SOCIO-ECONOMIC ASPECTS OF FRESHWATER PRAWN CULTURE DEVELOPMENT IN BANGLADESH

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By

NESAR AHMED

B.Sc. Fisheries (Hons.), MS in Aquaculture and Management

Institute of Aquaculture
University of Stirling
Scotland, UK

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To my father

To whom this have been the happiest event in his life as all that he ever dream of his children to be highly educated

To my mother

Without whose sacrifice and struggle, I would never have reached where I am today

To my grandfather

He was very special to me and passed away while I was writing-up my thesis

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He always encouraged me for higher studies

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In the name of Allah, the most compassionate and the merciful

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Declaration

I hereby declare that this thesis has been composed entirely by myself and has not been previously submitted for any other degree or qualification.

The work of which it is a record has been performed by myself, and all sources of information have been specifically acknowledged.

Nesar Ahmed

Abstract

This thesis is concerned with social and economic aspects of freshwater prawn (*Macrobrachium rosenbergii*) culture development in converted paddy field *gher* systems in SW Bangladesh, based on economic features of prawn production and social impacts within and around prawn farming communities.

Based on a sample of 400 farmers from the four different zones in Bagerhat district in SW Bangladesh, 345 (86.25%) cultured prawn with fish and rice in their *gher*. The culture period is typically nine months, wild fry are stocked when available in May-June and harvested from November to January. A variety of feeds are used but the preferred material is the freshwater snail, *Pila globosa*. Productivity is variable, averaging 432 kg ha^{-1}. The freshwater prawn is a highly valued product for international markets and is therefore almost all exported.

All farmers in all zones and different *gher* size categories made a profit, with seed and feed dominating variable costs. Considerable variation in production costs and profitability was observed. The culture of prawn in *gher* systems is technically possible in a variety of conditions though expanding small scale of farming mainly depends on reducing production costs. Future targets could be to integrate with other agricultural activities especially dike cropping and rice production in the monsoon.

The livelihoods of a large number of people are associated with prawn farming. Four different fry, snail and prawn markets were surveyed, including a sample of 60 fry catchers, 40 fry traders, 75 snail collectors, 40 snail traders and 40 prawn traders. A sample of 200 women, associated with *gher* farms was also surveyed.

In spite of socio-economic constraints, most of the households of farmers (81%) have improved their status through prawn farming where prawn have brought out clearly positive changes of economic activities and generated new employment. All appeared to have gained from their activities, women have enhanced their position in families and societies.

However, concerns arise about the long-term sustainability of prawn farming due to high production costs, low supply of wild fry and snail meat, poor natural resources, poor institutional support and inadequate extension services, all of which have affected sustainable livelihoods of farmers and associated groups. It may necessary to establish local ingredients feed industries, prawn hatcheries and to provide low-interest credit with institutional and policy support for sustainable *gher* farming.

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List of Abbreviations

ASA	Association for Social Advancement
BAFRU	Bangladesh Aquaculture and Fisheries Resource Unit
BBS	Bangladesh Bureau of Statistics
BOBP	Bay of Bengal Programme
BRAC	Bangladesh Rural Advancement Committee
CIHI	Centre for International Health Information
DFID	Department for International Development
DIFTA	Danish Institute for Fisheries Technology and Aquaculture
DOF	Department of Fisheries
FAO	Food and Agriculture Organisation
FFWC	Flood Forecasting and Warning Centre
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GNP	Gross National Product
GOLDA	Greater Option for Local Development through Aquaculture
GSS	*Gono Sahajya Sangstha*
HSC	Higher Secondary Certificate
MBBS	Bachelor of Medicine and Bachelor of Surgery
NGO	Non Government Organisation
PRA	Participatory Rapid Appraisal
PRISM	Projects in Agriculture Rural Industry Science and Medicine
REB	Rural Electrification Board
RRA	Rapid Rural Appraisal
SAARC	South Asian Association of Regional Co-operation
SESRTCIC	Statistical, Economic and Social Research and Training Centre for Islamic Countries
SSC	Secondary School Certificate
UNDP	United Nations Development Programme

Glossary of Terms

Aman	Rice planted during the monsoon beginning in June and harvested in November-December.
Aus	Rice planted during March-April and harvested during July-August.
Baor	Closed water body equivalent to an oxbow lake, up to several hundred hectares.
Baperi	A kind of broker who is related in fry trading. Their job is to buy prawn post-larvae from fishermen in coastal markets and carry them to fry traders in prawn farming areas.
Beel	Seasonal open water bodies often containing low-lying agricultural land.
Behundi	A net use of prawn post-larvae catching.
Bigha	A unit of land equivalent to 0.21 ha.
Boro	Rice grown in the dry season from January to April.
Dadon	A system of tied credit through which the prawn traders advance money to the prawn farmers in exchanging for the assured sale of prawns.
Depot malik	A small-scale prawn trader.
Foria	Local agent in fry and prawn trading, their job is to carry fry from traders to the farmers and also carry market size prawn from farmers to the prawn traders.
Gher	An enclosure made for prawn cultivation by modifying rice fields through building higher dikes around the field and excavating a canal several feet deep inside the periphery of the dikes to retain water during the dry season.
Goga jal	A barrier net use of prawn harvesting.
Gol pata	A kind of palm, widely used in prawn farming communities for house making.
Haor	Low lying areas that are seasonally flooded, normally for 5 to 6 months per year.

Katcha	Rough and rural.
Khepla jal	A cast net use of prawn harvesting.
Maund	A unit of weight measure equivalent to approximately 37.4 kg.
Pucca	Proper and good quality.
Thana	An administrative unit in Bangladesh equivalent to a sub-district.
TK	Bangladesh unit of currency; US$ 1= Tk 50 (January 2000), Tk 45 (January 1998).

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background

In Bangladesh, freshwater prawn farming is currently one of the most important sectors of the national economy, and during the last two decades its development has attracted considerable attention for its export potential. This thesis is concerned with social and economic aspects of its development in Bangladesh, one of the world's least developed countries, in which patterns of rural development, and of market structures, may be expected to change markedly over coming years. Before developing the main themes of the work, it is useful to provide some background of Bangladesh, its resources and its population.

The People's Republic of Bangladesh emerged on the world map as an independent state on December 16, 1971. The territory of the present Bangladesh was historically under Muslim rule from 1201 to 1757 A. D. Subsequently, it was part of British India, when the British ruled over the entire Indian sub-continent, including this territory, for nearly 190 years from 1757 to 1947. With the termination of British rule in August 1947 the sub-continent was partitioned into India and Pakistan. Bangladesh was than a part of Pakistan, known as East Pakistan, and remained under the internal colonial regime of Pakistan for 24 years from 1947 to 1971. It became an independent and sovereign state on December 1971 following its victory of the war of liberation against Pakistan from March 25 to December 16, 1971.

Bangladesh is located in Southern Asia, bordering the Bay of Bengal, between Myanmar and India. The state covers an area of about 144,000 km^2 (Coutsoukis, 1999). The vast majority of Bangladesh's inhabitants are Bengalis, who are largely descended from Indo-Aryans, who began to migrate into the country from the west thousands of years ago and who mixed within Bengal with indigenous groups of various racial stocks. Ethnic minorities include the 'Chakma' and 'Mogh', Mongoloid peoples who live in the hilly area in the Southeast, and include the 'Santal', mainly descended from migrants from present-day India; and the 'Biharis', non-Bengali Muslims who migrated from India after the partition (National Data Bank, 1998).

Bangladesh had a population of about 127 million in July 1999, making it the world's eight most populous country (Coutsoukis, 1999). The average density of about 763 persons per square kilometre, is much higher than that of any other country in the world (National Data Bank, 1998). About 85% of the Bangladeshi people live in villages or semi-urban areas (Chakraborty, 1998). From the total population, 88.3% are Muslims, 10.5% are Hindus, 0.6% are Buddhists, 0.4% are Christians and the rest (0.2%) belong to the other faiths (Chakraborty, 1998; Coutsoukis, 1999). The literacy rate was recorded at 38.1% in 1995, 49.4% for males and 26.1% for females. The population growth rate was estimated at 1.59% annually in 1999, falling from a previous high of 2.32% in 1995 (Coutsoukis, 1999). Nearly 36% of the population remains below the poverty line for the very poor (i.e. could not able to eat food three times a day) and 53% below the poverty line for the poor (i.e. could able to eat food, but lack of other basic needs) (World Bank, 1998). Moreover, child malnutrition and maternal mortality remain among the highest in the world (World Bank, 1998). Bangladesh spends only 2% of its Gross National Product (GNP) on education, compared to 3.2% for average low-income countries (Khandker, 1996). Low investment in education results in low literacy, which in turn results in low productivity, low incomes, poor health and high population growth.

Bangladesh is often called the 'land of rivers' (Bundell and Maybin, 1996), and rivers are a prominent and important feature of its landscape. The landmass comprises mainly the delta of the three major rivers, the Ganges, the Brahmaputra and the Megna, presenting a typical disposition of vast green fields bounded by low hills. Its flat alluvial plains comprise some of world's most fertile agricultural lands (Chakraborty, 1998).

The mineral endowment of Bangladesh is meagre. The principal energy resource, natural gas, is found in several small fields in the northeast. There is a coal field in the northwest and large peat beds underlie most of the delta. Limestone and pottery clays are found in the northeast (National Data Bank, 1998).

The people of Bangladesh have been subjected to a number of military coups. Bangladesh followed a socialist economic philosophy from 1971 to 1975, followed by a limited and gradually extended scope for private ownership established by the subsequent military regimes until 1991. Parliamentary democracy has been taking shape for the last few years. After a period of 15 years of military rule from 1975 to 1990, two governments were elected democratically, in 1991 and in 1996. The economic policies adopted by the democratically elected governments aimed to provide full co-operation to private investors to ensure their maximum participation in the economy.

Throughout the internal colonial regime of Pakistan, the economic and social development of the country were neglected. The economic conditions of the country, just after the war of liberation, can be understood from the following lines of Sobhan (1982).

"The systematic drainage of Bangladesh's resources through the mechanism of internal colonial exploitation left the economy at the outset of liberation with a large external resource gap. This manifested itself through a deficit in the availability of good grains, low levels of internal savings and a high proportion of its population living below the poverty line. The parameters of poverty and dependence bring out a scenario of secular increase in external dependence during the decade of 1960."

Bangladesh has been hampered by a relative lack of natural resources and a limited infrastructure. It is highly vulnerable to natural disasters such as flood, tornado, cyclone and drought. Its economy has been heavily dependent on foreign aid, because of which it remains highly vulnerable to pressure from aid donors in influencing its external alignments and the course of its domestic policy. Indeed, there is no area in the development field where donors do not choose to exercise a say (Hoque, 1991). Sobhan (1982) observed that "*the donors have attempted to influence policies on state ownership, the role of private sector, the monetary and fiscal policies, pricing policy, distribution policy, the use of administrative controls, the structure of development, the* *pattern of development administration and a variety of the operational policy oriented and ideological issues".*

Presently a good number of international missions have been working in Bangladesh to fight poverty and improve the quality of livelihood through sustainable growth and investment in people. Since Bangladesh joined the World Bank in 1972, the International Development Association (IDA), the World Bank's concessional lending arm, has financed more than 177 operations in Bangladesh, with interest-free long-term loans totalling more than US$ 8 billion (World Bank, 1998). Presently the bank's active lending portfolio for Bangladesh includes more than 20 projects such as emergency flood recovery credit, female secondary schools assistance project, mitigation of arsenic contamination of ground water etc. Despite sustained domestic and international efforts to improve economic and demographic prospects, Bangladesh remains one of the world's a poorest, most densely populated, and least developed nations.

In spite of these constraints, Bangladesh has made progress on human development. Key social indicators: fertility, life expectancy, school enrolment for girls, and child immunisation have improved significantly since independence in 1971. The country can now grow enough food in normal years to meet its own demand. Bangladesh's Non Government Organisations (NGOs) are among the most vibrant in the world, providing microcredit and social mobilisation to some 8 million poor, mostly women (World Bank, 1998). It has pioneered innovative models of development led by NGOs that are being replicated world wide.

1.2 The national economy

The country's macro economy has been stable and social indicators are improving, but long-term economic growth has been sluggish and only recently has poverty started to decline. Bangladesh followed prudent macroeconomic policies and adopted some measures to open up the exchange and trade systems, improve the fiscal structure, and deregulate the financial sector during the early 1990s (World Bank, 1998). These measures have contributed to low inflation, developing a viable external position, provided some financial deepening, and increased international trade. Economic growth has been faster recently (World Bank, 1998), but though the government wants an outward-oriented private sector to drive economic growth, the business environment is unpredictable (Quddus and Rashid, 1998).

The value of Gross Domestic Product (GDP) and Gross National Product (GNP) can be used to indicate economic progress. The GDP is defined as value of all the final goods and services produced in the economy is a year (Hall and Taylor, 1993), while GNP, the sum of the money values of consumption, gross investment, government purchases of goods and services, and net exports (Samuleson and Nordhaus, 1992), is the most comprehensive measure of a nation's total output of goods and services (Parkin and King, 1995). Until very recently there has been little notable difference between GDP and GNP in Bangladesh (Table 1.1).

Table 1.1 Major economic groups in GDP over the years 1994-1998.

National accounts	1994-95	1995-96	1996-97	1997-98
GDP at current market prices (million US$)	29,053.1	31,144.5	31,956.7	32,848.6
GNP at current market prices (million US$)	30,435.2	32,582.7	33,585.6	34,455.6
Agriculture in GDP (%)	31	30	30	……..
Industry in GDP (%)	18	18	17	……..
Services in GDP (%)	52	52	53	……..
Total consumption: public and private (million US$)	26,801.4	28,805.7	29,566.0	30,253.5
Total investment: public and private (million US$)	4,812.3	5,369.0	4,880.6	4,761.9

Source: SESRTCIC, 1999 (year ending 30 June).

