Bangladesh Bank (BB) etc.

3.7 Editing and Tabulation of Data

After collection of primary data, the filled schedules were edited for analysis. These data were verified to eliminate possible errors and inconsistencies. All the collected data were summarized and scrutinized carefully. For data entry and data analysis, the Microsoft Excel programs and SPSS programs was used. It might be observed here that information was collected initially in local units and after checking the collected data, it was converted into standard units. Finally, a few relevant tables were prepared according to necessity of analysis to meet the objectives of the study.

3.8 Analytical Techniques

Data were analyzed with the purpose of fulfilling the objectives of the study. Both descriptive and statistical analysis was used for analyzing the data.

3.8.1 Descriptive Analysis

Tabular technique of analysis was generally used to find out the socio-demographic profile of the respondent, to determine the cost, returns and profitability of shrimp farm enterprises. It is simple in calculation, widely used and easy to understand. It was used to get the simple measures like average, percentage etc.

3.8.2 Production Function Analysis

The production function represents the technological relationship between output and factor inputs. To estimate the production function, one requires development of its properties leading to specification of an explicit functional form.

One of the most widely used production function for empirical estimation is the Cobb Douglas production. This function was originally used by C.W. Cobb and P.H. Douglas in twenties to estimate the marginal productivities of labor and capital in American manufacturing industries. Their main purpose was to estimate the shares of labor and capital in total product; hence they used this function with the constraint that the sum of elasticities or regression coefficients should total one. Later on, they relaxed this restraint. Cobb and Douglas originally fitted the function to time series 1930s and 1940s; the same form was used for cross section of industries.

This form of the function was subsequently used in many production function studies for technical units (crops, livestock) and farm-firms in agricultures. The popularity of this function is because of the following characteristics of the function:

(i) It directly provides the elasticities of production with respect to inputs;

(ii) It allows more degrees of freedom than other algebraic forms (like quadratic function) which allow increasing or decreasing marginal productivities, and

(iii) It simplifies the calculations by reducing the number of regression to be handled in regression analysis.

The original form used by Cobb and Douglas was

$$Q = aL^{\beta}K^{1-\beta}U$$

This forces sum of elasticities to one. Their later modification was

$$Q = aL^{\alpha}K^{\beta}U$$

Where, $\alpha + \beta$ need not equal one.

In agriculture, this form of function has not been used in its original form. Neither the sum of elasticities is kept equal to one nor is the number of variables limited to two. Even then as the basic idea of functional form was provided by Cobb and Douglas, various forms of this function have continued to be called as Cobb-Douglas production function.

The Cobb–Douglas production function, in its stochastic form, may be expressed as

$$Y_i = {}_1X_{2i}^{\square 2}X_{3i}^{\square 3}e^{u_i} \qquad \text{…….. (3.1)}$$

Where, ***Y*** **= output**

X_2= labor input

X_3= capital input

u = stochastic disturbance term, e = base of natural logarithm.

From Eq. (3.1) it is clear that the relationship between output and the two inputs is nonlinear. However, if we log-transform this model, we obtain:

$$\ln Y_i = \ln \beta_1 + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + u_i$$

$$= \alpha_0 + \alpha_2 \ln X_{2i} + \beta_3 \ln X_{3i} + u_i \quad \text{…….. (3.2)}$$

Where $\beta_0 = \ln \beta_1$.

Thus written, the model is linear in the parameters β_0, β_2, and β_3 and is therefore a linear regression model. Notice, though, it is nonlinear in the variables *Y* and *X* but linear in the logs of these variables. In short, (3.2) is a log-log, double-log, or log-linear model, the multiple regression counter part of the two-variable log-linear model.

The properties of the Cobb–Douglas production function are quite well known:

1. β_2 is the (partial) elasticity of output with respect to the labor input, that is, it measures the percentage change in output for, say, a 1 percent change in the labor input, holding the capital input constant.
2. Likewise, β_3 is the (partial) elasticity of output with respect to the capital input, holding the labor input constant.
3. The sum (β_2+ β_3) gives information about the returns to scale, that is, the response of output to a proportionate change in the inputs. If this sum is 1, then there are constant returns to scale, that is, doubling the inputs will double the output, tripling the inputs will triple the output, and so on. If the sum is less than 1, there are decreasing returns to scale—doubling the inputs will less than double the output. Finally, if the sum is greater than 1, there are increasing returns to scale—doubling the inputs will more than double the output.

Before proceeding further, note that whenever you have a log–linear regression model involving any number of variables the coefficient of each of the X variables measures the (partial) elasticity of the dependent variable Y with respect to that variable. Thus, if you have a k-variable log-linear model:

$$\ln Y_i = \beta_0 + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \ldots\ldots + \beta_k \ln X_{ki} + u_i \quad \text{…….. (3.3)}$$

Each of the (partial) regression coefficients, β_2 through β_k, is the (partial) elasticity of Y with respect to variables X_2 through X_k. Assuming that the model

(3.2) satisfies the assumptions of the classical linear regression model; we obtained the regression by the OLS. (Acharaya, 1988).

3.8.3 Specification of the Cobb-Douglas Production Function

The input-output relationships in bagda shrimp farming was analyzed with the help of Cobb-Douglas production function approach. To determine the contribution of the most important variables in the production process of shrimp farming, the following specification of the model was used.

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}X_6^{b_6}e^{u_i}$$ **…….. (3.4).**

The Cobb-Douglas production function was transformed into following logarithmic form so that it could be solved by ordinary least squares (OLS) method.

$$lnY = lna + b_1 lnX_1 + b_2 lnX_2 + b_3 lnX_3 + b_4 lnX_4 + b_5 lnX_5 + b_6 lnX_6 + + U_i$$

..(3.5)

Where, Y= Gross income from year round shrimp (Tk/ha);

X_1= Cost of shrimp fry (Tk./ha);

X_2= Cost of Feed (Tk/ha);

X_3= Cost of lime (Tk/ha);

X_4= Cost of fertilizer & manure (Tk/ha);

X_5= Cost of human labor (Tk/ha);

X_6= Cost of water management (Tk/ha);

a= Intercept;

b_1…..b_6= Coefficient of the respective variable;

Ui= Error Term;

i= 1, 2,…….6.

3.9 Multicollinearity Test

Economic variables usually exhibit a certain degree of interdependency mostly due to the general interdependence of economic phenomena. However it becomes difficult to disentangle the effects of each of the explanatory variables on the explained variable where the explanatory variables are highly inter-correlated. The practical question that needs to be asked is how these inter-correlations can be a problem in our inference about the individual parameters and what needs to be done to redress this problem.

In case of two explanatory variables one can judge whether there is a colinearity problem by looking at the correlation coefficient between the two variables. When there are more than two explanatory variables, the simple correlations among them become meaningless. There are several rules of thumb that have been suggested in the literature to detect when multicollinearity can be treated as a serious problem. For instance Klein says, "An inter correlation of variables is not necessarily a problem unless it is high relative to the overall degree of multiple correlation." By Klein's rule multicollinearity would be regarded as a problem only if $R^2_y < R^2i$ where R^2y is the squared multiple correlation coefficient between y and explanatory variables. R^2y is total explanatory power of the equation and R^2i represents the squared multiple correlation coefficient between xi and other explanatory variables (Maddala, 1989). Following this method R^2i's are estimated and compared with the R^2y's for selected explanatory variables for shrimp production function.

3.10 Measurement of Resource Use Efficiency

In order to test the efficiency, the ratio of Marginal Value Product (MVP) to the Marginal Factor Cost (MFC) for each input were computed and tested for its equality to 1. i.e., MVP/MFC = 1.

The marginal productivity of a particular resource represents the additional to gross returns in value term caused by an additional one unit of that resource, while other inputs are held constant. When the marginal physical product (MPP) is multiplied by the product price per unit, the MVP is obtained. The

most reliable, perhaps the most useful estimate of MVP is obtained by taking resources (Xi) as well as gross return (Y) at their geometric means.

In this study the MPP and the corresponding values of MVP were obtained as follows:

MPP_{xi}*P_{yi} = MFC,

Where, MPP_{xi} *P_{yi} = MVP,

But, MPP = bi*(Y/Xi)

So, MVP = bi* (Y/Xi) P_{yi}

Where,

b_i = regression coefficient per resource

Y = Mean output

X_i = Mean value of inputs

P_{yi} = price of output

MFC = price per unit of input.

Decision Criteria: The decision criteria for choosing efficiency will be-

- When the ratio of MVP and MFC is equal to unity indicates that the resource is efficiently used.
- When the ratio of MVP and MFC is more than unity implying the resource is underutilized.
- When the ratio of MVP and MFC is less than unity implying the resource is overused.

3.11 Profitability Analysis

Cost and return analysis is the most common method of determining and comparing the profitability of different farm household. In the present study, the profitability of shrimp farming is calculated by the following way-

3.11.1 Calculation of Gross Return

Per hectare gross return was calculated by multiplying the total amount of product and by-product by their respective per unit prices.

Gross Return= Quantity of the product * Average price of the product + Value of by-product.

3.11.2 Calculation of Gross Margin

Gross margin is defined as the difference between gross return and variable costs. Generally, farmers want maximum return over variable cost of production. The argument for using the gross margin analysis is that the farmers are interested to get returns over variable cost. Gross margin was calculated on TVC basis. Per hectare gross margin was obtained by subtracting variable costs from gross return. That is,

Gross margin = Gross return – Variable cost.

3.11.3 Calculation of Net Return

Net return or profit was calculated by deducting the total production cost from the total return or gross return. That is,

Net return = Total return – Total production cost.

The following conventional profit equation was applied to examine farmer's profitability level of the shrimp producing farms in the study areas.

$$\text{Net profit, } \pi = \Sigma P_m Q_m + \Sigma P_f Q_f - \Sigma (P_{xi} X_i) - TFC.$$

Where, π **= Net profit/Net return from shrimp farming (Tk/ha);**

P_m **= Per unit price of shrimp (Tk/kg);**

Q_m **= Total quantity of the shrimp production (kg/ha);**

P_f **= Per unit price of other relevant fish (Tk/kg);**

Q_f **= Total quantity of other relevant fish (kg/ha);**

P_{xi} **= Per unit price of i-th inputs (Tk);**

X_i **= Quantity of the i-th inputs (kg/ha);**

TFC = Total fixed cost (Tk); and

i = 1, 2, 3,....., n (number of inputs).

3.11.4 Undiscounted Benefit Cost Ratio (BCR)

Average return to each taka spent on production is an important criterion for measuring profitability. Undiscounted BCR was estimated as the ratio of total return to total cost per hectare.

$$\text{BCR} = \frac{\text{Total Return}}{\text{Total Cost}}$$

3.12 Problem Faced in Collecting Data

During the period of data collection, the researcher faced the following problems.

i) Most of the farmers felt disturbed to answer questions since they thought that the researcher might use the information against their interest. To earn the confidence of the farmers a great deal of time was spent.

ii) The farmers do not keep records of their activities and day to day expenses. Therefore the author had to depend upon their memory.

iii) The farmers were usually busy with their filed works. So, the researcher sometimes also had to pay extra visits to meet the farmer.

CHAPTER 4
DESCRIPTION OF THE STUDY AREA

4.1 Introduction

The description of the study area is important because it provide a brief, clear and unambiguous description of the study area to identify the farmer's level of living and the salient features of the area. The description of the study area includes location, area and population, educational and occupational status, physical features and topography such as climate, temperature and rainfall, economic condition, transportation, communication and marketing facilities. This information is essential for better understanding of the facts and findings of the research and for the selection of a representative sample.

4.2 Location

Bagerhat Sadar is a coastal upazila in Bagerhat district of Khulana division in Bangladesh. Total area of this upazila is 316.97 sq km, located in between 22°35' and 22°50' north latitudes and in between 89°38' and 89°53' east longitudes. It is bounded by Fakirhat and Chitalmari upazilas on the north, Rampal and Morrelganj upazilas on the south, Kachua upazila on the east, Fakirhat and Rampal upazilas on the west. The main river is Bhairab, Chitra, Daudkhali and Taleswar. Mangrove forest Sundarban is attached to Rampal upazila (Banglapedia, 2015).

4.3 Area and Population

Bagerhat thana was formed in 1842 and it was turned into an upazila in 1983. It consists of 10 union parishads, 169 mouzas and 183 villages. Bagerhat (town) consists of 9 wards and 31 mahallas. The area of the town is 7.24 sq km. The town has a population of 46455. The density of population is 6416 per sq km. It has one dakbunglow. Muslims comprise 207064 of total population, Hindu 49694, Christian 19 and Buddhist 411 and others 85. There are 452 mosques, 13 temples, and 1 sacred place. Total population of this upazila is 257273 of which male is 133514 and female is 123759. The area of Rakhalgachhi union is 4557 sq km. Total population of this union is 12352 which includes male 6290 and female

6062. Socio-economic condition is poor. Most of the people live on shrimp cultivation, fishing, agriculture and small enterprise business. Scarcity of safe drinking water, erosion and damage of embankment is major problem in this upazila. People in this upazila lives with fear of cyclone and surge from July to December (Banglapedia, 2015).

4.4 Educational and Occupational Status

Average literacy rate of Bagerhat Sadar upazila is 60.9 percent, 63.3 percent for male and 58.4 percent for female. 13 colleges, 44 secondary schools, 03 lower secondary school, 160 madrasas, 160 primary school, 2 technical schools, 10 library, 4 institute and 1 women organization are the main educational institutions. Main occupation of Bagerhat Sadar upazila are agriculture 42.01 percent, non-agricultural laborers 7.41 oercent, industry 1.27 percent, commerce 21.31 percent, transport and communication 4.55 percent, service 10.61 percent, construction 1.78 percent, religious service 0.26 percent, rent and remittance 0.54 percent and others 10.26 percent (Banglapedia, 2015).

4.5 Physical Features, Topography and Soil Type

Bagerhat is coastal belt area. Nature of water available here is saline. There is evidence that the salinity regime of the entire southwestern region of Bangladesh has been changing as a result of reduced freshwater flow from upstream. This reduced flow is said to be associated with increased compartmentalization of water bodies, excessive groundwater extraction and withdrawal of upstream flow by India's Farakka Barrage. Ownership of agricultural land in this upazila: Landowner 56.38 percent, landless 43.62 percent, and agricultural landowner: urban 52.08 percent and rural 57.29 percent. Fisheries, dairies and poultries in this upazila: Shrimp cultivation (Chingri gher) 10461 (Galda and Bagda), dairy 42, poultry 320, hatchery 10 (Banglapedia, 2015).

4.6 Transport, Communication and Marketing Facilities

Transport, communication and marketing facilities play a significant role in overall agricultural and economic development; especially rural development becomes impossible without these facilities. Bagerhat district has an excellent transport system and is well connected by highways, waterways and railways

linking to all the districts of Bangladesh and capital city Dhaka. The distance from Dhaka to Bagerhat is about 260 km. Bagrhat Sadar is about 35 km away from Khulna. There are several luxury and economy nationwide bus services available in Bagerhat Sadar, Bagerhat. Most of them are private bus services. BRTC also operates, inter-district bus services from Bagerhat, Khulna and Barishal is available. Khulna railway station is the main railway station in the city. Bangladesh railway operates Express trains between Khulna-Dhaka. Jessore airport, located 71 km north of Khulna city centre, is the only airport in the region. And those airlines have AC bus services from the airport to Khulna.

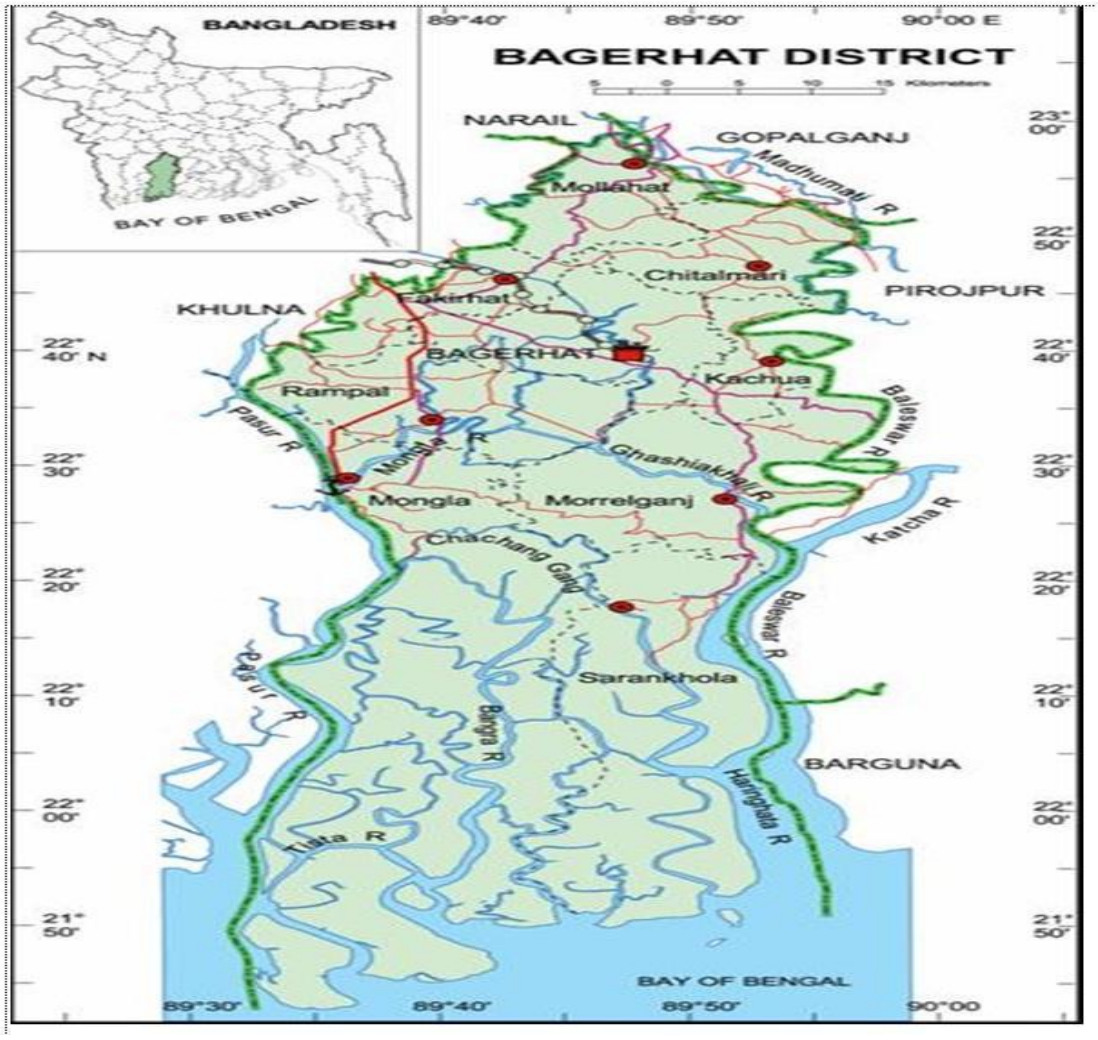

Figure 4.1: Map of Bagerhat District.

Communication facilities are of concrete road 156 km, semi-concrete road 53 km, mud road 367 km, railway 12.75 km. Marketing facilities is also well developed in this area. Hats and bazars are 31, fairs 5, most noted of which are Jatrapur Hat,

Barakpur Hat, Babur Hat, Katakhali Hat and Panighater Mela, Jatrapur Rath Mela, Koramar Kasundi Mela and Krishi (agriculture) Mela (Banglapedia, 2015).

4.7 Climate, Temperature and Rainfall

Climate of Bagerhat Sadar upazila is humid during summer and pleasant in winter. It has an annual average temperature of 33.5°C: maximum 34°C in May and minimum 12.5°C in January. Humidity is about 76.1 percent on an average. Annual average rainfall of Bagerhat Sadar upazila is 1710 millimeters. Approximately 87 percent of the annual average rainfall occurs between May and October (BBS, 2013a).