As shown in Table 1.1, the largest sector in the Bangladesh economy is agriculture (SESRTCIC, 1999; Iqbal, 2000), in 1997, accounting for about 30% of the GDP, 68.5% of employment and one fifth of exports (BBS, 1998). As large agricultural holdings are uncommon, the scope for the use of modern intensive methods of farming may be limited, though through co-operative farming, the use of modern machinery has been successfully introduced and is gaining popularity. Rice and jute are the principal crops, while sugarcane, potato, oilseeds, pulses, tea and tobacco are also important. The introduction of high yielding rice has revolutionised rice production in terms of areal yield. Rice being the staple food in Bangladesh, its production is of crucial importance (Chakraborty, 1998). Wheat production has also increased substantially while cotton is making a steady headway.

The country's per capita GDP has steadily risen in recent years, as shown in Figure 1.1, from Tk[1] 4,626 in 1986, increasing to Tk 6,717 in 1990, Tk 8,685 in 1994, and Tk 11,316 (US$ 276) in 1998. Though a positive sign of the country's economic improvement, the rate of increase is very low comparing to other SAARC[2] countries except Nepal. In 1998, per capita GDP in SAARC countries were: Bhutan US$ 430, India US$ 430, Maldives US$ 1,180, Nepal US$ 210, Pakistan US$ 480 and Sri Lanka US$ 810 (World Bank, 1998).

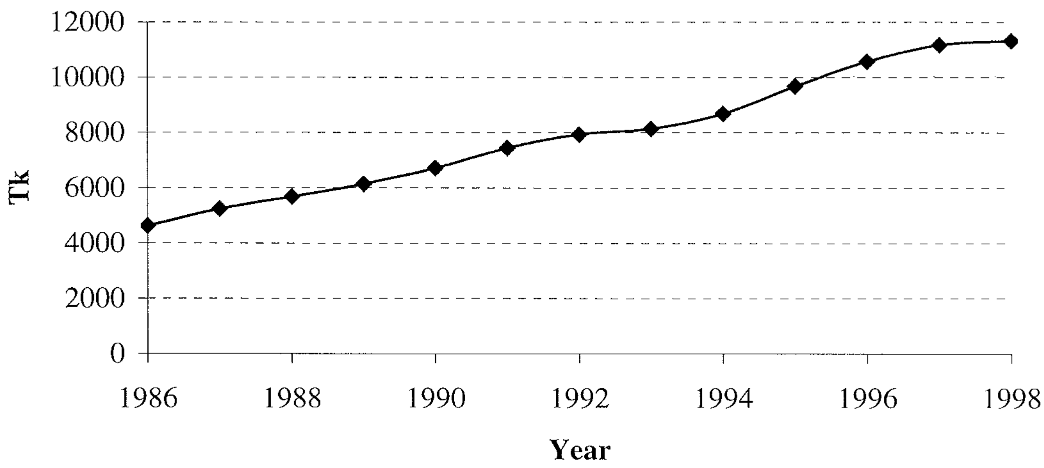

Figure 1.1 Per capita GDP over the years 1986-1998.

Source: BBS, 1998 (year ending 30 June).

[1] Bangladesh unit of currency; US$ 1= Tk 50 (January 2000), Tk 45 (January 1998).

[2] SAARC: The South Asian Association of Regional Co-operation (SAARC) was established in 1985, comprising the seven countries of South Asia, those are Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and Sri Lanka.

Main export commodities are ready-made garments and accessories, jute and jute goods, fishery products, leather and leather goods and tea. In 1995, Bangladesh was the world's largest jute exporter (BBS, 1998). By 1997-98[3], exports had doubled to 16% of GDP over the past decade following economic liberalisation. The success story of exports of ready-made garments from US$ 7 million in 1981-82 to US$ 3 billion in 1997-98 testifies to Bangladesh's potential as a competitive producer (BBS, 1998). Frozen seafood exports, particularly prawn and shrimp, doubled in the past five years to US$ 322 million, leather showed some growth, and tea has recently done well (World Bank, 1998).

1.3 Role of fisheries sector

The fisheries sector plays a very important role in the country's socio-cultural and economic life, providing food, employment and foreign exchange (Rahman, 1994a). Sixty percent of the national protein supply is from fish, and the sector contribution to GDP was about 5% in 1997-98 (DOF, 1999). The sector has been a longstanding and an indispensable part in the life and livelihood of the peoples of Bangladesh and is commonly regarded as part of the country's cultural heritage. About 12 million people (10% of the total population) directly or indirectly depend on fisheries, of which 1.2 million people (1% of the total population) depend full time on fish and fishing activities (DOF, 1999). Freshwater and brackishwater aquaculture, fish, prawn and shrimp seed collection, fish transportation, fish trade, fish processing, net making etc. also provide a large sources of associated employment, and further multipliers might be expected.

[3] Bangladesh fiscal year: 1 July – 30 June.

Bangladesh is endowed with very considerable marine, estuarine and inland waters, and a rich and extensive fishery resource, with a wide variety of indigenous and exotic fish faunas (Rahman, 1994a). Approximately 256 species of freshwater fishes, 25 types of tortoises and turtles, 150 species of waterfowl, 50 species of reptiles, 24 species of mammals, and 8 species of amphibians are found in Bangladesh (Ali, 1991; World Bank, 1991; MAEP, 1996). Aquaculture activities are concentrated in two major sectors: 1) freshwater, mainly carp culture; and 2) brackishwater, mainly shrimp culture (Chowdhury, 1987; Rahman, 1994a).

The soil, water and climate favour high levels of inland fisheries production in both open and closed water (DOF, 1999). Inland fisheries cover an area of 4,337,690 ha of which 93% comprises capture fisheries (Table 1.2). Culture fisheries sources include ponds, *baor*[4] (ox-bow lakes) and prawn and shrimp farms. The flood plains and the *beels*[5], covering 2,946,953 ha also offer great scope and potential for augmenting fish production by adopting culture-based fishery enhancement techniques (DOF, 1999).

[4] Closed water body equivalent to an ox-bow lake, up to several hundred hectares.
[5] Open water bodies often containing low-lying agricultural land.

Table 1.2 Inland water resources in Bangladesh.

Water bodies		Water area (ha)
Open water	River and brackish water	1,031,563
	Beel	114,161
	Kaptai lake	68,800
	Flood plain	2,832,792
Sub-total		4,047,316
Closed water	Ponds (12,88,222 in number)	146,890
	Baor (Ox-bow lake)	5,488
	Prawn and shrimp farms	137,996
Sub-total		290,374
Grand total		4,337,690

Source: DOF, 1999.

The country also has considerable potential for the development of brackishwater aquaculture, with a 480 km coast line and 25,000 km^2 of coastal area, though these areas also support a huge population engaged in a variety of land use practices (Mahmood *et al.*, 1997; Rahman, 1994a). The nation's economic zone extends 320 km out into the sea from the coast line. The coastal belt of Bangladesh extends over 76 *thanas*[6], with livelihoods of large numbers of people depending on fishing and fishery exploitation (Feroze-Ahmed, 1997). Already, more than a decade ago, thousands of persons in the coastal area made a living collecting prawn fry (Angell, 1990).

Bangladesh is the third largest producer of inland capture fisheries in the world, after China and India (FAO, 1999a). In 1997-98, total fish production was 1.49 million t, with inland capture fisheries, inland culture fisheries and marine fisheries accounting for

[6] An administrative unit in Bangladesh equivalent to a sub-district.

42%, 38% and 20% respectively (Table 1.3). Despite significant growth in total production, overall output of inland fisheries has been static, as capture fisheries have declined. Apparent per capita fish consumption was 10.0 kg head^{-1} year^{-1} (27 g head^{-1} day^{-1}) in 1996-97, whereas per capita fish consumption was 12.0 kg head^{-1} year^{-1} (33 g head^{-1} day^{-1}) in the early of 1970s (DOF, 1999).

Table 1.3 Fish production (thousand tonne) in Bangladesh, 1990-1998.

Year	Production source						Total production
	Inland capture fisheries		Inland culture fisheries		Marine fisheries		
	Production	%	Production	%	Production	%	
1990-91	443	49	211	24	242	27	896
1991-92	479	50	227	24	246	26	952
1992-93	532	52	238	23	251	25	1021
1993-94	573	53	264	24	253	23	1090
1994-95	591	50	317	27	264	23	1172
1995-96	609	49	379	30	269	21	1257
1996-97	600	46	432	33	275	21	1307
1997-98	619	42	570	38	301	20	1490

Source: DOF, 1999 (year ending 30 June).

Exports of fish and fisheries products have grown rapidly, and this is now the third largest export commodity after ready-made garments and jute products (DOF, 1999). Prawn and shrimp[7] are the main exportable items and earn a substantial amount of foreign exchange (Tk 11,814.8 million or US$ 295.4 million in 1997-98), increasing to a great extent in the last two decades. Total fisheries sector exports during 1985-86 amounted to 23,048 t, worth Tk 3,562.5 million (US$ 93.75 million) rising to 30,158 t,

[7] According to FAO convention, the term 'prawn' will be reserved for freshwater creatures only, and their marine / brackish water relatives will be called 'shrimp'.

worth Tk 13,878.1 million (US$ 346.95 million) in 1997-98, constituting about 5.93% of the country's total export earnings (DOF, 1999) (see Appendix 1, Table 1.1).

Figure 1.2 shows that the contribution of fisheries sector outputs to total export earnings has varied over recent years showing a gradual decline to 5.93% in 1997-98. However, in absolute term the sector is still important; the decline being due to the welcome use in manufactured goods (and the recent emergence of petroleum/gas products).

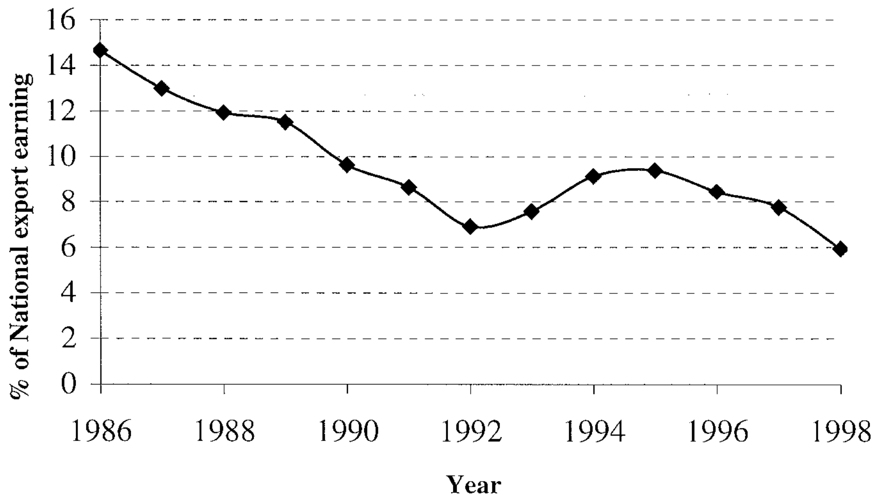

Figure 1.2 Contribution of fisheries of national export earning over the years 1986-1998.

Source: DOF, 1999 (year ending 30 June).

Aquaculture development continues to have a high priority in the plans of Bangladesh government (DOF, 1999), though development goals have, in most cases not been reached due to institutional and social constraints (Roy, 1997). Increased of export earnings, improved fisheries production in both open and closed water, alleviation of poverty and generation of new employment are some of the major national development objectives (DOF, 1999). Table 1.4 states the government's recent activities for fisheries development.

Table 1.4 Role of the Department of Fisheries.

A. Transfer of technology:

1. Extension service on aquaculture and management.
2. Training and advisory services to the people on aquaculture and management.
3. Render advisory services to provide credit on fisheries.
4. Dissemination of modern technology on aquaculture, fisheries management, hatchery operation etc.

B. Conservation of fisheries resources:

1. Enhancement of fisheries through conservation and management of fisheries resources.
2. Enforcement of fisheries rules, regulation etc.

C. Quality control of fish and fishery products:

1. Ensure quality of fish and fishery products and issuance of health certificate for exportable fish products.
2. Enforcement of fish and fish products (inspection and quality control) rules.

D. Others:

1. Advising the government in formulating policies related to fisheries.
2. Collection of data on fisheries and its compilation, editing and publication.
3. Planning, formulation, implementation, monitoring and evaluation of fisheries development projects.
4. Socio-economic upliftment of fisher-folk community.
5. Poverty alleviation through fisheries activities.

Source: DOF, 1999.

1.4 Potential of freshwater prawn culture

1.4.1 Freshwater prawn

The term "freshwater prawn" refers to the genus, *Macrobrachium* (Phylum – Arthropoda, Class – Crustacea, Order – Decapoda, Family – Palaemonidae) a large genus of Crustacean comprising over 150 species (Brown, 1991). Many of the species provide significant local fisheries where they occur (Holthuis, 1980). Of these, the giant freshwater prawn *Macrobrachium rosenbergii* (De Man, 1879) is the most widely cultured, and is found in most inland freshwater areas including lakes, rivers, swamps, irrigation ditches, canals and ponds, as well as in estuarine areas, but not in sea water due to high salinity (Kurian and Sebastian, 1982). However, the species requires brackish water in the initial stages of their life cycle, and therefore they are found in water that is directly or indirectly connected with the sea (New and Singholka, 1985). As a primarily freshwater animal, *M. rosenbergii* is referred to as "prawn" (Csavas, 1988), though according to FAO its official common names are: Giant river prawn (English), Bouquet geant (French) and Camaron gigante (Spanish) (Holthuis, 1980). This species is known by several common names around the world, such as 'Golda chingri' in Bangladesh (Holthuis, 1980; Hussain, 1994; New, 1995), 'Koong yai' in Thailand (Holthuis, 1980), 'Udang galah' in Malaysia (Ling, 1969), 'Mocha chingri' in India (George, 1969; Holthuis, 1980), and freshwater prawn in Taiwan, Vietnam and China (Ling, 1969; New, 1988).