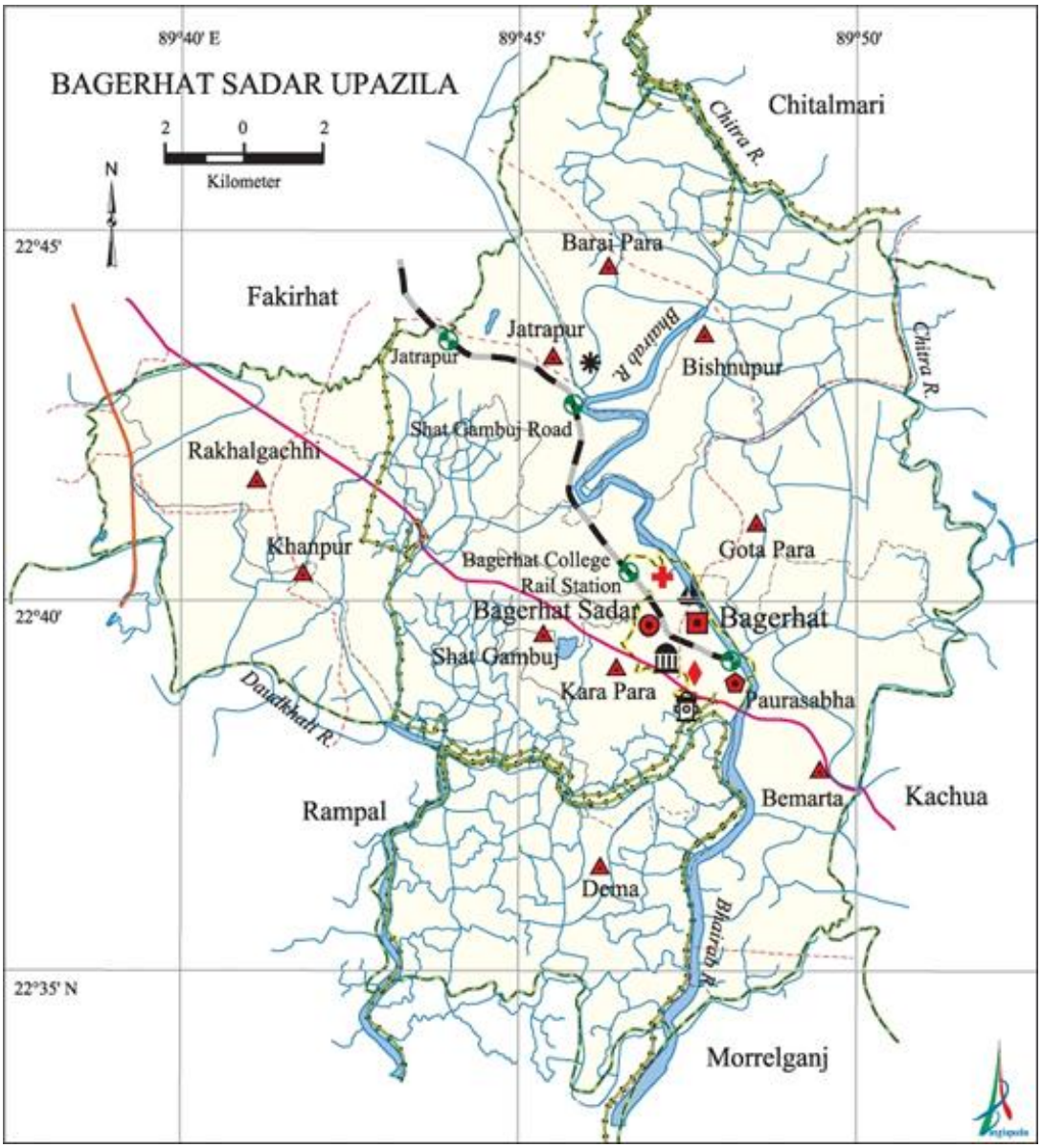

Figure 4.2: Map of Bagerhat Sadar upazila.

4.8 Health, Sanitation and Electricity

Bagerhat Sadar is a coastal belt area. Almost all of water are available here saline in nature. There safe drinking water coverage is 70.55 percent. So they suffer a lot by various types of water borne diseases such as diarrhea, dysentery. People of this upazila are used to take high protein diet and fry spicy food. As a result, they are suffering from acidity, appendicitis etc. So health condition of these upazila must need to increase. All the wards and unions of the upazila are under rural electrification net-work. However 40.76 percent of the dwelling households have access to electricity. Sources of drinking water: Tube-well 70.55 percent, pond 13.73 percent, tap 13.95 percent and others 1.77 percent. Sanitation: 49.9 percent (rural 45.37 percent and urban 71.45 percent) of dwelling households of the upazila use sanitary latrines and 45.94 percent (rural 50.16 percent and urban 25.85 percent) of dwelling households use non-sanitary latrines, 4.16 percent of households do not have latrine facilities. Health centers: Hospital 1, satellite clinic 2, union health and family planning centre 10, child and maternity clinic 1, midwife training institute 1, nursing school 1, and private clinic 81. The coverage of sanitary latrine was high before SIDOR and AYLA and at present it has reduced due to bad impact of SIDOR and AYLA. Hope coverage of drinking water and sanitary latrines will be 100 percent in future (Banglapedia, 2015).

4.9 Non-Government Organizations

Non-Government Organizations (NGOs) play an important role for increasing the overall condition such as they are working in the country with the vision that they can provide a better life for under privileged and marginalized communities of Bangladesh and can help the poor farmers. In Bagerhat Sadar upazila, different NGOs are working on their activities. Some of them are BRAC, CARE, ASA, Grameen Bank, Nobolok, Proshika etc. they provide agricultural credit to farmers, microcredit to women and landless farmers at a reasonable interest rate (Banglapedia, 2015).

4.10 Concluding Remarks

The above short description gives an overview of the physical, topographical, demographic and socioeconomic situation of the Bagerhat district in general and for

the study upazila in particular. Bagerhat Sadar upazila has potential for shrimp cultivation and its contribution in the national economy. The proper management and utilization of the available natural resources is also indispensable to enhance the productivity of shrimp farming.

CHAPTER 5

SOCIO-DEMOGRAPHIC PROFILE OF SHRIMP PRODUCING FARMERS

5.1 Introduction

This chapter deals with the socioeconomic characteristics of the sample farmers. Socioeconomic characteristics of the farmers are important in influencing production planning. People differ from one another in many respects. Behavior of an individual is largely determined by his/her characteristics. There are numerous interrelated and constituent attributes that characterize an individual and profoundly influence development of his/her behavior and personality. It was, therefore, assumed that enterprise combination, consumption pattern, purchase pattern, and employment patterns of different farm household would be influenced by their various characteristics. In the present study 46 (43.80 percent) and 59 (56.20 percent) farmers were taken from the village Sugandhi and Korari respectively. Finally socioeconomic aspects of the sample households were examined. These were family size and composition, age distribution. Occupation, level of education, involvement of women, land ownership pattern etc. A brief discussion of these aspects is given below.

5.2 Age Distribution and Family Size of the Sample Farmers

Age of farmers have an influence on the production and in the better management of the farming system. Some researchers think that older farmers are more experienced and more efficient in resource use. Other researchers comment that younger farmers are eager to adopt improved technology than older.

Table 5.1 Age Distribution and Average Family Size of the Respondent

Age category	No.	Percent (%)
20-30 years	22	21.00
31-45 years	65	61.90
Above 45 years	18	17.10
Total	105	100.00
Average family size	4.20	

Source: Field survey, 2014.

In the present study, all categories of farmers of the study area were classified into different age groups as presented in Table 5.1. It is evident from the table that most of the farmers were middle aged in the study area. The shrimp producing farmers were classified into three age groups: up to 20-30 years, 31-45 years and above 45. Out of the total sample farmers 21.00 percent belonged to the age group of 20-30 years, 61.90 percent belonged to the age group of 31-45 years and 17.10 percent fell into the age group of above 45. The average family size of our country was about 4.40 (BBS, 2013b). The average family sizes of the shrimp producing farmers were found to be 4.20 which were slight less than the average family size of the country. This finding imply that majority of the sample farmers were in the most active age group of 31-45 years indicating that they provided more physical efforts for farming. This age group is supposed to have enormous vigor and risk bearing ability.

5.3 Educational Status of the Respondents

Education is generally regarded as an index of social improvement of a community. It plays a critically important role in reducing poverty and inequality, improving health and enabling the use of knowledge. Education means efficiency. Education of farmers helps to increase skill and productivity. Education plays an important role in accelerating the pace of agricultural development and it greatly influences the new technology and scientific knowledge regarding farming. It is evident from table 5.2 that out of 105 sample farmers, 17.10 percent farmers had primary education, 14.30 percent farmers had completed P.S.C level education, 26.70 percent farmers had completed J.S.C level education, 27.60 percent farmers had completed their secondary level education, 6.70 percent farmers had completed their higher secondary education and last of all only 7.60 percent farmers had completed their higher study.

Table 5.2 Educational Status of the Shrimp Producing Farmers

Level of education	No.	Percent (%)
Primary level	18	17.10
P.S.C	15	14.30
J.S.C	28	26.70
S.S.C	29	27.60
H.S.C	7	6.70
Higher study	8	7.60
Total	105	100.00

Source: Field survey, 2014.

5.4 Occupational Status of the Shrimp Producing Farmers

The work in which a man was engaged more or less throughout the year was considered as the occupation of the person. The distribution of principle occupation is fascinating because it varies greatly depending on how much they are involved and what level of income is earned from the present occupation. In the present study, the selected farmers were engaged with various types of occupation along with shrimp farming. It was observed that, as a main source of income, shrimp farming was the principle occupation for shrimp farmers. Some of them had opportunity to be engaged in other activities. Occupational status of the sample farmers are shown in the following figure 5.1 and 5.2. It is evident from the figure that 73 percent and 32 percent farmers were involved in shrimp farming as a main and subsidiary occupation. After that Business was their second most important occupation. Very few of them were also involved in crop farming, agriculture and fisheries etc.

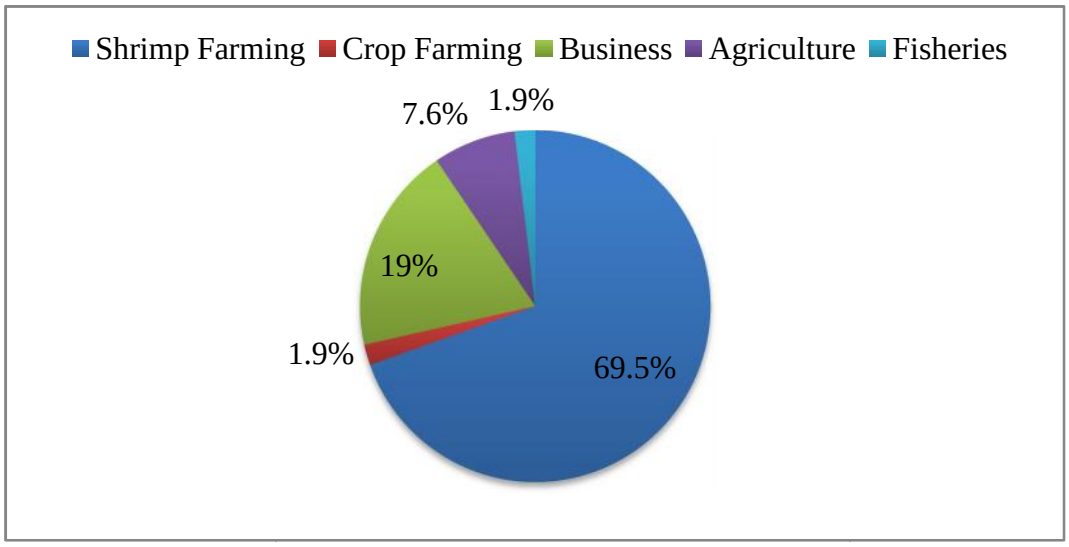

Figure 5.1: Main Occupation of the Shrimp Producing Farmers

Source: Field survey, 2014.