There are many advantages to the culture of *M. rosenbergii.* According to Ling and Costello (1976), it offers high farming potential with qualities such as better survival rate, higher tolerance to wide range of temperature and salinity, and acceptance to both plant and animal diet. It is the largest in size and fastest in growth among the freshwater prawns (Nuruzzaman, 1993), and will stay in ponds rather than escape. Its polyculture with other fishes is feasible (Malecha *et al.*, 1981; Tang, 1982), and its production can be enhanced using simple feeds. The species is also of high nutritional value (Nuruzzaman, 1993) and although not distinctly flavoured, has a good appearance and market value. There is a wide inter-specific variation in maximum size of *M. rosenbergii,* the great size of males being 320 mm and females being 259 mm (Brown, 1991). The typical culture size of male and female is 290 mm and 235 mm respectively (Kurup *et al.*, 1992).

1.4.2 Geographical distribution

M. rosenbergii is widely distributed, mainly through the tropics but also within the subtropic and temperate zones (Brown, 1991). It is indigenous in the whole of the south and southeast Asian region as well as in northern Oceania and in the western Pacific Islands. It is the species most used for commercial prawn production and is now farmed in many countries, including USA (Hawaii), Honduras, Mauritius, Taiwan, Thailand, India, Bangladesh, Myanmar, Vietnam, Costa Rica, Israel, Indonesia, Malaysia, Australian, China, Mexico, Philippines and Zimbabwe (New and Singholka, 1985; Rabanal and Soesanto, 1985; Brown, 1991; New, 1995). In Asia, farmed freshwater prawns had mainly originated from Taiwan, Thailand and Vietnam (New, 1995). The culture of *M. rosenbergii* became possible and widespread when S. W. Ling in Malaysia in 1962, discovered the need for a brackish water medium for larval culture, and was thus able to close the life cycle in the laboratory (Brown, 1991). The pioneer work of Ling (1962), translated into a method for the mass production of post-larvae[8] (PL) by Fujimura and Okamoto (1972) in Hawaii, has subsequently been introduced into almost every continent for farming, developing steadily through the 1960s and early 1970s (New and Singholka, 1985).

1.4.3 Global production

In spite of its widespread development, the culture of freshwater prawn has been less important than that of marine shrimp. In 1996, global farmed production of prawn and shrimp was 1,091,106 t, of which only 8.49% was prawn. Global production of farmed *M. rosenbergii* was 92,630 t in 1996 (FAO, 1998), having risen steadily, with the exception of a decline in 1992 due to a severe production problems in Taiwan. These were only partially offset by increased production elsewhere, notably in India and Vietnam (New, 1995). However, global production of freshwater prawns in 1996 was still nearly ten times as high as in 1985 and three times as high as in 1990 (Figure 1.3).

[8] The term post-larvae usually applies to animals from the time of metamorphosis up to about 60 days later, which is commonly known as PL.

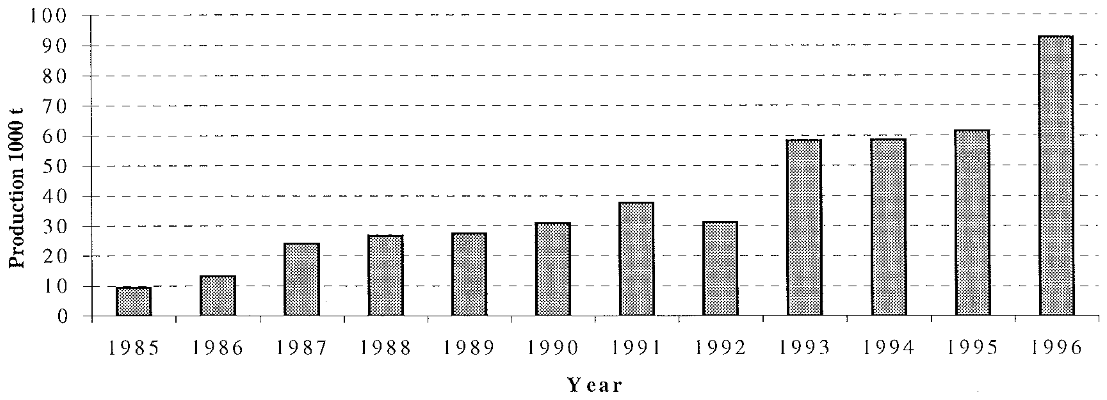

Figure 1.3 Global freshwater prawn production over the years 1985-1996.

Source: FAO, 1998.

Nearly three-quarters of production of freshwater prawn still originates from Asia, in common with aquaculture generally. In 1996, Asia produced 65,819 t (71.06%) of freshwater prawns, North and Central America 22,066 t (23.82%), Europe 2,390 t (2.58%), South America 1,861 t (2.01%) and Africa 114 t (0.12%) (Table 1.5). Within Asia, Taiwan, Thailand, China, India, Vietnam, Bangladesh and Indonesia were the most important prawn producers (FAO, 1998).

Table 1.5 Production of farmed freshwater prawn by continent in 1996.

Continent	Production (tonne)	Percentage
Africa	114	0.12
Asia	65819	71.06
Europe	2390	2.58
North and Central America	22,066	23.82
South America	1861	2.01
Other	380	0.41
Total	92630	100

Source: FAO, 1998.

1.5 Prawn farming in Bangladesh

1.5.1 History

Bangladesh has very considerable inland waters suitable for the growth of many species of freshwater prawns including *M. rosenbergii* (Hussain, 1994). About 23 species of freshwater prawns including 10 species of *Macrobrachium* are available; however, only *M. rosenbergii* has significant aquaculture potential and is commercially cultured (Akand and Hasan, 1992).

In Bangladesh, freshwater prawn farming first started in the southwestern region in the early 1970s (Mazid, 1994; Aftabuzzaman, 1996). Locals learnt to catch prawn fry from people on the other side of the Ichamati river, on the border between Bangladesh and India at Debhata. After the 1971 'war of liberation' Hormuz Ali of Basantapur village noticed people on the Indian side "catching something" with a net. Crossing the river, he learned they were catching "something very valuable", so he studied their techniques, bought a net on the Indian side and began catching fry in the waters near his village (BOBP, 1990). It was Hormuz Ali who introduced the technique of prawn fry collection.

Around 1978, a few well-off local farmers in the area began to experiment with stocking *M. rosenbergii* in freshwater carp ponds built on their land. These early innovators experimented with construction design, feeding, stocking and other technical aspects, and profited well from their success (Kendrick, 1994). Finally a few pioneers, some time between the late 1970s and the mid 1980s, developed the first prawn cultivation in low-lying agricultural land and paddy fields. The name most frequently raised as the "Father of freshwater prawn farming" is Keramat Ali of Bagerhat district in southwestern Bangladesh (Rutherford, 1994). Since the early 1980's prawn farming has now become one of the financially most attractive investment opportunities in many areas of Bangladesh (DIFTA, 1993).

In the late 1980s, the farming practice began to be adopted widely in the original location in Bagerhat, in which freshwater prawns are grown along with carp, rice and other crops. The expansion of freshwater prawn cultivation has been dramatic, and since 1990 adoption has accelerated, spreading to other southern districts such as Barisal, Khulna, Satkhira and Jessore (Kamp and Brand, 1994). Figure 1.4 shows map of Bangladesh and its freshwater prawn producing areas.

MAP NO. 3711 UNITED NATIONS
NOVEMBER 1992

Figure 1.4 Map of Bangladesh showing prawn farming areas.

1.5.2 Farming practice

Within the overall agro-based economy of the country, the contribution of prawn production had been considered to hold good promise for creating jobs, earning foreign currency and supplying protein (Rahman, 1994a; DFID, 1997). However, as currently practised it may have certain disadvantages for local poor communities. Though the livelihoods of a large number of people are associated with prawn farming, many prawn farmers had been reported to be socially, economically and educationally disadvantaged and, lacking their own financial resources, were heavily indebted to traders and middlemen (Rahman, 1994b).

In 1994, the total freshwater prawn farming area covered 8,307 hectares; of which three-quarters were in the southwestern and the rest in the southeastern region (Rosenberry, 1993; DOF, 1995) (see Appendix 1, Table 1.2). Although freshwater prawn farming practice is still traditional and productivity is low (Nuruzzaman, 1993; Rahman, 1994a; Karim, 1997), many farmers now practice improved methods where prawns are cultivated semi-intensively (Bundell and Maybin, 1996).

The cultivation of freshwater prawn in modified rice fields, locally referred to as '*ghers*', has been a recent development in Bangladesh and one which was genuinely originated by farmers (BOBP, 1990; Rosenberry, 1992; Rutherford, 1994). Accoroding to Kamp and Brand (1994) *gher* farming is a "quiet, indigenous technological revolution", suitable for the cultivation of prawn, fish and other crops. The principal districts in which the practice is currently found are Khulna, Bagerhat and Satkhira in the southwest

(Chapman, 1997). The Bangla term '*gher*' is an enclosure made for prawn cultivation by modifying rice fields through building higher dikes around the field and excavating a canal several feet deep inside their periphery to retain water during the dry season (Kendrick, 1994). The *ghers* are generally situated in low-lying areas of the flood plain, which are irregular in shape and may be up to 100 hectares in area (New, 1995).

According to DFID[9] (1997), *gher* farming can be considered as a method of combining aquaculture and agriculture on one plot. During the rainy season the whole water body is used for the cultivation of prawn and fish. However, when the weather is dry then only the trenches are used for fish and rice is planted in the central plot. At all times of year the dikes can be used for growing vegetables, fruit, wood and fodder.

Muthu (1981) indicated the criteria considered important in site selection for freshwater prawn farm construction, listed as: 1) soil characteristics 2) water characteristics 3) availability of the natural resources in the areas 4) the flora and fauna of the region 5) freedom from pollution 6) accessibility and nearness to markets 7) legal regulation and 8) socio-economic condition of the locality. In Bangladesh, freshwater prawn farming is widespread in the southwestern region due to the availability of wild fry, favourable resources and climatic conditions such as the availability of low lying agricultural land, warm climate, fertile soil and cheap and abundant labour (Haroon, 1990; Rahman, 1994a). Potential returns for prawn farming are good and farmers have been attracted by its potential as an income earner (Chapman, 1997; DFID, 1997). For the people of

[9] Department for International Development (DFID), UK government aid agency.

Fakirhat, proudly called the "little Kuwait of Bangladesh", prawn production was reported to have increased subsistence farmers' incomes considerably (Kendrick, 1994; Rutherford, 1994).

The early *gher* innovators tended to be large and middle size farmers, but increasing numbers of small and marginal farmers also started prawn farming in *ghers* (Rutherford, 1994). The majority of these farmers were quite poor and unskilled in technical aspects of the new technology, and because of their marginality had been inexperienced in planning and managing for the higher input costs and capital needs of the more sophisticated production systems (Kamp and Brand, 1994). Though prawn farming in *gher* systems had great potential benefits, increasing cost, high level of debt, and an almost total lack of technical assistance had left many of these adopters of the new technology in a state of increased vulnerability (Chapman, 1997; CARE, 1998a).

The principal operating costs associated with prawn culture in Bangladesh were reported to be fry, feed, fertiliser and labour (Angell, 1990; CARE, 1997). The industry depends on catches of wild fry (Angell, 1994a), and farmers begin stocking their *ghers* as soon as fry become available, typically in April, and continue adding fry up until about May (BOBP, 1990; Rosenberry, 1990). The supply of prawn fry has also generated additional employment as fry-catchers for thousands of rural poor in coastal areas, though despite their role in sustaining the industry, they remain poor and under-privileged (Angell, 1990). Rosenberry (1992) noted that more than 40,000 people - men, women and children were associated with prawn and shrimp seed collection in the coastal belt of

Cox's Bazar, while in the Satkhira, Khulna and Bagerhat districts, the number was over 100,000. According to Rosenberry (1992), they were mostly the landless and the poor who had virtually no other means of income or employment.

The '*bundh*', a unique trapping system for collecting *M. rosenbergii* seed is now widely practised in the Sunderbans[10]. Different types of bamboo traps are used for collection of prawn and fish fry. According to Nuruzzaman (1993), *M. rosenbergii* seed and fish seed collections from the *bundh* in a season were normally 25.72 kg and 42.40 kg respectively. However, the marketing system had not been well developed and high fry mortality occurs due to poor handling. As Angell (1994b) noted, the growing freshwater prawn farming sector, continued to demand increasing quantities of fry.

Successful commercial farming of freshwater prawns must involve supplementary feeding (New and Singholka, 1985). In southwestern Bangladesh, a variety of feeds such as rice bran, wheat flour, oil cake, cooked rice, fish meal etc. are used in prawn culture; however, the preferred feed is the freshwater snail *Pila globosa* (CARE, 1997).

The profitability of a prawn farm investment largely depends on the production level and on the average weight of harvested prawn. Khan *et al.*, (1980) stated that in Bangladesh, freshwater prawn juveniles released into culture ponds and reared for a year, attained an average length and weight of 210.4 mm and 142.25 g respectively. The rate of survival was about 82%, which was considered as a most promising result for prawn culture in

[10] The Sundarbans is one of the world's most unique delta regions, located along the mouth of the Bay of Bengal, over 10,000 km^2, which is the largest mangrove in the world (Townsend, 1999).

impounded waters. However, the current practice of producing '*Golda*[11]' has developed as a result of a range of practical inputs, using relatively simple, artisanal techniques.

1.5.3 Production

The production of prawn in Bangladesh is quite variable because of the simple culture method. Rahman (1994a) reported that the average per hectare yield of prawn in Bangladesh was only 168 kg, which is low compared to other countries in the region, and was considered to be due to the traditional farming method and the relatively low technical and financial inputs. However, more recently, reported yields had increased, with typical yield of 200 to 250 kg ha^{-1} being obtained (Rahman, 1999), while Hoq *et al.*, (1996) reported that prawn production when reared together with fish, varied from 162 to 428 kg ha^{-1} after 10 months. Production levels of prawn with integrated farming averaging 360 to 462 kg ha^{-1} $year^{-1}$ in Egypt (Sadek and Moreau, 1996), and 200 to 400 kg ha^{-1} $year^{-1}$ in Vietnam have been obtained (Lin and Lee, 1992). The Taiwanese national average yield of freshwater prawn was 1,500 kg ha^{-1} $year^{-1}$ (New, 1995).