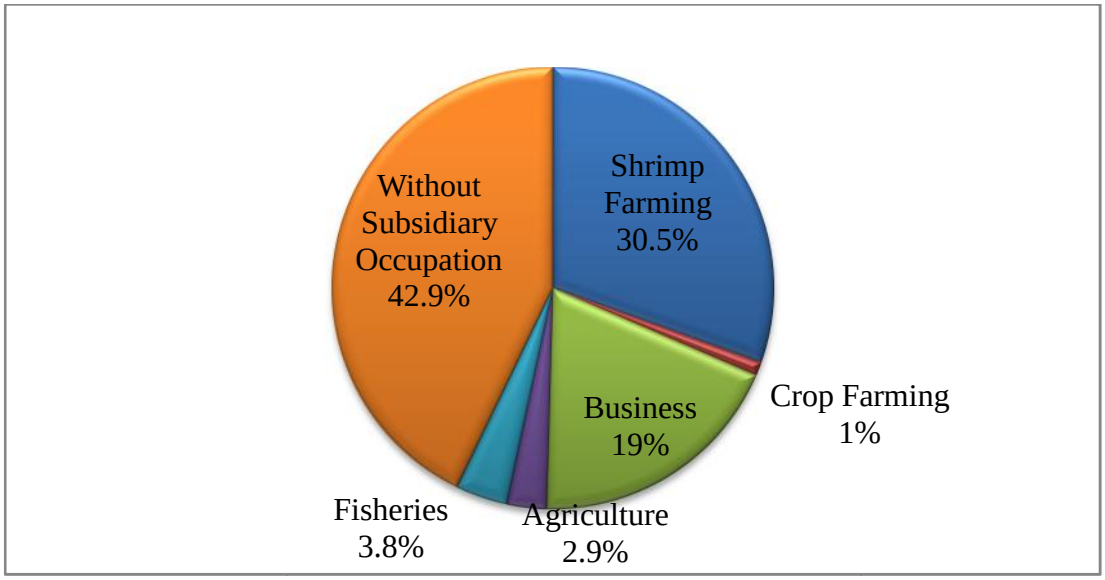

Figure 5.2: Subsidiary Occupation of the Shrimp Producing Farmers

Source: Field survey, 2014.

5.5 Ownership Pattern of Selected Sample Farmers

Most of the agricultural lands in Bangladesh are divided and sub-divided into small plots mainly due to law of inheritance. The ownership patterns of the shrimp producing farmers were classified into three categories: single, double and multiple. About 56.20 percent shrimp farmers were single owner, 36.20 percent were belonged to double ownership and those of 7.60 percent had multiple ownerships (Table 5.3).

Table 5.3 Ownership Pattern of the Sample Farmers

Ownership pattern	No.	Percent (%)
Single	**59**	**56.20**
Double	**38**	**36.20**
Multiple	**8**	**7.60**
Total	**105**	**100.00**

Source: Field survey, 2014.

5.6 Involvement of Women in Shrimp Farming

Women in our country are the most deprived one but at present this situation is changing. About half of the population of our country is women. So without their development, the total social and economical development of our country is not possible. In the present study, involvements of women in shrimp farming were categorized into three categories: 1 women involvement, 2 women involvement and 3 women involvement. It is evident from the table 5.4 that 24.76 percent farmers used 1women labor in their farm, 11.43 percent farmers used 2 women labor in their farm and only 0.95 percent farmers used 3 women labor in their farm. So the result implies that involvement of women in shrimp farming activities were very small. About 62.86 percent farmers did not use women labor in their farm.

Table 5.4 Involvement of Women in Shrimp Farming

Category of women involvement	No.	Percent (%)
No women involvement	66	62.86
One women involvement	26	24.76
Two women involvement	12	11.43
Three women involvement	01	0.95
Total	105	100.00

Source: Field survey, 2014.

5.7 Size of Land Holdings of the Sample Farmers

In the present study the size of land holdings of the shrimp producing farmers are classified into different categories. Size of land holdings includes homestead area, orchard, pond, cultivated land, fellow land, leased in, leased out and mortgage in as reported by the sample farmers. It is evident from the table 5.5 that 2.75 percent, 16.08 percent, 33.79 percent, and 10.84 percent areas were homestead area, cultivated land, leased out and leased in area respectively hold by the sample farmers on an average.

Table 5.5 Size of Land Holdings of the Sample Farmers

Types of land	Average area (Decimal)	Percent (%) of area
Homestead	15.27	2.75
Orchard	48.48	8.75
Pond	7.15	1.29
Cultivated land	89.12	16.08
Fellow land	21.84	3.94
Leased in	60.10	10.84
Leased out	187.31	33.79
Mortgage in	125.05	22.56
Total	554.32	100.00

Source: Field survey, 2014.

5.8 Sources of Credit Facilities of the Respondent

Available amount of funding is an important factor for any kind of farming. The sources of credit facilities for the shrimp producing farmers include Banks, NGOs, Relatives and also their own funding. In the study area different NGOs such as BRAC, ASA, CARE, Nobolok etc are operating their services for providing loan to the poor farmers rate, so they can use this fund in the shrimp farming business. About 19.05 percent farmers were taken loan from Banks, 40.95 percent farmers were taken credit from NGOs and 23.81 percent farmers

were taken loan from their relatives as reported by the sample farmers. And 76.19 percent farmers were used their own funding (Table 5.6).

Table 5.6 Sources of Credit Facilities of the Sample Farmers

Items	No.	Percent (%)
Banks	20	19.05
NGOs	43	40.95
Relatives	25	23.81
Own funding	80	76.19

Source: Field survey, 2014.

Note: one shrimp farmer reported more than one source, so addition of percentage will not necessarily equal to 100.

5.9 Income Distribution of the Respondent

The yearly income of shrimp farmers differs from one another. In the present study, the incomes of shrimp farmers were categorized as follows: less than 150,000, from 150,000 to 250,000 and above 250,000. It is evident from the figure 5.3 that most of the farmer's yearly income belonged to the category of 150,000 to 250,000. About 56.2 percent of the shrimp producing farmers were earned Tk. 150,000 to 250,000 per year, 23.8 percent of the farmers were earned Tk. less than 150,000 per year and 20 percent farmers were earned Tk. Above 250,000 per year.

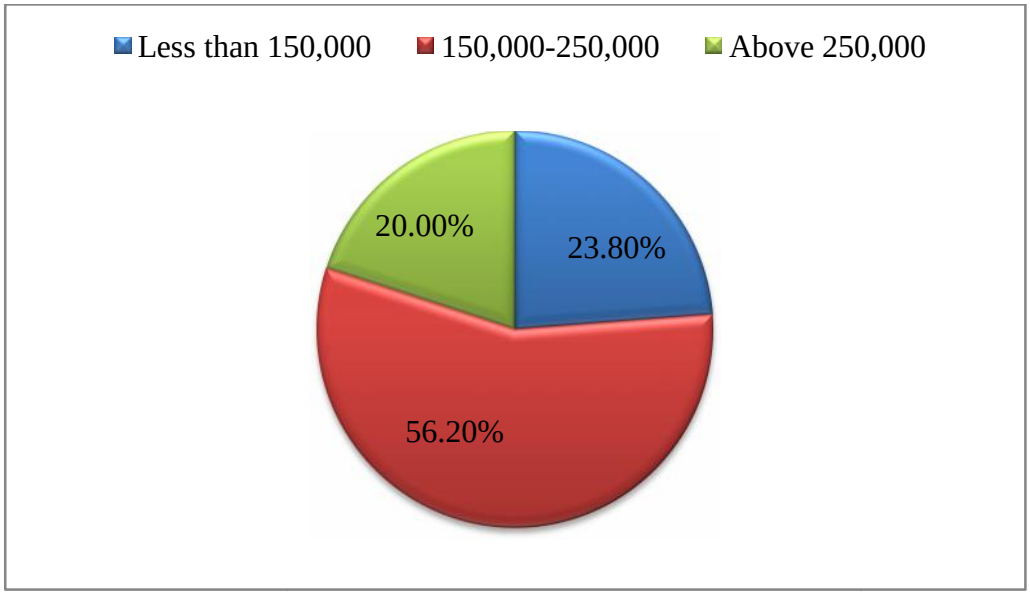

Figure 5.3: Income Distribution of the Respondent

Source: Field survey, 2014.

5.10 Concluding Remarks

This chapter analyzed the socioeconomic attributes of the sample farmers. The findings of analysis clearly indicate the socioeconomic characteristics from each other in respect of age distribution, education, occupation, farm size, ownership pattern, involvement of women & income etc.

CHAPTER 6
COSTS AND RETURNS OF SHRIMP FARMING

6.1 Introduction

For every production process, cost plays a vital role for making right decision of the farmers. This chapter mainly deals with the estimation and analysis of costs of shrimp production. The costs were classified into variable costs and fixed costs. Most of the inputs were valued at the current market rate and sometimes governments' rates in the study area during the survey period or the prices at which farmers bought the inputs. But, for some unpaid inputs such as family labor, non-cash price was actually paid and pricing was very difficult in such cases. In these cases, the rule of opportunity cost was followed.

In this chapter, in terms of shrimp farming per hectare yield, gross return, gross margin, net return and undiscounted benefit-cost ratio are discussed. Therefore, a financial return of producing shrimp was calculated from the standpoint of farmers. All the returns were accounted for the study period. A brief account showing how the individual costs and returns were estimated in the present study is presented below. For analytical advantages, the cost items were classified under the following heads:

i. Human labor cost
ii. Shrimp fry cost;
iii. Lime cost;
iv. Fertilizer cost;
v. Manure cost;
vi. Feed cost;
vii. Water management cost;
viii. Land use cost;
ix. Construction of guard shed, office and other housing cost;
x. Miscellaneous cost;
xi. Interest on operating capital (OC).

6.2 Variable Costs

6.2.1 Human Labor Cost

Human labor is one of the most important variable inputs in the production process. Human labor is required for various activities and management of the selected farms such as- farm preparation, raising dyke, weeding, sorting, grading, harvesting etc. Human labor was classified into: (a) hired labor and (b) family labor. It is easy to calculate hired labor costs. To determine the cost of family labor, the opportunity cost concept was used.

In this study, the opportunity cost of family labor was assumed to be as wage rate per man i.e., the wage rate, which the farmers actually paid to the hired labor for working a man-day. The labor of women and children was converted into man-equivalent day by presenting a ratio of 2 children day = 1.5 women days = 1 man equivalent day (Miah, 1987). In this study a man-day was considered to be 8 hours of work. For avoiding complexity, average rate has been taken into account. Labor wage rate varies with respect to different seasons. In the study area it varied from 300 to 350 Tk. per man-days. Thus the computed average rate was Tk. 325 per man-days for shrimp farming.

Use of human labor and its relevant cost incurred were shown in table 6.1. The per hectare labor cost was Tk. 33475 which constituted 32.15 percent of total variable cost.

6.2.2 Cost of Shrimp Fry

Shrimp fry is a major input of bagda shrimp farming in the study area. The farmers used purchased seed from fry collectors and hatchery. There was a variation in the per unit price of seed from location to location and time to time. But cost was calculated on the basis of actual price paid by the farmers. The average price of shrimp seed was Tk. 0.76 per piece. The per hectare average costs of shrimp fry were estimated at Tk. 20631 which constituted 19.81 percent of total variable cost (Table 6.1).

6.2.3 Cost of Lime

Lime is an important factor to the shrimp farmers which prolongs healthy and productive environment for shrimp in the shrimp farm. It was used to neutralize acidity in the soil and pond water and it prevents diseases of shrimp. Lime assists in the release of nutrients from the soil and promotes bacterial breakdown of organic material including green manure. Cost of lime was charged at the price actually paid by the farmers. The average price of lime was estimated to be Tk. 15 per kg during the study period. There is a required dose for lime application, but the shrimp farmers in the study area used 105 kg/ha for shrimp production. Average per hectare costs of lime was calculated at Tk. 1575 which constituted 1.51 percent of total variable cost (Table 6.1).

6.2.4 Cost of Fertilizer

Fertilizer is an important input for shrimp farming. Shrimp farmers applied two kinds of fertilizer such as Urea and TSP. Uses of these fertilizers influence in increasing the growth of shrimp. The purpose of using fertilizer in the farm is to create a condition which facilitates to increase in production of good quality natural feeds, thereby increasing shrimp production. The cost of fertilizer was estimated by using the prevailing market rate which was actually paid by the farmers. The prices of these fertilizers were assumed to be same in all categories of farms. The average prices of Urea and TSP were Tk. 20 per kg and Tk. 25 per kg respectively in the study area.

The estimated costs of fertilizer are shown in table 6.1. It was observed that shrimp farmers incurred cost of Tk. 1440 for Urea and Tk. 1400 for TSP on an average which constituted 1.38 percent and 1.34 percent of total variable cost respectively.

6.2.5 Cost of Manure

Manure (cowdung) was commonly used as organic fertilizer for producing shrimp. There was no fixed rate for buying manure in the study area. Farmers used purchased manure. Cost of manure was computed at the prevailing market price, which was estimated to be Tk. 2 per kg during the study period.

Per hectare cost of using manure was calculated at Tk. 544 for practicing shrimp farming which accounted for 0.52 percent of total variable cost (Table 6.1).

6.2.6 Cost of Feed

Supply of artificial supplementary feeds, which can compliment nutritional deficiency, is important to increase shrimp production. In the study area shrimp farmers used rice bran, wheat bran, pulse bran and different types of oil cake, as supplementary feed for shrimp growth. Cost of feeds was estimated at the prevailing market price. The average cost of ready feed was calculated at Tk. 45 per kg during the study period. Per hectare average costs of feed were calculated at Tk. 31410 which was found to be 30.17 percent of total variable cost (Table 6.1).

6.2.7 Cost of Water Management

Brackish water shrimp culture is mainly based on saline water supply. Water is needed at the appropriate time for the proper growth of shrimp and its survival. Without saline water bagda shrimp cannot be cultivated. In the study area farmers used motor for saline water uplifting and supplying it to the canal. So, cost of diesel was computed on the basis of prevailing market rate. The cost of diesel was calculated at Tk.68 per liter during the study period. Average per hectare costs of saline water uplifting were calculated at Tk. 7888 which was 7.58percent of total variable cost (Table 6.1).

6.2.8 Miscellaneous Cost

Shrimp farmers had to bear some miscellaneous cost for purchasing different material, such as rope, light, umbrella, bamboo, boat, transportation, netting, commission for caretaker, rent of motor etc. It also included the payment of some charges and donation of different religious and social institutions. These miscellaneous costs were calculated on the basis of actual price paid by the farmers. In the study area, per hectare average miscellaneous costs for shrimp farming was found to be Tk. 1281 which constituted 1.23 percent of total variable cost (Table 6.1).

6.2.9 Interest on Operating Capital

Interest on operating capital was determined on the basis of opportunity cost principle. The operating capital actually represented the investment on different farm operation over the period because all the cost was not incurred at the beginning or at any single point of time. The cost was incurred throughout the whole production period; hence, at the rate of 9 percent per annum interest on operating capital for six months was computed for shrimp production (Interest rate was taken according to the bank rate prevailing in the market during the study period). Interest on operating capital was calculated by using the following standard formula (Miah, 1992).

Interest on Operating Capital (IOC) = Alit

Where,

Al= Total investment /2,

t = Total time period of a cycle

i= interest rate which was 9percent per year during the study period.

The interest on operating capital was estimated at Tk. 4483 constituted 4.31 percent share of total variable cost (Table 6.1).

Table 6.1 Per Hectare Variable Costs of Shrimp Farming

Variable cost items	Units	Quantity (Unit/ha)	Price (Tk./Unit)	Cost (Tk.)	Percent of total variable cost (%)
Human labor	Man-days	103	325	33475	32.15
Shrimp fry	No.	27146	0.76	20631	19.81
Lime	Kg	105	15	1575	1.51
Urea	Kg	72	20	1440	1.38
TSP	Kg	56	25	1400	1.34
Manure	Kg	272	2	544	0.52
Feed cost	Kg	698	45	31410	30.17
Water management cost	Diesel in liter	116	68	7888	7.58
Miscellaneous cost	-	-	-	1281	1.23
Interest on operating cost (OC)	-	-	-	4483	4.31
Total	-	-	-	104127	100

variable cost					

Source: Field survey, 2014.

6.2.10 Total Variable Cost

In the study area, the total variable costs varied from year to year. It was observed that the total per hectare variable cost for shrimp farming was Tk. 104127 which comprised of 70.22 percent of total cost (Table 6.3).

6.3 Fixed Costs

6.3.1 Land Use Cost

The farmers used the land as per conditions of leasing arrangement. The term leasing cost means the cost which was required for shrimp farmers to take land lease which would be used for shrimp production to a particular period of time. Leasing cost varies from one place to another depending on the location, soil fertility, topography of the soil and distance from the sources of water etc. Leasing cost was the single highest cost item in the study areas. The value of own land was calculated as opportunity cost concept. Land use cost for shrimp farming was estimated at the prevailing rental value per hectare in the study area. The rental value of per hectare land was estimated at Tk. 38361 which occupied 86.86 percent of total fixed cost (Table 6.2).

6.3.2 Construction of Guard Shed, Office and Other Housing Cost

Guard shed was constructed to protect shrimp from thieves and dacoits. Cost for constructing guard shed, office and other housing cost were taken one third of the average of this cost. The per hectare average construction cost of guard shed, office and other housing cost were calculated at Tk. 5803 for shrimp farming which shared 13.14 percent of total fixed cost (Table 6.2).

Table 6.2 Per Hectare Fixed Costs of Shrimp Farming

Fixed cost items	Cost (Tk./ha)	Percent of total fixed cost (%)
Land use cost	38361	86.86
Construction of guard shed, office and other housing cost	5803	13.14
Total fixed costs	44164	100

Source: Field survey, 2014.

6.3.4 Total Fixed Cost

In the study area, it was estimated that per hectare total fixed cost for year round shrimp farming was Tk. 44164 which comprised of 29.78 percent of total cost (Table 6.3).

6.4 Total Cost

The total costs were calculated by adding up total variable cost and total fixed cost. In the study per hectare total cost of shrimp farming was calculated at Tk. 148291 (Table 6.3).

Table 6.3 Per Hectare Total Cost of Shrimp Farming

Cost items	Cost (Tk./ha)	Percent of total cost (%)
a. Total variable cost	104127	70.22
b. Total fixed cost	44164	29.78
Total cost (a+b)	148291	100

Source: Field survey, 2014.

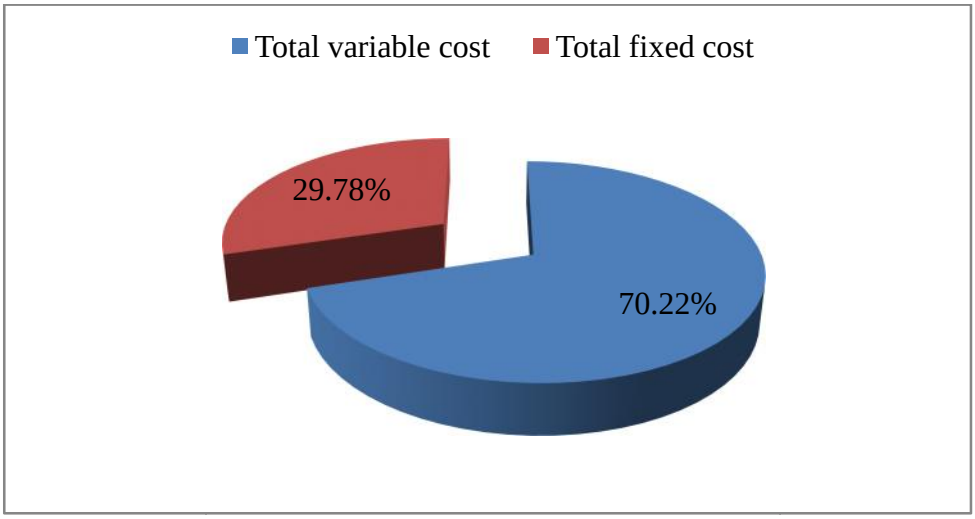

Figure 6.1: Percentages of Per Hectare Total Variable Cost and Total Fixed Cost of Shrimp Farming

6.5 Returns of Shrimp Farming

6.5.1 Gross Return

Gross return is the pecuniary value of total product. Per hectare gross returns were calculated by multiplying the total amount of production by their respective market prices. In the study area, per hectare average yield of shrimp was 422 kg and its money value was Tk. 297670. Shrimp has a different grading system. Most shrimp are graded on the basis of size (weight). Here the grading was done on the basis of number of pieces forming one kg as reported by the farmer. For, calculation, three types of grading system was followed.