By 1997-98, the country's total prawn production was still comparatively low at 31,425t, of which only 5,000 t was cultured (15.9%), the rest having been captured (DOF, 1999). However, production from culture and capture has been increasing since 1990-91 through at a rather irregular pace (Table 1.6). The average annual growth of production over 1990-98 was 9.34% per year.

[11] In Bangladesh, freshwater prawn (*M. rosenbergii*) is commonly known as '*Golda*'.

Table 1.6 Freshwater prawn production in Bangladesh over the years 1990-1998.

Year	Production (tonne)	Percent (%) growth per year
1990-91	17,985	+ 4.55
1991-92	16,730	- 6.98
1992-93	20,224	+ 20.88
1993-94	25,191	+ 24.56
1994-95	26,977	+ 7.09
1995-96	27,741	+ 2.83
1996-97	27,579	- 0.58
1997-98	31,425	+ 13.95

Source: DOF, 1999 (year ending 30 June).

1.5.4 Export and marketing

Bangladesh is a major exporter of *M. rosenbergii* caught by artisanal fishers in rivers, lakes and flooded depressions (Angell, 1992), and has been well placed to develop an export market for farmed output (New, 1995). In the early 1990s, the vast majority – more than 90% of the freshwater prawns exported from Bangladesh derived from natural resources, with an estimated 60% deriving from the Khulna-Bagerhat area, 35% from Comilla and Noakhali districts and only 5% from Cox's Bazar area (DIFTA, 1993). Due to the importance of freshwater prawns as an export product, the government had declared prawn cultivation to be of primary industry status and facilities, and designed a specific support programme to boost production (Datta, 1995; DOF, 1999).

Over recent years, there has been a notable increase in the export prices of the Bangladeshi prawn in particular on the USA, Japan and European market. The European market, especially Belgium, has largely accepted this prawn because of its reported similarity in taste to the preferred coldwater species *Crangon* sp. (Nierentz and Josepeit, 1988; Chauvin *et al.*, 1992). In 1997, Bangladesh exported 25,742 t of prawns valued at US$ 246.94 million (US$ 9,593 t^{-1}) (FAO, 1999b). However, export of prawns and associated foreign currency earnings have declined in 1997 compared with the previous two years (Table 1.7). Of the total exported in 1997, 30.4% was sold to the USA, 21.47% to Japan, 14.24% to Belgium, 8.6% to the UK, 8.57% to the Netherlands, 7.59% to Thailand, 7.53% to Germany, and 1.6% to Singapore (DOF, 1999). Although a fully developed global commodity market for freshwater prawns has not yet emerged, it is anticipated that changes will come, and the potential of Bangladesh as a low cost producer may generate even greater future economic benefits.

Table 1.7 Export of freshwater prawns over the years 1993-1997.

Year	Export (tonne)	Earning foreign currency (US$ 1000)	Earning foreign currency (US$ per tonne)
1993	19,224	182,036	9,469
1994	22,054	207,450	9,406
1995	26,277	279,145	10,623
1996	26,531	281,744	10,619
1997	25,742	246,936	9,593

Source: FAO, 1997a; FAO, 1999b.

1.5.5 Constraints of prawn farming

Despite the great potential of freshwater prawn (*M. rosenbergii*) farming in Bangladesh, successful commercial culture faces a number of problems. Major constraints include:

Lack of capital

According to Kendrick (1994), the lack of capital was found to be a major issue for both prawn farmers and processors, who claimed to be almost unable to avail themselves of credit. This had earlier been noted as a major problem for prawn culture in the developing countries (Ahmed, 1986), and might still be a critical factor, not only in continuing the overall rate of development, but in defining which sectors of society gain opportunities.

Insufficient supply of fry

The prawn culture industries in Bangladesh including freshwater prawn farming still depend on wild fry (Angell, 1994a; Islam and Chowdhury, 1999). By the late 1980s, catches of wild prawn post-larvae were already reported to have declined in Bangladesh due to excessive harvesting (Mahmood, 1987). Phillips (1994a) noted that natural fluctuations in abundance of post-larvae were aggravated by factors such as over-fishing, pollution, and habitat destruction. Dependence on such wild caught supplies, and the variability of supply – with unpredictable timing, quantity and quality, is a major constraint. Although hatchery production is technically feasible, and has been introduced into Bangladesh, it has not effectively been established.

Disease

Disease is a common and major problem of freshwater prawn farming in Bangladesh. According to the annual report of World Shrimp Farming (1995), if viral diseases had not hit the industry, Bangladesh would have produced considerable amounts of prawn in 1995. A wide variety of diseases are found in freshwater prawns such as shell diseases or black spot, white spot, gill disease etc. 'Black spot', the most obvious disease of post-larval to harvest-size prawns, is caused by bacteria and sometimes, later, by fungus (Cai *et al.*, 1997), causing mortalities and also reducing the value of harvested prawns through disfigurement. Environmental factors such as poor water quality and the presence of toxins and nutritional deficiency of feed are key causes (Cai *et al.*, 1995; Cai *et al.*, 1997). Brock (1983) noted that important disease factors in prawn culture included poor husbandry, overcrowding and unsuitable water quality. However, though maintaining good environmental conditions is important in disease control (Brown, 1991; Cai *et al.*, 1997), this does not necessarily protect against more invasive diseases.

Pollution

Most prawn producers fertilise their ponds, and periodically exchange water, or drain out waste water during harvest. Few *M. rosenbergii* farms in Bangladesh appear to treat their waste water before its discharge. It is simply pumped out into creeks and canals which flow on to adjacent waste land. The high levels of organic wastes and fertilisers deoxygenate the water (Bundell and Maybin, 1996), killing or driving away prawns and fish as well as other aquatic life.

Environmental

The production of prawn farming is closely linked with the behaviour of the monsoon, and the related problems of flood and drought, resulting from excessive water during the wet season and practically no water during the dry season (Nuruzzaman, 1994). Bangladesh lies within a zone of cyclone storms and devastating tidal bores which tend to occur during early summer, April and May or during late rains in September to November. During the past three decades six catastrophic storms with winds reaching

240 km h^{-1} have devastated coastal areas (Rashid, 1991). Khalil (1992) noted that from 1797 to 1991, Bangladesh has experienced 60 severe cyclones, which caused the death of thousands of people and major disruptions and loss to wildlife. Chowdhury (1990) stated that two-thirds of Bangladesh land was flooded during 1988 flood, which drew world wide attention. Muthiah (1991) observed the losses and damages of fisheries as well as prawn farms in Bangladesh, by the cyclone of April, 1991. More recently, the 1998 flood affected 30 million people (25% of the total population) covering 100,000 km^2, where 918 people died and severely damaged agricultural, fisheries and livestock (FFWC, 1998).

Flooding may in the future be aggravated by global warming and the associated rise in sea water levels. By the year 2050, if water levels rise by one meter, as in some predictions, Bangladesh could lose 11.5% of its land surface, where some 8.5 million people reside, and the mangrove areas will be reduced by 50% (UNDP, 1994). These areas are amongst the most important for the existing prawn production sector.

Socio-economic considerations

The introduction of freshwater prawn farming to Bangladesh is reported to have been accompanied by a number of social impacts (Bundell and Maybin, 1996). Prawn farmers are socially disadvantaged and lacking their basic needs such as housing, drinking water supply, health and sanitary facilities, and education (DFID, 1997). According to Rahman (1994b) prawn farmers were below the poverty line and were struggling to survive, with health, nutrition, sanitation, water supply, soil fertility, cooking fuel, animal feed and house building materials a day to day problem. Constraints also arose from over-population, low incomes, low economic status, and lack of alternative employment opportunities (Rahman, 1994a). Unless significant change has subsequently arisen through economic benefits of the sector, such factors are likely both to limit the scope for expanding and developing the industry, and for its benefits to be dispersed effectively amongst the rural population in producing areas.

Poor road and transport facilities

The lack of a good infrastructure, and especially an inadequate communication system, is a common problem in prawn farming areas of Bangladesh. This is also a problem for both the prawn processing and marketing sectors, causing a range of inefficiencies and losses at all production stages, and in the processes of maintaining and adding value at the market level. Joshi and Raje (1993) also noted that the supply of *M. rosenbergii* seedlings, in particular, either from hatchery production or collected from wild, faced considerable problems of heavy mortality during transportation.

Lack of education

Lack of education may also be an important constraint. From a survey of fishing villages in Bangladesh, Rahman (1994b) indicated that 57% of household members were illiterate while the remaining 43% had varying levels of literacy up to secondary level. Those having only nominal education (below primary level) predominated and less than 10% of the literate had education up to primary or secondary level. According to Ali *et* *al.*, (1982), education and farming efficiency are closely related, and a high rate of illiteracy resulting in low farm efficiency.

Institutional support

Other problems of prawn culture in Bangladesh include lack of institutional and administrative support, insufficient investment, lack of appropriate technologies, infrastructures and extension services and inadequate resources of trained, experienced manpower (Kendrick, 1994; Rutherford, 1994; Jahangir, 1998).

1.6 Objectives of the study

According to Tisdell (1994), successful development of aquaculture not only requires appropriate natural environmental conditions and the availability of workable technical methods but also receptive and supportive social and economic conditions. On the economic side, needs, markets, availability of suitable resources and appropriate systems of property rights are seen as important. Significant social influences are security of property, types of social mechanisms used for resources allocation and determination of resource use, the legal system, the political system, tastes, and social values.

Social and economic issues influence the development of aquaculture and need to be taken into account in fostering and planning it. Even if biological, technological and environmental conditions are favourable for the development of aquaculture, it may fail if social and economic factors are unfavourable. The development of aquaculture calls for a holistic approach accounting for all of the factors indicated in Figure 1.5.

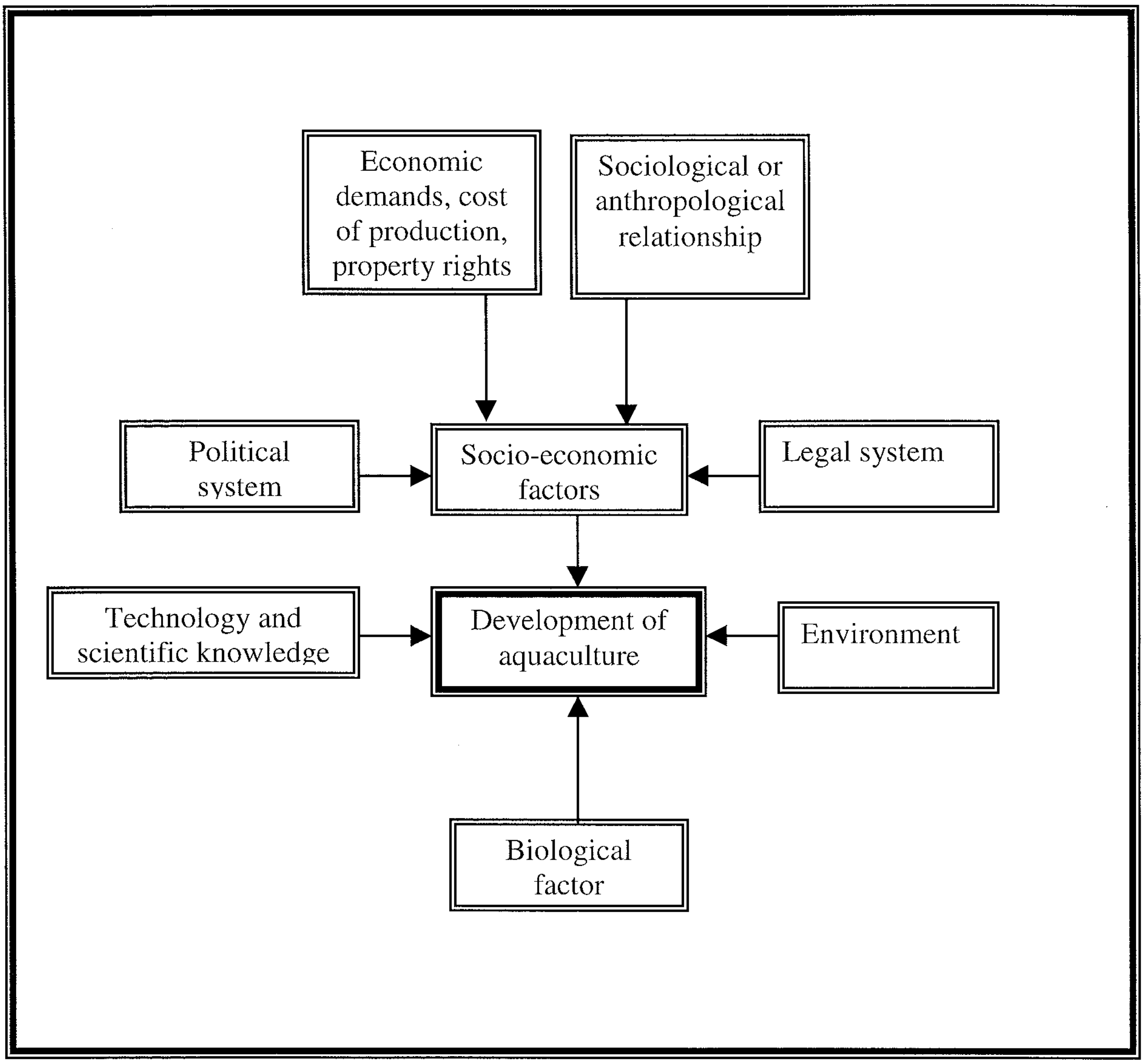

Figure 1.5 Socio-economic influences on the development of aquaculture (adapted from Tisdell, 1994).