- A-grade: 12-15 numbers of shrimp is required to make 1kg weight.
- B-grade: 20-28 numbers of shrimp is required to make 1kg weight.
- C-grade: 30^{+} numbers of shrimp is required to make 1 kg weight.

Apart from these, few species of shrimps and fishes were also grown in shrimp farms. They are known as fin fish included pershey, tilapia, vetki, horina, chaka, & tangra etc. Per hectare average yield of fin fish was 472 kg and its money value was Tk. 66552. Therefore, the gross return for one year shrimp farming was accounted for Tk. 364222 (Table 6.4).

6.5.2 Net Return

In general net return is termed as entrepreneur's income. To evaluate the profitability of shrimp production, net return is an important aspect. Net return is the difference between gross return and total costs. Per hectare net return was estimated at Tk.215931 which indicates that shrimp production is profitable business for the shrimp farmers (Table 6.5).

6.5.3 Gross Margin

Farmers usually want to gain maximum return over variable cost of production. The probable reason is that estimation of fixed cost of production is difficult to determine. Thus the gross margin analysis has been taken into account to calculate the relative profitability of shrimp farming. The gross margin of shrimp farming was estimated at Tk. 260095 (Table 6.5).

Table 6.4 Per Hectare Return of Shrimp Farming

Items	Yield(kg/ha)	Price (Tk./kg)	Gross income (Tk./hectare)	Percent of gross income (%)
(a) Shrimp				
A-grade	**153**	**970**	**148410.00**	**40.75**
B-grade	**148**	**603**	**89244.00**	**24.51**
C-grade	**121**	**496**	**60016.00**	**16.47**
Subtotal	**422**	**-**	**297670.00**	**81.73**
(b) Fin fish	**472**	**141**	**66552.00**	**18.27**
Gross return from shrimp and fin fish (a+b)	**-**	**-**	**364222.00**	**100**

Source: Field survey, 2014.

Table 6.5 Gross Margin and Benefit Cost Ratio (Undiscounted) of Shrimp Farming

Sl. No.	Items	Amount (Tk./hectare)
A.	**Gross returns (GR)**	**364222.00**
B.	**Total variable costs (TVC)**	**104127.00**
C.	**Total costs (TVC+TFC)**	**148291.00**
D.	**Net return (GR-TC)**	**215931.00**
E.	**Gross margin (GR-TVC)**	**260095.00**
F.	**Benefit-cost ratio (BCR) = GR/TC**	**2.46**

Source: Field survey, 2014.

6.5.4 Benefit Cost Ratio (Undiscounted)

Benefit cost ratio was calculated by dividing gross return by gross cost or total cost. It implies return per taka invested. It helps to analyze financial efficiency of the farm. It was evident from the study that the benefit cost ratio of shrimp farming was accounted for 2.46 implying that Tk. 2.46 would be earned by investing Tk. 1.00 for shrimp production. So, the shrimp farming was found to be profitable for farmers (Table 6.5).

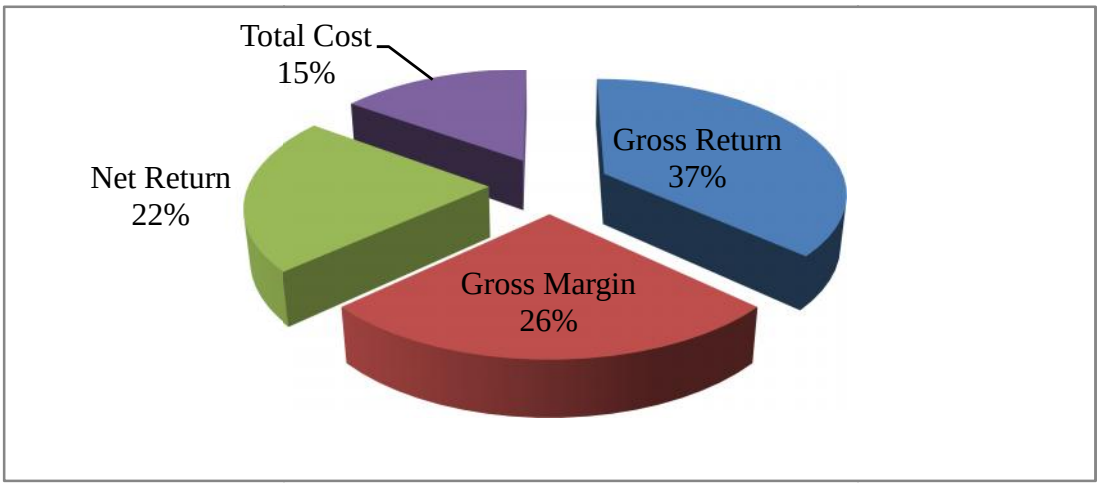

Figure 6.2: Percentages of Per Hectare Gross Return, Net Return, Gross Margin and Total Costs of Shrimp Farming.

6.6 Concluding Remarks

It was evident from the results that per hectare total variable cost for shrimp farming were more than per hectare total fixed costs for shrimp farming. Shrimp farming provides higher returns to the farmers. Shrimp cultivation is gaining popularity in the country gradually due to its high yield potentiality and high demand in the international market. Sample farmers showed their opinion that higher yield and income encouraged them to continue shrimp production.

CHAPTER 7

FACTORS AFFECTING RETURNS OF SHRIMP FARMING

7.1 Introduction

An attempt has been made this chapter to identify and measure the effects of the major variables on shrimp production. Cobb-Douglas production function was chosen to estimate the contribution of key variables on the production process of shrimp farming. The estimated values of the model are presented in Table 7.1.

7.2 Functional Analysis for Measuring Production Efficiency

Production function is a relation or a mathematical function specifying the maximum output that can be produced with given inputs for a given level of technology. Keeping in mind the objectives of the study and considering the effect of explanatory variables on output of shrimp farming, six explanatory variables were chosen to estimate the quantitative effect of inputs on output.

Management factor was not included in the model because specification and measurement of management factor is almost impossible particularly in the present study, where a farm operator is both a labor and manager. Other independent variables like water quality, soil condition, time etc., which might have affected production of farm enterprises, were excluded from the model on the basis of some preliminary estimation. A brief description is presented here about the explanatory variables included in the model.

7.3 Estimated Values of the Production Function Analysis

i. F-value was used to measure the goodness of fit for different types of inputs.
ii. The coefficient of multiple determinations (R^2) indicates the total variations of output explained by the independent variables included in the model.
iii. Coefficients having sufficient degrees of freedom were tested for significance level at 1 percent, 5 percent and 10 percent levels of significant.
iv. Stage of production was estimated by returns to scale which was the summation of all the production elasticity of various inputs.

The estimated coefficients and related statistics of the Cobb-Douglas production function for shrimp production are shown in Table 7.1.

Table 7.1 Estimated Values of Coefficients and Related Statistics of Cobb-

Douglas Production Function

Explanatory variables	Coefficient	Standard error	t- value
Intercept	2.775***	0.586	4.739
Cost of shrimp fry (X_1)	0.133*	0.072	1.846
Cost of feed (X_2)	0.229**	0.092	2.492
Cost of lime (X_3)	-0.050NS	0.077	-0.654
Cost of fertilizer & manure (X_4)	0.384***	0.081	4.713
Cost of human labor (X_5)	0.239**	0.118	2.026
Cost of water management (X_6)	0.123*	0.069	1.775
R^2	0.83		
Adjusted R^2	0.82		
Return to scale	1.06		
F-value	79.926***		

Source: Field survey, 2014.

Note: * Significant at 1 percent level;**

**** Significant at 5 percent level;**

***** Significant at 10 percent level; and**

NS: Not Significant

7.4 Interpretations of Results

Cost of shrimp fry (X_1): The estimated coefficient of shrimp fry was 0.133 and significant at 10 percent level for shrimp farming. It implies that 1 percent increase in the cost of shrimp fry, keeping other factors constant, would increase gross returns by 0.133 percent (Table 7.1).

Cost of feed (X_2): The estimated coefficient of feed cost was 0.229 which was positive and significant at 5 percent level for shrimp farming. It indicates that 1 percent increase in the feed cost, keeping other factors constant, would increase gross returns by 0.229 percent (Table 7.1).

Cost of lime (X_3): The regression coefficient of lime cost (-0.050) was negative and insignificant for shrimp farming. It implies the 1 percent increase in the cost of lime,

keeping other factors constant, would decrease gross returns by 0.050 percent (Table 7.1).

Cost of fertilizer (X_4): The fertilizer used for shrimp farming included the category of Urea, TSP and Manure. The regression coefficient of fertilizer cost was 0.384 and significant at 1 percent level for shrimp farming. It indicates that 1 percent increase in cost of fertilizer, remaining other factors constant, would increase gross returns by 0.384 percent (Table 7.1).

Cost of human labor (X_5): Estimated coefficients of human labor were significant for shrimp farming. It implies that 1 percent increase in the cost of labor as additional expenditure, remaining other factors constant, would increase gross returns by 0.239 percent (Table 7.1).

Cost of water management (X_6): The estimated coefficient of water management for shrimp farming was 0.123 and significant at 10 percent level. It indicates that 1 percent increase in the cost of water management for shrimp farming, remaining other factors constant, would increase gross returns by 0.123 percent (Table 7.1).

7.5 Coefficient of multiple determinations (R^2)

The values of the coefficient of multiple determination of shrimp farming was found to be 0.83 which implied that about 83 percent of the total variation in the gross return could be explained by the included explanatory variables of the model. So we can say the goodness of fit of this regression model is better since R^2 indicates the goodness of fit of the regression model (Table 7.1).

7.6 Adjusted R^2

Here the term adjusted means adjusted for the degrees of freedom. The adjusted R^2 for shrimp farming was found to be 0.82 which indicated that about 82 percent of the variations of the output were explained by the explanatory variables included in the model (Table 7.1).

7.7 Returns to Scale in Shrimp Production

The summation of all the production coefficients of shrimp farming is equal to 1.06. This means that production function for shrimp farming exhibits increasing returns to scale. This means that, if all the variables specified in the model were increased by 1 percent, gross return would also be increased by 1.06 percent (Table 7.1).

7.8 F-value

The F-statistic was computed to denote the overall goodness of fit of any fitted model. The F-value for the shrimp farming was estimated at 79.926 which were highly significant at 1 percent level. It means that the explanatory variables included in the model were important for explaining the variation in gross return of shrimp production (Table 7.1).

7.9 Multicollinearity Tests

Before final estimation of the empirical model, multicollinearity tests among the explanatory variables were done using Klein's rule to tests multicollinearity. Following this method R^2i's were estimated and compared with the R^2y's for selected explanatory variables. Total multiple correlation coefficients is much higher than partial multiple correlations, which indicate that there is no severe correlation among the explanatory variables (Table 7.2).

Table 7.2 Test of Multicollinearity of the Explanatory Variables for Shrimp Production Function

Particulars	Value of total R^2 and partial R^2	Comment
Total R^2	0.83	
Partial R^2		
Ln cost of shrimp farming	0.183	NSC
Ln cost of feed	0.244	NSC
Ln cost of lime	-0.066	NSC
Ln cost of fertilizer & manure	0.430	NSC
Ln cost of human labor	0.200	NSC
	0.176	NSC

Ln cost of water management		

Note: NSC means no severe correlations.

7.10 Resource Use Efficiency in Shrimp Production

In order to identify the status of resource use efficiency, it was considered that a ratio equal to unity indicated the optimum use of that factor, a ratio more than unity indicated that the yield could be increased by using more of the resources. A value of less than unity indicated the unprofitable level of resource use, which should be decreased to minimize the losses because farmers over used this variable. The negative value of MVP indicates the indiscriminate and inefficient use of resource.

The ratio of MVP and MFC of shrimp fry (1.91) for shrimp production was positive and more than one, which indicated that in the study area shrimp fry was under used (Table 7.3). So, farmers should increase the use of shrimp fry to attain efficiency considerably.

Table 7.3 showed that the ratio of MVP and MFC of feed (2.22) for shrimp farming was positive and more than one, which indicated that in the study area feed for shrimp growth was under used. So, farmers should increase the use of shrimp feed to attain efficiency level.

The ratio of MVP and MFC of lime was found to be -9.41 for shrimp farming was negative and less than one, which indicated that in the study area use of lime for shrimp production was over used (Table 7.3). So, farmers should decrease the use of lime for shrimp production to attain efficiency considerably.

Table 7.3 revealed that the ratios of MVP and MFC of fertilizer and manure used for shrimp production was positive and more than one (6.09), which indicated that fertilizer and manure application was underutilized. So, farmers should increase the use of fertilizer and manure to attain efficiency in shrimp production.

It was evident from the table 7.3 that the ratio of MVP and MFC of human labor (2.74) for shrimp farming was positive and more than one, which indicated that in the study area use of human labor for shrimp farming was under used. So, farmers should increase the use of human labor to attain efficiency in shrimp production.

Table 7.3 Estimated Resource Use Efficiency in Shrimp Production

Variables	GM	MVP	MFC	MVP/MFC	Comment
Shrimp fry	25657.39	1.45	0.76	1.91	Underutilized
Feed	638.89	99.85	45	2.22	Underutilized
Lime	99.31	-141.19	15	-9.41	Over utilized
Fertilizer & manure	374.32	286.22	47	6.09	Underutilized
Human labor	74.94	890.54	325	2.74	Underutilized
Water management	103.84	330.53	68	4.86	Underutilized

Source: Field survey, 2014.

The ratio of MVP and MFC of water management (4.86) for shrimp farming was positive and more than one, which indicated that in the study areas use of saline water for shrimp production was under used (Table 7.3). So, farmers should increase the use of saline water to attain efficiency considerably.

7.11 Concluding Remarks

It is evident from the Cobb-Douglas production function model, that the included key variables had significant and positive effect on shrimp production except the negative and insignificant effect of lime. Multicollinearity test revealed that there was no severe correlation among the explanatory variables. Resource use efficiency indicated that all of the resources were under used for

shrimp production except overutilization of lime. So there is a positive effect of key factors in the production process of year round shrimp farming.

CHAPTER 8
PROBLEMS AND CONSTRAINTS OF SHRIMP FARMING

8.1 Introduction

Fishery as a source of livelihood has been an age-old practice for thousand of fishermen in Bangladesh. But fishermen are socially, economically and educationally backward. In the present study, an attempt had been made to identify and analyze the major problems and constraints faced by the farmers which act as main barriers in running the business of shrimp farming. The problems were broadly classified under three categories such as economic, technical and social. Thereafter, the problems were ranked on the basis of their percentages.

8.2 Economic Problems

High Price of Input: About 55.20 percent of farmers reported that high price of input was one of the most important problems for shrimp farming (Table 8.1). But at present high price of input is not a major problem for the farmers. Because the government is already given subsidy on fertilizer like urea and other inputs required for shrimp farming.

Lack of Sufficient Fund: Most of the farmers were not economically solvent. They had to borrow money from local NGOs at higher interest rate for continuing shrimp production. About 38.10 percent of farmers reported that lack of sufficient fund was one of the major problems for them (Table 8.1). They pointed out that when they need loan for shrimp farming as per possible amount they did not get that help from institutional sources due to complicated bureaucratic procedures. To mitigate this problem, immediate measures should be taken to simplify the lending procedures as early as possible.

Lack of Marketing Facilities: Lack of marketing facilities both for inputs and outputs was the major problems faced by the farmers in conducting shrimp farming in the study area. About 17.10 percent of farmers reported that there were inadequate marketing facilities such as storage and transport facilities (Table 8.1).

Low Price of Output: Low price of output was considered as another important problem and reported by 24.80 percent of farmers (Table 8.1). Most of the farmers reported that they had to sell their products at local market at low price owing to the transportation problem. But the findings of the study indicated that BCR was high and price of output was also good. So, there was some inconsistency of their answer.

8.3 Technical Problems

Lack of Scientific Knowledge and Technology: Scientific knowledge and skilled labor are essential for shrimp farming. Among the respondent farmers, some farmers had basic knowledge of input use, but there were many farmers who had knowledge gap in farming of shrimp. In the study area, about 25.70 percent of farmers claimed that they had lack of scientific knowledge and technology (Table 8.1). Training including optimum application of fertilizers, feeds, fingerlings and lime should be given. Research organizations and NGOs can play a vital role to disseminate scientific knowledge and technology.

Over flooding in Rainy Season: Uncertainties due to flooding during the heavy rains, the shrimp farms become flooded and fish escape from one field to another. About 16.20 percent of shrimp producing farmers reported such type of problem in the study area (Table 8.1). This problem can be solved by making embankment, proper canal and drainage system.

Insufficient Water in Dry Season: About 40 percent of shrimp producing farmers reported that insufficient water in dry season hampered production of shrimp (Table 8.1). Government can solve this problem by keeping the diesel price at a reasonable level so that farmers can supply sufficient water in the canal in dry season.

Attack of Shrimp Diseases: About 39 percent of shrimp producing farmers reported that attack of shrimp disease hampered the production of shrimp (Table 8.1). To overcome this problem, scientific use of chemicals should be ensured and supplementary supply of artificial irrigation should be arranged in

dry season. Extension workers, Upazila Fisheries Officers (UFO) & FRI scientists may take initiatives to ensure scientific approach to overcome this problem.

Lack of Extension Services: About 35.20 percent of farmers complained that they did not get extension services regarding the improved method of shrimp production (Table 8.1). Farmers used traditional method of shrimp cultivation. For these reasons, extension workers should pay an immediate attention to this matter for the improvement of this situation.

Table 8.1 Major Problems Faced by the Sample Farmers

Problems and constraints	No. of respondent	Type of problems	Percent (%)	Rank
High price of input	58	Economic	55.20	1st
Insufficient water in dry season	42	Technical	40.00	2nd
Attack of shrimp diseases	41	Technical	39.00	3rd
Lack of sufficient fund	40	Economic	38.10	4th
Lack of extension services	37	Technical	35.20	5th
Lack of scientific knowledge and technology	27	Technical	25.70	6th
Low price of output	26	Economic	24.80	7th
Lack of marketing facilities	18	Economic	17.10	8th
Over flooding in rainy season	17	Technical	16.20	9th
Theft of shrimp from farm	17	Social	16.20	9th
Capture of shrimp and shrimp farm by force	12	Social	11.40	10th
Pushing poison to shrimp	9	Social	8.60	11th
Multiple ownership	4	Social	3.80	12th

Source: Field survey, 2014

Note: one shrimp farmer reported more than one problems, so addition of percentage will not necessarily equal to 100.

8.4 Social Problems

Theft of Shrimp from Farm: About 16.20 percent of shrimp producing farmers reported that theft of shrimp from farm by thieves was another major problem

(Table 8.1). Farmers should look after their shrimp farm at a regular basis. Social security must be provided by the local government.

Multiple Ownerships: About 3.80 percent of shrimp producing farmers reported that they were suffering from this problem (Table 8.1). Measures should be taken by the government to resolve the land use conflict.

Pushing poison to Shrimp: About 8.60 percent of farmers reported that this problem was hampering their total production (Table 8.1). To overcome this problem community based management should be developed.

Capture of Shrimp and Shrimp Farm by Force: About 11.40 percent of shrimp producing farmers reported that capture of shrimp and shrimp farm by political leaders, or socially powerful persons (Table 8.1). Proper action should be taken by the government to overcome this problem.

8.5 Concluding Remarks

The above mentioned problems and constraints, of course, are interrelated with one another and hence, need to be removed comprehensively through an integrated programme for the overall development of shrimp (bagda) farming. Problems faced by the farmers were ranked on the basis of corresponding percentages. Most of the farmers were reported that high price of input was the main constraint for their shrimp production. And this problem occupies first position according to its ranking. But I think there is some inconsistency of their answer. My opinion is that attack of shrimp diseases and the insufficient water in the dry season were the main constraints hampering shrimp production. Government is already given subsidy on these inputs. So, price of input was not a severe problem for the farmers. If proper vaccine were given and direct entry of water at the right time were provided then the production will be increased significantly and thus the farmers will be benefited.