Such issues are equally important for the successful development of prawn farming in Bangladesh. Here, it is not only necessary to take into account economic returns but also equity factors such as its impact on the distribution of income and on the sustainability of income (Ruddle 1993; Tisdell, 1994). Income helps poor farmers gain access to social services (DFID, 1997). Enhancing social and economic conditions of prawn farmers depends on increasing food security, improving the status of women in the household, increasing employment opportunities and reducing susceptibility to environmental risks (CARE, 1997). Thus the social and economic improvement of prawn farmers and associated groups is a primary objective in developing and sustaining prawn production. The present study aims to assess the significance of such factors in present day *gher* farming. To reach these objectives the following elements are proposed:

1) To identify the social and economic features of the communities associated with prawn farming in southwestern Bangladesh, and to understand the factors which may be important in maintaining a favourable condition for vulnerable groups.

2) To assess the current or potential impacts of structural and technology changes.

3) To identify future ways for extending or reinforcing livelihood opportunities amongst key groups.

1.7 Thesis structure

The thesis is divided into seven chapters whose relationship is illustrated in Figure 1.6. A brief description of their contents follows –

Chapter 1: summarises the national context, its resources, population and economic conditions, and provides an overview of the social, economic and political situation. The role of the fisheries sector and its impact on the national economy, and a background to freshwater prawn culture in Bangladesh are also addressed, leading to an outline of the context and background against which the present study has been carried out.

Chapter 2: presents the research hypothesis and its related elements, describes the research methods, the selection of the study area, procedures for selecting the sampling method, procedures for determining sample size, and methods employed to gather the data. The analytical tools used to realise the objectives of the study are also discussed.

Chapter 3: presents results concerning current practices of prawn farming in the *gher* systems, including stocking, feeding, harvesting, marketing, processing, and describes the wider upstream and downstream connections and their human agents. It also describes the current or potential environmental impacts.

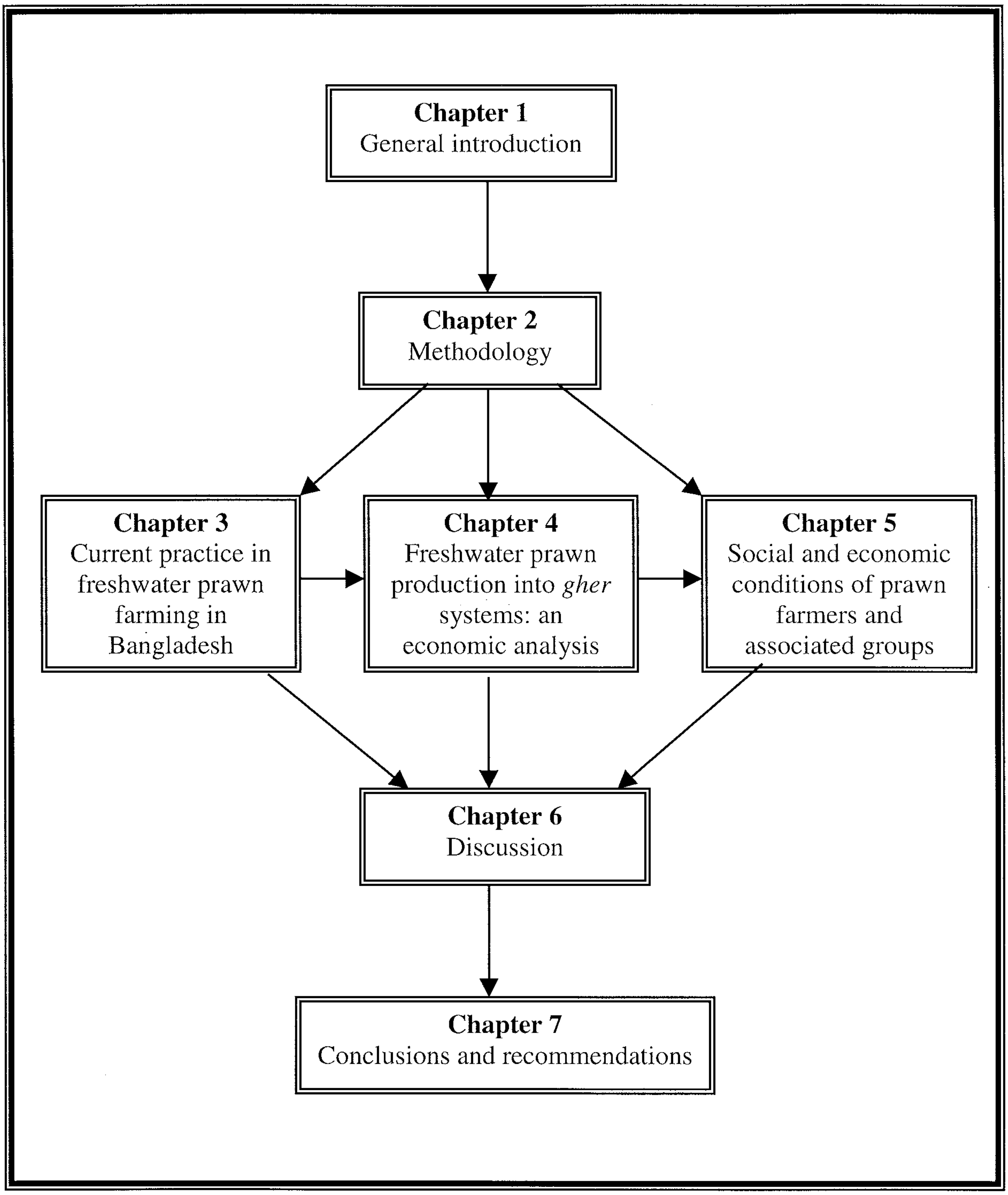

Figure 1.6 Structure of the thesis.

Chapter 4: develops an economic analysis of *gher* production in the study area. This includes cost structure, profitability, and analyses the role of location and *gher* size on financial performance.

Chapter 5: examines and analyses the social and economic constraints of farmers and other associated groups, identifies improvement of socio-economic conditions linked with prawn farming, disadvantaged groups in the target communities, and considers the nature and dynamic and impact of social and economic changes associated with prawn farming.

Chapter 6: brings together the results of the previous sections and considers the hypothesis relating to the success of prawn farming in contributing to wider benefit. It further considers the interpretation of study results in terms of livelihood conditions, opportunities and further aims.

Chapter 7: provides conclusions and recommendations for the development of freshwater prawn culture in Bangladesh based on results from the previous chapters.

CHAPTER 2

METHODOLOGY

2.1 Introduction

This chapter describes the research strategy and methodology followed to achieve the objectives of the study and explains the choice for selecting research tools and the methods for data collection. It also describes the selection of the research site, the identification of survey targets within and associated with the prawn farming sector, the consequent sampling structure and strategy. Finally, it describes the process of negotiating to obtain information and gather the necessary data, the major tools used to analyse the data, the constraints encountered in these, and the means employed to overcome them.

2.2 Research hypothesis

The first stage in defining the approach of the study, having described the broad context of the research area has been to develop a primary hypothesis in relation to the key research issues, and thereby to set out the key areas of enquiry.

The key research issue is an exploration of the practices and activities of freshwater prawn farming and the means by which they might bring social and economic benefits within the area and more broadly in Bangladesh. This involves asking the basic questions of how people in Bangladesh benefit from prawn production. The specific issues involved would include questions about:

i) in what ways various prawn farming related sectors within the community gain from the cultivation of *M. rosenbergii* in *gher* systems?

ii) how the prawn farming is economically beneficial, and if so, whether and how these benefits depend on resource ownership?

iii) are particular sectors within the community being adversely affected by prawn production, who is reaping the greatest benefits and who the least?

As Rutherford (1994) notes: what happens when a village economy based on rice cultivation is swept away in a matter of a few years and replaced by prawn farming activities? Rutherford describes "such a transformation has taken place in southwestern Bangladesh, where rice fields have been turned into '*ghers*' – dikes enclosures of shallow water dedicated to the production *of M. rosenbergii.* It is easy to imagine that wealthier, better educated farmers might be able to make the leap into the new technology. It seems certain that the rich are getting richer as a result of the shift to *M. rosenbergii* production". As Kendrick (1994) notes, the literature suggests that overall, the impact of the *gher* revolution appear to have had a positive effect and certainly most members of the community had confirmed this. However, the impact of prawn farming into *gher* systems has been subjected to a very limited number of studies since the initial growth phase of the *gher* sector. According to Rutherford (1994), big *gher* owners and early innovators have reaped benefits from *gher* farming and the middle and small farmers who were able to convert their land for prawn production without taking interest loans have also profited. Kendrick (1994) also found the opportunities for day labourers to find work has increased significantly for prawn cultivation into *gher* systems. Wage earning opportunities for women have also increased since prawn farming was introduced. However, their trends may be expected to change as the sector evolves, and as the economic forces created by the dramatic changes in local crop value have their effect in the community structures.

The overall hypothesis of the work is therefore that

> **"The introduction of freshwater prawn production into *gher* systems in the southwestern Bangladesh is able to bring about widespread and sustainable social and economic benefits".**

Clearly, there is tremendous interest among the farmers in the southwestern Bangladesh and the expansion of the *gher* system of prawn cultivation over the last several years has been considerable (Chapman, 1997). Evidence has suggested that the positive impact of prawn farming is higher among those farmers who have training, practical experience and technical assistance of prawn farming (Kamp and Brand, 1994). One important factor, resource ownership, however, has received little or no attention in past research dealing with economic benefits in prawn farming. Resource ownership was also considered meaningful in terms of relative power in prawn farming communities

(Chapman, 1997). Based on these and related considerations, the overall hypothesis was subdivided into three inter-related sub-elements, which require to be tested:

1. **That freshwater prawn production is capable of continuing; this would depend on inputs, production systems, markets, and technology development.**

2. **That sufficient economic benefits are retained within the community; this would depend on market chains and on resource ownership.**

3. **That benefits are sufficiently distributed; this would depend on allocation of benefits and relative power relationships within the community.**

The subsequent research plan was structured to allow these hypotheses to be examined. Table 2.1 presents the overall hypothesis, its basic questions and inter-related sub-elements.

Table 2.1 Structure of the research hypothesis.

The overall research hypothesis:

"That the introduction of freshwater prawn production into *gher* systems in the southwestern Bangladesh is able to bring about widespread and sustainable social and economic benefits".

Basic questions for this hypothesis:

i) in what ways various prawn farming related sectors within the community gain from the cultivation of *M. rosenbergii* in *gher* systems?

ii) how the prawn farming is economically beneficial, and if so, whether and how these benefits depend on resource ownership?

iii) are particular sectors within the community being adversely affected by the prawn production, who is reaping the greatest benefits and who the least?

Inter-related sub-elements of this hypothesis:

The overall hypothesis was subdivided into three inter-related sub-elements, which require to be tested:

1) That freshwater prawn production is capable of continuing; this would depend on inputs, production systems, markets, and technology development.	→	2) That sufficient economic benefits are retained within the community; this would depend on market chains and on resource ownership.	→	3) That benefits are sufficiently distributed; this would depend on allocation of benefits and relative power relationships within the community.

2.3 Selection of the study areas

The primary area for the study was Bagerhat district, a coastal area of Bay of Bengal, situated in the southwestern part of Bangladesh (Figure 2.1). Geographically Bagerhat has been identified as the most important area for freshwater prawn (*M. rosenbergii*) culture, because of the availability of wild post-larvae (Haroon, 1990; Haroon *et al.*, 1992). In 1994, a total of 13,277 freshwater prawn farms were operational in Bangladesh; of which 10,442 were located in Bagerhat district (DOF, 1995).

Bagerhat district is divided into 9 *thanas* (sub-districts), namely: 1) Bagerhat Sadar 2) Fakirhat 3) Mollahat 4) Chitalmari 5) Kachua 6) Rampal 7) Morelganj 8) Mongla and 9) Sarankhola. Among the nine *thanas*, only the first five are important for freshwater prawn farming, the rest being important for salt water shrimp (*Penaeus monodon*) farming due to saline water intrusion (Islam, 1998). These five *thanas* were therefore selected for the study. However, on the basis of geographical location, proximity to the main river system, number of *ghers*, number of prawn farmers, and the importance of prawn farming these five *thanas* were grouped into four zones, that is:

1. Bagerhat Sadar
2. Fakirhat-Mollahat
3. Chitalmari and
4. Kachua

These zones were chosen to carry out comparative studies of prawn farming in *gher* systems, economic analysis of *gher* productions and farmer's socio-economic conditions. Here it was expected that differences might be found to experience in *gher* farming, to social, cultural, religious differences and to other geographical factors.