CHAPTER 9
SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

9.1 Summary

Fisheries sector in has been playing a very vital role in the economy of Bangladesh from the time immemorial. Bangladeshi people are popularly referred to as "Mache Bhate Bangali" or "fish and rice makes a Bengali". This sector plays a significant role in meeting the protein demand, earning foreign exchange and socio-economic development of the rural poor by reducing poverty through employment generation.

Broad agriculture sector which includes crops, livestock, fisheries and forestry contributes 16.33 percent to the Gross Domestic Product (GDP) as a whole in the FY 2013-14. In 2013-14, fisheries sub-sector contributed about 22.61 percent to the broad agricultural sector Gross Domestic Product (GDP). The ecology of the country is appropriate for the growth and production of the fisheries resources. Fish production in ponds, lakes, burrow pits, floodplains, oxbow lakes, and semi-closed water bodies are increasing day-by-day with the blessings of modern technology. Fish production has increased to 35.55 lakh MT in 2013-14, which was 25.63 lakh MT in 2007-08. Bangladesh is endowed with vast water bodies such as 39.25 lakh hectares of open water fisheries, 7.74 lakh hectares of culture fisheries and 0.48 sq. nautical miles of marine fisheries. In 2013-14, total fish production was 35.55 lakh MT of which 55 percent production has been contributed by the culture fisheries, 28 percent by the open water fisheries and rest 17 percent by the marine water fisheries. The country earned about Tk. 517 crore during the year 2013-14 by exporting fish, shrimp and prawn of which shrimp alone contributes Tk. 716.30 crore. In Bangladesh, shrimp industry is the second largest foreign currency earner after the garment industry.

In this context, the specific objectives of the study were formulated to determine relative profitability and to assess the resource use efficiency of shrimp farming in selected areas of Bagerhat district. The specific objectives were as follows:

e) To identify the socio-demographic profile of the respondents.
f) To calculate the profitability of shrimp farming.
g) To assess the resource use efficiency of shrimp farming.

h) To address the problems and suggest some policy recommendations for the improvement of shrimp farming.

The study was mainly based on primary data, which were collected by the researcher himself through interviewing the sample farmers. A total of 105 year round shrimp farmers were selected from two villages namely, Sungandhi, and Korari of Rakhagachi union under sadar upazila of Bagerhat district. Survey method was followed to collect production related data while, simple random sampling technique was used to select the shrimp farmers. Tabular as well as statistical technique was followed to fulfill the objectives of the study.

With respect to socioeconomic features of the sample farmers, the findings revealed that none of the farmers had the age below 20 years. The shrimp producing farmers were classified into three age groups: up to 20-30 years, 31-45 years and above 45. Out of the total sample farmers 21.00 percent belonged to the age group of 20-30 years, 61.90 percent belonged to the age group of 31-45 years and 17.10 percent fell into the age group of above 45. The average family sizes of the shrimp producing farmers were found to be 4.20. Out of 105 sample farmers, 17.10 percent farmers had primary education, 14.30 percent farmers had completed P.S.C level education, 26.70 percent farmers had completed J.S.C level education, 27.60 percent farmers had completed their secondary level education, 6.70 percent farmers had completed their higher secondary education and last of all only 7.60 percent farmers had completed their higher study. The main occupation of the majority of the sample farmers was shrimp farming. About 56.20 percent shrimp farmers were single owner, 36.20 percent were belonged to double ownership and those of 7.60 percent had multiple ownerships. Most of the farmer's yearly income belonged to the category of 150,000 to 250,000. Land use cost shared major portion of total cost for shrimp farming. Commonly used fertilizers namely urea and TSP were used by the sample farmers in producing shrimp.

To determine the profitability of shrimp farming both the inputs and outputs were valued at market price during the study period. For analytical advantages, the cost item were identified as human labor, shrimp fry, urea, TSP, manure,

feed, lime, water management cost, land use cost, construction of guard shed, office and other housing cost, miscellaneous cost and interest on operating capital. Cost and returns were worked out to estimate profitability of shrimp production. Per hectare total cost, gross return, net return and gross margin were Tk. 148291.00, Tk. 364222.00, Tk. 215931.00 and Tk. 260095.00 respectively.

In this study, Cobb-Douglas production function model was used to determine the effects of key variable inputs. The most important six explanatory variables were included in the model to explain the gross income or return of shrimp farming. Most of the variables in the production function were significant in explaining the gross return except the negative and insignificant effect of lime. The coefficient with expected sign indicates the selected inputs contributed positively to the gross return. The values of the coefficient of multiple determination of shrimp farming was 0.83 which implied that about 83 percent of the total variation in the gross return could be explained by the included explanatory variables of the model. Production function for shrimp farming exhibits increasing returns to scale (1.06). This means that, if all the variables specified in the model were increased by 1 percent, gross return would also increased by 1.06 percent. . The F-value for the shrimp farming was 79.926 which were highly significant at 1 percent level. Multicollinearity test indicated that there were no severe correlations among the explanatory variables. Resource use efficiency indicated that all of the resources were under used for shrimp production except overutilization of lime. So there was a positive effect of key factors in the production process of year round shrimp farming.

This study also identified some of the problems and constraints associated with shrimp farming. These were categorized into economical, technical and social problems. The findings revealed that high price of input, lack of sufficient fund, lack of marketing facilities, low price of output, lack of scientific knowledge and technology, over flooding in rainy season, insufficient water in dry season, attack of shrimp diseases, lack of extension services, theft of shrimp from farm, multiple ownerships, pushing poison to shrimp and capture of shrimp and shrimp farm by force etc were the major obstacle which stand in the way of Bagda shrimp farming in the study area.

9.2 Conclusion and Policy Recommendations

It may be concluded that shrimp farming is highly profitable. If modern inputs and production technology can be made available to farmers in time, yield and production will be increased which can help farmers to increase income and improve livelihood standards. It can help in improving the nutritional status of rural people. The results however, clearly showed that per hectare yield of shrimp farming are still low among other shrimp producing Asian countries. There is an ample opportunity to improve per hectare yield of year round shrimp production. To enhance the productivity, efficiency and effectiveness of shrimp farming, the following recommendations are made as a part of present study which acts as a formulating strategy for enhancing shrimp production in Bagerhat district.

i. Though the government is already given subsidy on fertilizer like urea and other inputs required for shrimp farming but fair prices of inputs should be ensured so that the farmers can get the inputs at a reasonable price.
ii. Availability of saline water is an important factor for shrimp production. Government can solve this problem by keeping the diesel price at a reasonable level so that farmers can supply sufficient water in the shrimp farm in dry season.
iii. Physiological and soil related research should be conducted to identify the real causes of shrimp viral diseases and its outbreak. To overcome this problem, scientific use of chemicals should be ensured and supplementary supply of artificial irrigation should be arranged in dry season.
iv. Bank loan and institutional credit should be made available on easy term and conditions to the shrimp farmers.

v. Scientific method of cultivation should be introduced to increase production. The farmers should be provided with training, adequate services, information and necessary facilities to cope with new and changed situation.

vi. Application of feed and fertilizer in relation to stocking density needed to increase the production of shrimp. Fair prices of outputs should be ensured.

vii. Attention should be given to improve transportation and marketing facilities of the study area.

viii. Law and order enforcing agencies should be vigilant in the study area to minimize the social tension and improve the situation of shrimp farming areas.

9.3 Limitations of the Study

It is very common that there is no study without some limitations. The study I have made is of great importance and require me huge work and time. During preparing this paper, I have tried my best. But while conducting this study I had to face a number of problems. The problems were-

- Most of the data collected through interview of the farmers so sometimes they were not well-cooperated with the interviewer.
- The information was collected mostly through the memories of the respondents which were not always correct.
- Lack of experience and time hampered the in-depth of the study.
- Secondary data are extremely difficult to collect and may be contradictory. All the information is not based on valid data.

9.4 Avenues for Further Research

The limitation of study indicated some new avenues of research which might be undertaken in the context of Bangladesh. These are discusses below.

- Similar study considering a large number of samples could be taken.
- As the present study covered only Bagerhat sadar upazila under Bagerhat district, a similar study could be conducted covering various geographical regions of the country and made a cross country comparisons of shrimp farming.
- In the present study resource use efficiency of shrimp farming was assessed. So there is an ample opportunity to conduct study on technical efficiency of shrimp farming.

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APPENDICES

Table A-1: Species-Wise Annual Fish Production From 2007-08 to 2012-13.

[Unit: MT]

Species/Group	2006-07		2007-08		2008-09		2009-10		2010-11		2011-12		2012-13	
	Inland	Marine	Inland	Marine	Inland	Marine	Inland	Marine	Inland	Marine	Inland	Marine	Inland	Marine
Major Carp	535492		547652		617761		692597		753572		777005		731662	
Other Carp	9821		9339		11155		64359		55021		60356		54130	
Exotic Carp	292961		333452		305938		376006		265375		299494		402490	
Cat Fish	58588		85869		117856		208972		221965		288887		360722	
Snake Head	102686		110460		122093		113989		117577		89351		53305	
Live Fish	58158		75286		77113		101368		94000		95063		102651	
Other Inland fish	643160		643876		646085		575620		710853		763668		835457	
Hilsha	82445	196744	89900	200100	95970	202951	115179	198574	114520	225325	114475	232037	98648	252575
Shrimp/Prawn	169262	51869	169889	53206	192755	52217	133826	52592	182471	56989	194863	57660	182201	46568
Sardine												20187		29636
Bombay Duck		36009		36980		58263		58464		60750		62817		71745
Indian Salmon		969		1040		7733		7733		4521		3030		2445
Pomfret		13061		16728		46643		50245		40478		39537		29693
Jew Fish		35214		33803		38414		35514		36639		37929		30600
Sea Cat Fish		18131		20534		16515		16722		17193		19700		8594
Shark/ Skate / Ray		4790		4767		3933		4794		4205		3865		5017
Other Marine Fish		130651		130415		87975		92644		100233		101858		112115
Total	1952573	487438	2065723	497573	2186726	514644	2381916	517282	2515354	546333	2683162	578620	2821266	588988
Total	2440011		2563296		2701370		2899198		3061687		3261782		3410254	

Source: DoF, 2014.