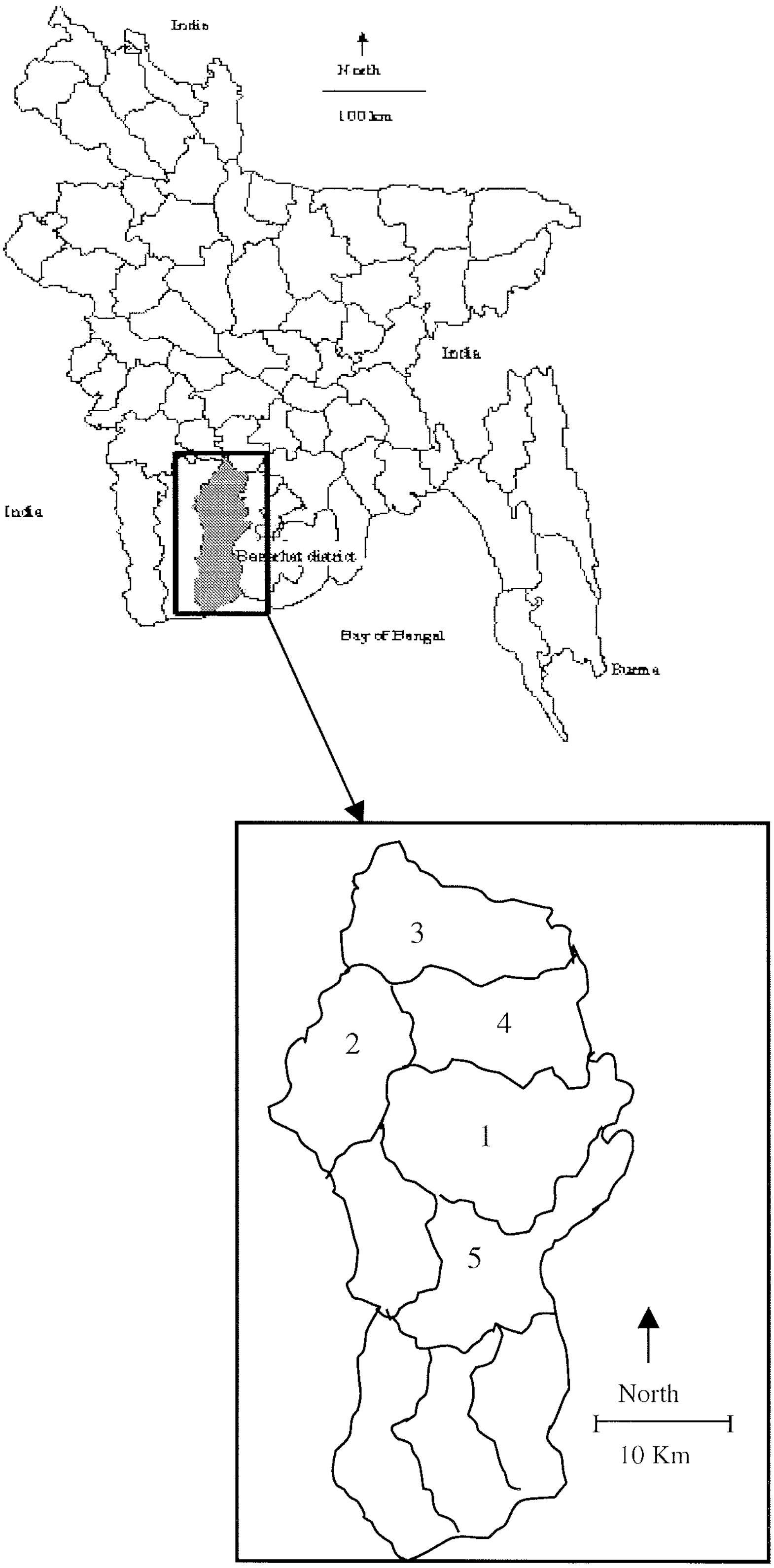

Figure 2.1 **Map of Bangladesh showing the study area Bagerhat district (1. Bagerhat Sadar, 2. Fakirhat, 3. Mollahat, 4. Chitalmari and 5. Kachua).**

In the study area, the Fakirhat-Mollahat zone is the largest, covering 349 km^2, and Kachua is the smallest covering 132 km^2. Bagerhat Sadar and Chitalmari cover 273 and 192 km^2 respectively. The highest number of people (~266,000) also live in the Fakirhat-Mollahat zone and the lowest (~103,000) in the Kachua zone (BBS, 1998; population census in 1991). The population of the Bagerhat Sadar and Chitalmari zone was 262,000 and 142,000 respectively. These and other structural data are presented in Table 2.2.

Table 2.2 Area, population, and number of schools, colleges, markets, banks, rivers and area covering by rivers in the study area.

Name of zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua
Area (km^2)	273	349	192	132
Population (1000)	262	266	142	103
No. of schools	121	169	114	65
No. of colleges	3	3	2	1
No. of markets	25	44	24	21
No. of banks	22	11	4	7
No. of rivers	2	8	2	2
Area covering by rivers (ha)	145	198	2,307	1,088

Source: District Fisheries Office, Bagerhat, 1998 (data presented in 1995).

Bagerhat district is characterised by a series of rivers, canals[1] and small *beels*[2]. Two rivers, the Madhumuti and Kaliganha separate the Bagerhat district from neighbouring districts in the north. Embankments around these rivers restrict the annual flooding of

[1] Rivers are connected with *beels* by canals during the rainy season where canals are the main filling and drainage route.

[2] Open water bodies often containing low-lying agricultural land.

land so that crops can be grown throughout the year. Embankments also prevent flooding of south Bagerhat from the Doudkandi river. Another major river, the Bhairab runs through Fakirhat-Mollahat and Bagerhat Sadar. There is also an extensive network of embankments in Chitalmari. Tables 2.2 and 2.3 provide further details.

Table 2.3 Comparative population and resource indications, by zone.

Name of zones	Bagerhat-Sadar	Fakirhat-Mollahat	Chitalmari	Kachua
Population/ km^2	959.7	762.2	739.6	780.3
No. of schools/ 1000 people	0.46	0.64	0.8	0.63
No. of colleges/ 1000 people	0.011	0.011	0.014	0.009
No. of markets/ 1000 people	0.095	0.16	0.17	0.2
No. of banks/ 1000 people	0.084	0.041	0.028	0.068
Percent of area occupied by rivers	0.53	0.57	12.0	8.25

Source: District Fisheries Office, Bagerhat, 1998 (data presented in 1995).

In the study area, the total number of *ghers* and *gher* farmers[3] were 21,773 and 19,496 respectively in 1997 (Table 2.4). The highest number of *ghers* (and *gher* operators) are located in Fakirhat-Mollahat zone (7,948) and the lowest in Kachua (2,414) due to periodic saline water intrusion through canals and rivers (DFO, 1998). As Table 2.4 shows, the highest number of *ghers* per km^2 are found in Chitalmari (32.75) followed by Fakirhat-Mollahat (22.77), Bagerhat Sadar (18.76) and Kachua (18.29), and the highest

[3] Prawn farmers are commonly known as *gher* farmers in the study area.

number of *ghers* per farmer are also found in Chitalmari (1.2) followed by Fakirhat-Mollahat (1.14), Kachua (1.06) and Bagerhat Sadar (1.03).

Table 2.4 Number of *ghers* and *gher* farmers in the study area.

Name of zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Average
No. of *ghers*	5,123	7,948	6,288	2,414	5,443 (total 21,773)
No. of farmers	4,993	6,957	5,262	2,284	4,874 (total 19,496)
No. of *ghers*/ farmers	1.03	1.14	1.2	1.06	1.1
No. of *ghers*/ km^2	18.76	22.77	32.75	18.29	23.14
No. of *ghers*/ population	0.02	0.03	0.04	0.02	0.03
No. of *ghers*/ market	204.9	108.6	262.0	114.9	172.6
Soil type	Sandy loamy	Sandy loamy and loamy clay	Sandy loamy	Sandy loamy	-----
Water quality	Freshwater	Freshwater	Freshwater	Freshwater, some saline intrusion	-----

Source: District Fisheries Office, Bagerhat, 1998 (data presented in 1997).

In Bagerhat district, the first *gher* farming started in Fakirhat area in 1987 (Kendrick, 1994). In Fakirhat, much of the land converted into *ghers* for raising prawns, falls within a *beel*. Since 1987 the pace of adoption had increased dramatically as more and more farmers watched their neighbors profiting from prawn cultivation and decided to jump on the bandwagon. The news had spread to other *thanas*, and farmers in Chitalmari, Kachua and other part of Bagerhat district were beginning to adopt this new technology as well a wider range of *beel* areas. Though the other areas have developed strongly, the number of *ghers* and *gher* farmers are still the highest in the Fakirhat-Mollahat zone.

The number of *ghers* has expanded rapidly in the study area. In 1994, the total number of *ghers* was 10,442 in all nine *thanas* of the Bagerhat district, of which 10,275 *ghers* (98%) were in the study area (DOF, 1995). Since then, the number of *ghers* has more than doubled by 1997, increasing an average 37% per year, with *gher* farming in the Kachua and Bagerhat Sadar expanding most rapidly (Figure 2.2). In Kachua and Bagerhat Sadar, the annual rate of increase was 756% and 398% respectively, while those in Fakirhat-Mollahat and Chitalmari were 12% and 21% respectively.

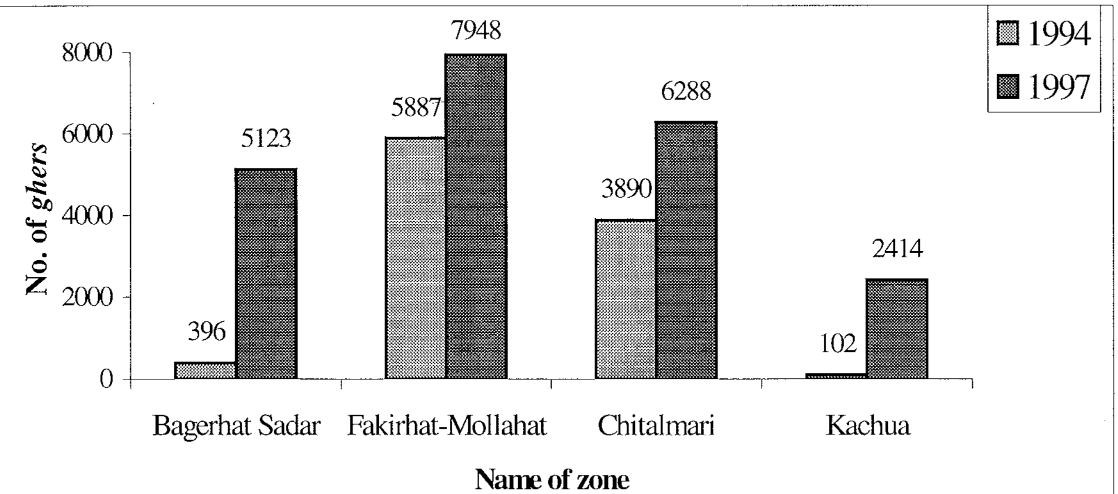

Figure 2.2 Number of *ghers* in the study area

Source: DOF, 1995; District Fisheries Office, Bagerhat, 1998.

2.4 Target groups associated with the prawn farming sector

A large number of people's livelihoods are associated with prawn farming, including prawn farmers, fry catchers, fry traders, snail collectors, snail traders, prawn traders and others (Kendrick, 1994; Rutherford, 1994). Individuals and families are involved, and the role of women is also significant. Figure 2.3 shows the diagram of the prawn production process, where different groups of people are involved in different activities.

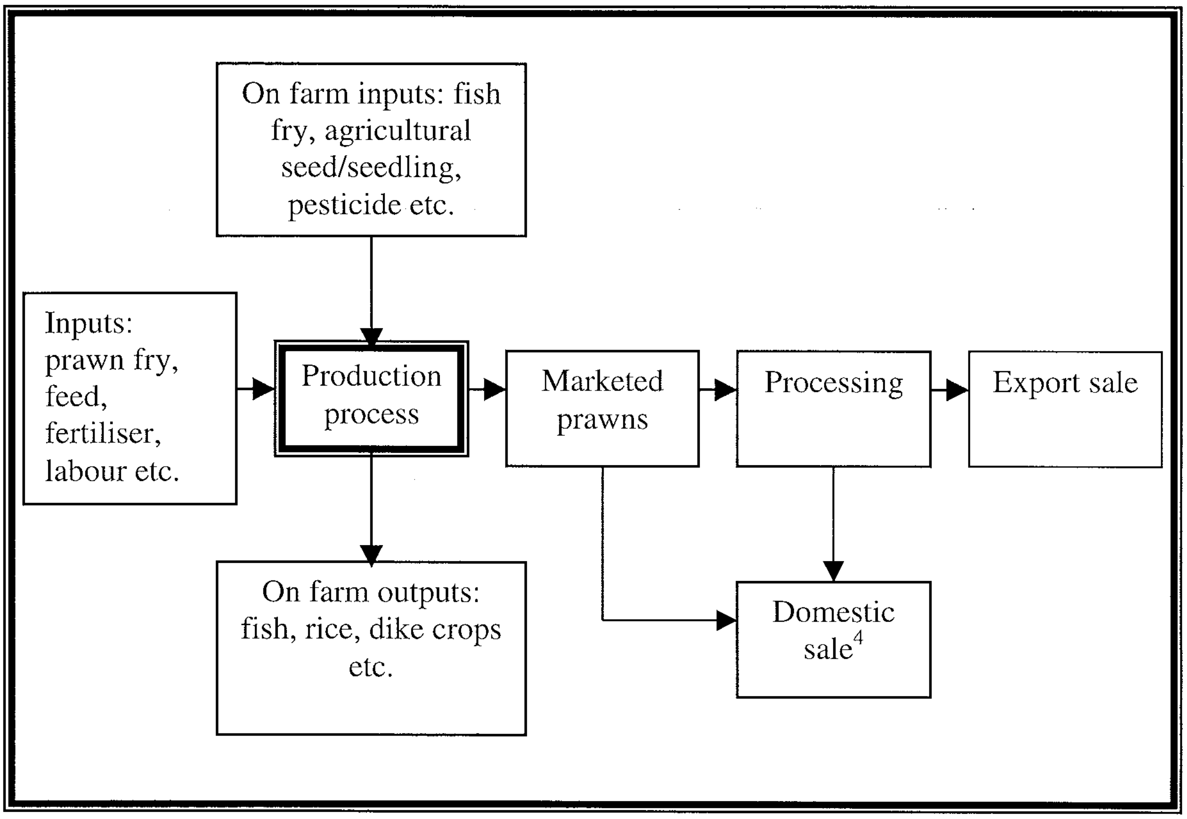

Figure 2.3 Diagram of freshwater prawn production process (source: DIFTA, 1993).

[4] According to DIFTA (1993), less than 1% of the total production had been for the domestic market. The export value of prawn is so high, that the domestic market is restricted, with the limited exception of markets in Dhaka and Chittagong.

To examine the hypothesis of the study, the following groups of people were identified:

1. Prawn farmers

In the study area, a large number of people earn their livelihood in prawn farming and its associated activities. Farmers culture prawns in their rice fields, which are modified to make the typical *gher* systems. It is reported that a few farmers are from solvent families who own land and the *gher*, but other have very little cash, and almost all 'small and marginal'[5] prawn farmers are poor. According to Sinha and Sampath (1994) small-scale prawn farmers were generally the poorest and the most disadvantaged sector of the society. Most of these farmers live in the rural areas and also work as seasonal labourers or as part-time farmers or occasional wage earners in order to supplement their family income.

According to Chandrasekera (1994), prawn farmers have traditionally been a socially neglected class in both Muslim and Hindu society. Rahman (1994b) noted that fishing was considered as a low-class profession. The standard of living of these farmers is commonly very low and they are considered to lack basic needs such as sanitary facilities, housing, electricity, drinking water supply, education, health and medical facilities (DFID, 1997; DFO, 1998).

According to Hannan (1994), many prawn farmers are highly dependent on middlemen

[5] According to Kendrick (1994) small and marginal farmers are those who have less than 1 ha land including *gher*, while Rutherford (1994) noted that small farmers are those who have less than 0.81 ha (two acres) land.

or moneylenders who provide money and take the lion's share of total earnings. They are in a chain of indebtedness to those moneylenders, because the farmers are reluctant to approach commercial banks for credit, as the procedures involved are too complex and cumbersome (Chandrasekera, 1994). Moneylenders have therefore developed strong bonds with the prawn farmers and are reported to have a strong hold on them.

2. Women

The role of women in the prawn related activities is potentially very important, and as gender issues are commonly a key area of understanding in terms of social impact and the potential for changing livelihoods, it is important to consider the role of women in the areas. According to Kendrick (1994), women are involved in a great variety of agricultural activities in Bagerhat district, and some are directly involved in *gher* activities. It is common throughout rural Bangladesh that women are anyway involved in productive activities such as homestead gardening, poultry rearing etc. and it may be that in the study area, their work load has increased as a result of prawn farming.

3. Prawn fry catchers[6]

In Bangladesh, the freshwater prawn culture industry depends almost entirely on catches of wild fry[7], because hatchery production of post-larvae (PL) is limited (Angell, 1994a; Islam and Chowdhury, 1999). A large number of fishermen is known to be engaged in wild fry catching in the coastal area. This is a seasonal activity (April to June), and

[6] According to DIFTA (1993) there is no differentiation between fry catchers and fishermen. Both describing individuals who target for valuable aquatic products in coastal and estuarine areas.
[7] The term fry and post-larvae are used interchangeably for the progeny of the prawn.

appears to be particularly associated with poor, often landless groups (Chapman, 1997; Islam and Chowdhury, 1999).

4. Prawn fry traders

In Bagerhat district, a number of individuals are engaged in fry trading during the catching and stocking season. According to DFID (1997), fry traders are mostly from the lower middle class and the rural poor, for whom fry trading is a substantial part of income, other earnings derived from *gher* farming, agriculture and small business.

5. Snail collectors

In Bagerhat district, a variety of feeds are used for prawn culture, but the preferred feed is the freshwater snail *Pila globosa* (Swainson) (Kendrick, 1994). These snails are now harvested from *beel* and river areas from neighbouring districts as it has become extinct in most parts of Bagerhat district, due to excessive harvesting (Rutherford, 1994). A wide variety of rural poor are reported to involved in snail collection during the rainy season (Jahangir, 1998).

6. Snail traders

Snail trading has become a popular business in the study area due to the extensive use of snail meat as prawn feed (Rutherford, 1994). A large number of rural poor are involved in snail trading during the season from July to October. Their job is to collect snails from the neighbouring districts and sell them to the prawn farmers (Jahangir, 1998).

7. Prawn traders

Prawn traders are locally known as '*Depot maliks*' (owners) who are small prawn businessmen. According to Rutherford (1994), their premises are modest - they might have a small rented tin-shed warehouse-cum-office equipped with a portable ice chest in a market, and few handle large amounts of capital. Many traders are engaged in prawn trading during the season (November to January). Their role is to collect prawns from farmers and supply them to larger processing and export companies[8] within 1 to 2 day's of harvest. Their role as suppliers of income, and often credit, to small farmers, may be crucial in the overall social and economic network.

It was the aim of the study to understand more clearly how these groups are identified, how they interact, and what implications this has for the hypothesis stated earlier. The broad approach has been to develop estimates of the numbers of each category (cross-checking with each group), and to structure data collection to ensure that representative responses are obtained.

2.5 Field visits

During the study period two periods of field assessment were carried out:

First phase field visit: scoping, study definition and initial assessments

The first phase field visit lasted 5 months between February 1998 and June 1998 (see

[8] Prawn processing and export companies are locally known as 'company' by the traders, prawn farmers and other associated people.

Appendix 2). During this visit, the study area and its zone were defined, after discussion with prawn farmers, local people, *Thana* Fisheries Officers and as a result of physical observation. Data was also collected to provide an overview of the prawn production systems, its human agents, its scale and its key relationships through primary interviews, secondary[9] data and Participatory Rapid Appraisal (PRA), which helped in planning the second phase field visit. Questionnaires were also tested during the first phase field visit, as per the recommendations of Casley and Lury (1981).

Second phase field visit: main assessment activities

The second phase field visit was carried out from November 1998 to December 1999 (See Appendix 2, Table 2.1). A more focused comparative examination of four different production zones was performed, covering the distribution and operation of *ghers*, the operation of the market structure, and the role of people associated with prawn farming in each zone. Almost all data were collected during the peak season of prawn production.

2.6 Data collection process

Data can be collected mainly by observation, documentary-historical methods, and survey methods. Surveys may be of different types, such as personal interviews, telephone interviews, mail survey, and panel or group surveys (Lin, 1976). The importance of interviewing as a research technique has come about as a result of the

[9] According to Casley and Lury (1981), "an individual research worker may be limited to the intensive study of the secondary sources available to him in local libraries, supplemented by personal observation". Secondary data may be used in as independent additional information, check on possible survey biases, and improving the survey estimates.

need by researchers to come into contact with respondents, to obtain access to the facts and opinion and to receive them directly. This technique of data collection is particularly useful in gathering data on issues such as past experience and motives, which is not possible using contemporary observation (Snow and Thomas, 1994).

2.6.1 Questionnaire interviews

According to Theis and Grady (1991) "questionnaire survey research is the most popular social research method, and is commonly used by universities and research institutions, as well as government and non-governmental organisations". It derives much of its popularity from its formal and standardised research techniques, which produce quantifiable, representative, verifiable, and comparable data, which can be statistically analysed. Questionnaire surveys are still the most common method used for "central uppers" to learn about the lives and conditions of "peripheral lowers" (Chambers, 1997). Casley and Lury (1981) defined "questionnaires" as a group or source of questions designed to elicit information upon a subject, or sequence of subjects, from an informant". Unless very carefully designed and conducted, questionnaire surveys used to gain insights, especially for project formulation, may select and simplify reality, often mislead, and can simply reconfirm the realities of uppers, missing local complexity and diversity (Guijit and Pretty, 1992). Mukherjee (1995) noted that one consequence of the evolution of participatory methods has been the discovery of alternatives to many of the normal applications of questionnaire surveys.

Questionnaire interviews may either be structured or unstructured depending on the degree of standardisation imposed on the interview schedule[10]. Hence, a highly structured interview is one where the questions asked and the responses permitted are completely pre-determined i.e. 'closed', while in a highly unstructured interview, the questions to be asked are only loosely pre-determined, and respondents are free to respond in their own words. In practice, the choice is not between these two extremes, but between many degrees of formality. Some researches have advocated the semi-structured or focus interview, where questions are mainly open-ended, but in which closed questions can also be included (Maccoby and Maccoby, 1976).

For this study the personal interview using semi-structured interview schedules were employed as the primary method of collecting data from different groups. This technique was preferred to others for the following reasons:

1) More detailed qualitative information was required, that could not have been achieved through structured interviews. Due to practical and cultural constraints, it was also inappropriate to use mail or telephone surveys. Personal interviews also offer the most potential for the use of open-ended questions and questions requiring visual aids, whilst in telephone interviews, for example, open-ended questions are difficult to use and questions requiring visual aids are impossible to use (Neuman, 1994).

2) Personal interviews have the highest response rates and permit the use of long questionnaires. They also enable researchers to use extensive probes (Neuman, 1994).

[10] Usually, a questionnaire, sometimes called on interview schedule, is used in the interview and contains the questions the interviewer puts to the respondent (Ackroyd and Hughes, 1981).

3) The personal face-to-face interview technique was deemed appropriate for studying in developing countries, where the level of education attained by most of the population is basic (Kholo, 1991), and clarifications of questions are necessary to obtain a complete response. Kelmer and Noy (1990) noted that the personal interview allows the interviewer an opportunity to clarify the interpretation of the terms being used. Structured and closed questionnaires could be utilised relatively successfully in more educated communities where the respondents themselves were capable enough of understanding questions and when they realise the responsibility to respond truly and fully. These conditions are unlikely to prevail in many developing countries (Kholo, 1991).

4) Face-to-face interviews with mostly open-ended questions, are also effective in developing and exploring issues which might not have been apparent in initial stages. Suggestions for using more uncontrolled techniques for data gathering are available in the literature on collection strategy (Mintzberg, 1994; Snow and Thomas, 1994).

Personal interviewing, however, has some limitations, of which researcher and interviewee bias are considered to be the most serious (Duhaime and Grant, 1994). The technique of standardising interviews across sample groups, as suggested by these authors, was used to minimise the researcher bias in the study. The interviewee bias was at least partially controlled by questions posed as probes during the interview. Cross check questions were also incorporated in the interview schedule. In many instances, it was necessary to take supplementary notes for responses, to gain a better qualitative understanding of the main issues of the research.

2.6.2 Participatory Rapid Appraisal (PRA)

Participatory Rapid Appraisal (PRA) is a specific form of Rapid Rural Appraisal (RRA), a research technique developed in the late 1970s and early 1980s by researchers in the international development as an alternative and complement to conventional sample surveys (Theis and Grady, 1991). PRA is a reversal of conventional, researcher-driven process of enquiring to aiming learn from rural people, directly, on the site, and face-to-face, gaining from local physical, technical and social knowledge (Chambers, 1992). PRA is an intensive, systematic but semi-structured learning experience carried out in a community, and has a range of potential applications in aquaculture (Muir *et al.*, 1999). Chambers (1997) stated that PRA is a group of methods to collect information from rural communities in a participatory fashion. The advantage of PRA over other methods is that through wider participation of the community, the information collected is likely to be more accurate.

PRA methods usually engage the commitment and analysis of local people, enable the expression and sharing of their diverse and complex realities, give insights into their values, needs and priorities, and can also lead on into participatory action (Guijit and Pretty, 1992). Townsley (1996) noted that PRA allows local people to present their own priorities for development and get them incorporated into development plans. Where aquaculture is identified as a priority during the course of a PRA, planners can be more certain that this responds to a real need among local people, whether that is for increased income, better fish supply or more intensive water use and management.

For this study, PRA tools such as Focus Group Discussion (FGD) were used to get an overview of particular issues from all target groups. In this method, small groups of people who are knowledgeable or who are interested in the topics are invited to participate. According to Theis and Grady (1991), FGD is a group meeting where people from the target communities discuss selected topics. The participation of a range of people from the community provides an opportunity for cross checking individual opinions as well as allowing the community to discuss the issues that they feel are important, rather than responding to a questionnaire.

2.7 Questionnaire design and development

2.7.1 Survey design

The interview schedule for prawn farmers was divided into 3 sections, which mainly addressed the issues of personal and family details, socio-economic status and prawn farming information (Appendix 2). The first section of the interview schedule was for personal information of the respondents and their families. The second section explored detailed information about farmer's conditions, including income, expenditure, housing condition, drinking water, health and other facilities. The third section related to prawn farming, culture systems, production technology, production, finance of prawn farming, credit, production costs, return, profit etc.

The other five sets of questionnaires for women, fishermen, fry traders, snail traders and prawn traders were more simple (see Appendix 2), focusing in only one section about the respondent's social and economic conditions. All the questionnaires were constructed in English and then translated to Bengali during face-to-face interview. As suggested by Easterby-Smith *et al.*, (1991) a translated copy of the interview schedules was carried during the interview mainly to present to the interviewees in case they might ask for it.

Although the questions in all six sets of the interview schedules were open-ended, there were some closed questions as well, with a number of alternative replies. Closed questions were divided into questions of fact and questions of perception, and were designed to obtain responses easily and quickly. Some questions were also designed as cross-references. A study of methods used in previous research studies on prawn as well as fish farming (Nuruzzaman, 1989; Hannan, 1994; Nuruzzaman, 1994; Rahman, 1994a) was conducted before setting the questions on the interview schedule. However, some modifications of questions and phrases were done after first phase field visit and pre-testing of the interview schedule; this was normally done in the course of a pilot survey.

2.7.2 Pre-testing of interview schedules

Pilot testing of the interview schedules was carried out with 40 prawn farmers, 20 women, 5 post-larvae catchers, 5 fry traders, 5 snail traders, and 5 prawn traders. The aim of the pilot test was to ensure that the questions and issues regarding the subject of the study were included in the schedules and cleared from any ambiguities and that the respondents could answer questions without significant constraint. The sophistication of the respondents, the level of enumerator, and the wording of the questions were matched (Casley and Lury, 1981).

Some of the respondents, in the first instance, did not show any interest in taking part in the interview. They suspected me to have been an employee or agent of the tax office, police department or other government agency, even though they had been presented with a letter from my institute before the interview. Reactions of respondents to some of the questions suggested that they would not talk freely unless they completely trusted the interviewer. Attention was therefore paid to communicating well with potential respondents to guarantee as many positive interviews as possible.

However, some respondents were still suspicious about the identity of the researcher and were reluctant to talk unless the association of farmers and traders gave the respondents a 'green light'. This happened mainly with those who had no formal education. Co-operation from the association was therefore sought, whenever possible, for interviewing these respondents. Although the reactions and responses of the farmers and traders were generally positive, this was not always so when they were asked questions on costs, returns or incomes, with data supplied based mainly on 'guess-work'. Most farmers and other related people in prawn farming did not have any proper notebooks of account, and therefore, great care had to be taken in compiling financial information.

It was also observed during the pre-testing that a few questions were not clearly understood by the respondents. Hence, some questions were dropped, and a number of additional questions added. The sequence, phrasing and language of some questions were also changed.

2.8 Sample size

According to McMillan and Schumacher (1989), the determination of sample size should take into consideration several factors; such as - the type of research, research hypothesis, financial constraints, the importance of the results, the number of variable studies, the method of data collection, and the degree of accuracy needed. For this study, the sample size for different groups were selected in following ways:

Prawn farmers

Prawn farming being a recent evolution in the study area, where technical support services are almost absent at the farmer's level, there is no monitoring information relating to *gher*. Due to this constraint, it is very difficult to realise what could be variations of different estimates. The safest way is to apply proportional estimate, which minimises the expected variances and therefore indicates a sample size that is sure to be large enough. The assumed proportion used for determining sample size is 0.5 and the expected precision level of 5%. The formula for determination sample size is given below:

$n = Z^2 P Q / d^2$ (Hays and Winkler, 1990; Owen and Jones, 1990)

Where, Z = Standard normal distribution value for alpha = 5%, (Z is given in the probabilities table of the standard normal distribution, 1.96)

P = Probability of prevalence of that particular variables = 0.5 (safe option)

Q = 0.5 (we know P + Q = 1; So Q = 1 – P = 1 – 0.5 = 0.5),

d = Degree of accuracy = 5% = 0.05

Therefore, $n = (1.96^2 \times 0.5 \times 0.5) / 0.05^2 = 384.16$

From the above calculation, prawn farmers sample size was determined at 400 where the samples for each zone distributed as equal number (100). Arens and Loebbecke (1981) also noted that if the total population is 20,000, the recommended sample size is 392.

Women

There was no data for the participation of women in prawn farming. However, Bagerhat District Fisheries Officer (A. Sheikh, pers. comm.) suggested that around 10,000 women were involved in prawn farming, around half the number of prawn farmers. Therefore the sample size for women was selected at 200, where the samples for each zone distributed as equal number (50) (Table 2.5).

Others

For other associated groups, considerable number of samples were selected after discussion with Bagerhat District and *Thana* Fisheries Officers, CARE GOLDA Project[11] staff and NGO workers where sample numbers were more than 10% and some cases up to 40% of the total population (Table 2.5).

[11] CARE GOLDA Project – a DFID-funded project, has been working with small-scale prawn farmers in Bagerhat, Khulna, Jessore and Gopalgonj districts since 1997. The Greater Options for Local Development through Aquaculture (GOLDA) is implemented by the Agriculture and Natural Resources (ANR) sector of CARE-Bangladesh.

Table 2.5 Data collection methods and sample size for target groups.

Target groups	Zone / area	Sample size	Data collection methods
Prawn farmers	Bagerhat Sadar (zone 1)	100	a) Transect walk b) Questionnaire interviews c) PRA tools such as FGD d) Cross check interviews with key informants
	Fakirhat-Mollahat (zone 2)	100	
	Chitalmari (zone 3)	100	
	Kachua (zone 4)	100 Total 400	
Women	Bagerhat Sadar (zone 1)	50	a) Questionnaire interviews b) PRA tools such as FGD c) Cross check interviews with key informants
	Fakirhat-Mollahat (zone 2)	50	
	Chitalmari (zone 3)	50	
	Kachua (zone 4)	50 Total 200	
Post-larvae catchers	Pasur river at Mongla of Bagerhat district	Total 60	a) Questionnaire interviews b) PRA tools such as FGD
Fry traders	Baroipara market (zone 1)	10	a) Questionnaire interviews b) Cross check interviews with key informants
	Faltita market (zone 2)	10	
	Babugonj market (zone 3)	10	
	Sinebord market (zone 4)	10 Total 40	
Snail collectors	Chanda *beel*, Gopalgonj district	Total 75	a) PRA tools such as FGD
Snail traders	Haderhat market (zone 1)	10	a) Questionnaire interviews b) Cross check interviews with key informants
	Faltita market (zone 2)	10	
	Matibanga market (zone 3)	10	
	Kasherhat market (zone 4)	10 Total 40	
Prawn traders	Baroipara market (zone 1)	10	a) Questionnaire interviews b) Cross check interviews with key informants
	Faltita market (zone 2)	10	
	Chitalmari market (zone 3)	10	
	Sinebord market (zone 4)	10 Total 40	
Company Managers	Khulna	5	a) Interviews with a list of questions (not questionnaire)
Day labourers	All study area (zone 1, 2, 3 and 4)	25	a) Interviews with a list of questions.
Moneylenders	All study area (zone 1, 2, 3 and 4)	5	a) Interviews with a list of questions.
Brokers	Mongla, Bagerhat district	10	a) Interviews with a list of questions.

Sample numbers are indicated only for questionnaire interviews (except snail collectors).

2.9 Survey operations

2.9.1 Data collection methods

1) Prawn farmers

Prawn farmer data were collected by using transect walk, questionnaire interviews, PRA and cross check interviews with key informants (Figure 2.4).

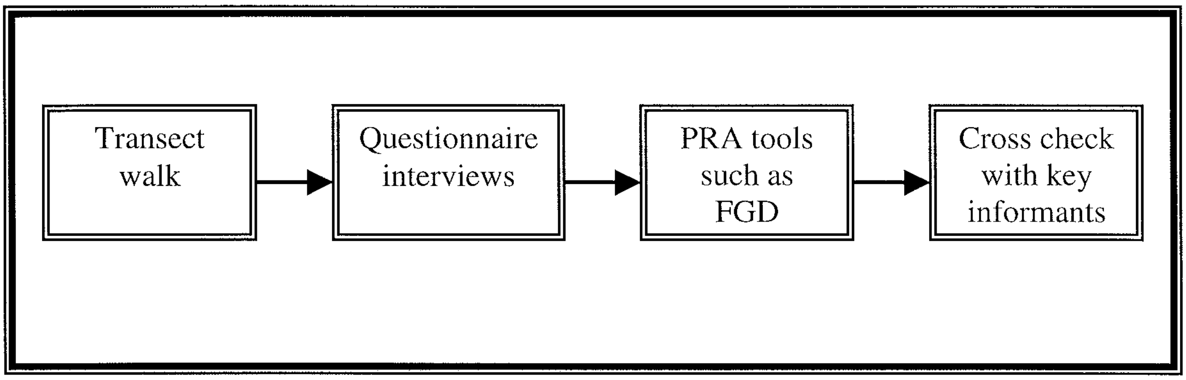

Figure 2.4 Steps of data collection methods from prawn farmers.

First stage: transect walk

Transect walk is a data collection method to know about a village by walking through the village as far as practicable in a straight transect line, allowing investigators talking with villagers and through observation (Chambers, 1997). As it was difficult to know the complete study area by walking, due to the large distances involved, a motorbike and a guide were used to cross a zone by cross section along the possible roads. The motorbike was stopped about half kilometre from prawn farming areas to allow walking into the area, and discussion with farmers as well other community people. During discussions, a list of questions were asked to the people. At every stopping place, around 15 to 20 people, including prawn farmers were spontaneously presented, where at least 30 minutes was spent for discussion. Approximately 50 discussions were conducted in this step for each zone with one week required for a zone, and a month for the four zones. This method was used to get a quick picture of the prawn farming areas and their farming systems. This step was also useful for building up rapport with prawn farmers, to assist in the next stage's data collection.

Second stage: questionnaire interviews

For questionnaire interviews, two sampling methods were followed for 400 farmers: stratified[12] and systematic[13] random sampling. Prawn farmers[14] were classified into four groups on the basis of *gher* size. As each of the groups has unique characteristics, the group is considered as stratum of the population. In order to identify such characteristics on an area-wise basis, stratified sampling was used. Using a data base of prawn farmers including *gher* size were collected from Bagerhat District Fisheries Office, CARE GOLDA Project, and NGOs[15], the sampling procedure was as follows:

[12] A stratified sample is one obtained by separating the population elements into non-overlapping groups, called strata, and then selecting a sample from each stratum (Scheaffer *et al.*, 1990). Arens and Loebbecke (1981) noted that stratification is used for most common reason is that reduces the sample size needed to achieve a desired level of precision and reliability.

[13] Systematic random sampling involves the selection of sampling units at intervals beginning with a randomly selected unit (Arkin, 1982). In the most commonly used method this is a fixed interval. The sampling intervals are obtained by dividing the population size by the sample size.

[14] Selected as a head of household.

[15] Bangladesh Rural Advancement Committee (BRAC), Association for Social Advancement (ASA), *Gono Sahajya Sangstha* (GSS), *Sawnirvar* Bangladesh, Heed Bangladesh, PRISM Bangladesh, Prodipon, World Vision etc. NGO are working in the study area.

i) Prawn farmers in each zone were classified into four groups on the basis of *gher* size: less than 0.21 ha (less than 51 decimal[16]), 0.21 to 0.4 ha (51 to 100 decimal), 0.41 to 0.61 ha (101 to 150 decimal), and more than 0.61 ha (more than 150 decimal). Prawn farmers of each group were viewed as the population of each stratum.

ii) The sample size was identified for each stratum: 179 for less than 0.21 ha, 136 for 0.21 to 0.4 ha, 49 for 0.41 to 0.61 ha, and 36 for more than 0.61 ha category (see Appendix 2, Table 2.2).

iii) Finally, samples were selected from each stratum of each zone following systematic random sampling technique.

Farmers were interviewed at their houses and/or farm sites. In a given day approximately 8 to 10 interviews were conducted, where each interview required about an hour. Therefore two weeks needed to fill up 100 questionnaires in each zone, a total of two months for four zones.

Third stage: PRA

PRA tools such as focus group discussion (FGD) was used to get an overview of particular issues such as social and economic conditions, social impact, constraints of prawn farming etc. FGD sessions were held on front of village shops, under the big

[16] Unit of land, 247 decimals equivalent to 1 ha.

trees, farmer's houses and school premises wherever there were spontaneous gatherings and where participants can sit, feel comfortable and are easily observed. A total of 25 FGD sessions were conducted in each zone, where each group size of FGD was 6 to 12 members and duration was approximately an hour[17]. Theis and Grady (1991) noted that small groups of people (6 to 12) are most suitable for focus group discussions.

Fourth stage: cross check interviews with key informants

Cross check interviews were conducted with key informants such as school teachers, local leaders, *Thana* Fisheries Officers, CARE GOLDA Project staff and NGO workers, where information was contradictory or requested further assessment. The interviews of respondents were conducted in their offices and/or houses. The time required for this stage was two weeks for the four zones.

According to Theis and Grady (1991), a key informant is anyone who has special knowledge on a particular topic. Key informants are expected to be able to answer questions in a relatively important way about the knowledge and behavior of others, and especially about the operations of the broader systems. Valuable key informants are outsiders who live in the community or people from neighboring communities, including people who have married into the community. Though preferred groups with specific status (e.g. school teachers) may be particularly useful care has to be taken to ensure that their own bias may not influence descriptions.

[17] During pilot survey, it was observed that people did not wish to take part for more than an hour.

2) Women

Data were collected by using questionnaire interviews, PRA and cross check interviews with key informants. For questionnaire interviews, women were selected through simple random[18] sampling. Women were interviewed at their houses. Approximately 10 interviews were conducted in a day, where each interview required 45 minutes to an hour. One week was required for questionnaire survey in a zone, total four weeks for four zones.

For PRA, 10 FGDs were conducted in each zone, held in women's houses and school premises. Each group size of FGD was 6 to 9 members and the duration was approximately an hour. Cross check interviews were conducted with key informants such as school teachers, local leaders, *Thana* Fisheries Officers, CARE GOLDA Project staff and NGO workers. For PRA and cross check interviews, time required one week in a zone, total four weeks for four zones.

3) Prawn fry catchers

For fry catchers, the site was selected on the Pasur river at Mongla in Bagerhat district, where fishermen are engaged in fry catching during April to June. Data were collected by using questionnaire interviews and PRA. Sixty fishermen were selected for questionnaire interviews through simple random sampling. A boat was hired for data

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[18] A sample is drawn from a population in such a way that every possible sample has an equal chance of being selected (Scheaffer *et al.*, 1990). Schofield (1993) noted that simple random sampling is the fundamental method of probability where 'simple' does not mean that it is easier to carry out than other methods, but that steps are taken to ensure that nothing influences selection each time a choice is made, other than chance.

collection and observation of post-larvae catching. Fishermen were interviewed on the river and/or river bank. Time required for an interview was about 30 minutes. For PRA, 10 FGDs were conducted with fishermen in their village where each group size was 6 to 9 members and duration was approximately an hour. Four weeks was required for all data collection including observations of fry marketing at coastal market.

4) Fry traders

One important fry market was selected for each zone (Table 2.5). There are 6 fry markets in the study area (Islam, 1998); among them 4 important markets were selected after discussion with prawn farmers, local leaders and *Thana* Fisheries Officers, based on market history, number of fry traders and duration of trading season. For questionnaire survey 10 fry traders were selected in each market through simple random sampling, and interviews were conducted at the market centre in their shop. Time required for an interview was about an hour. Data was collected during June 1999, the peak season for fry marketing. After data collection cross check interviews were conducted with key informants.

5) Snail collectors

For snail collectors, a site was selected in the Chanda *beel* of Gopalgonj district north of Bagerhat district, because snails have been over harvested in Bagerhat district and are effectively unavailable. PRA tools such as FGD were conducted with snail collectors for data collection, though no questionnaire was used due to time constraints and the greater distance (50 km) from the study area. A boat was hired for conducting FGDs and for observing snail harvesting. Ten FGDs were conducted covering 75 snail collectors where each group size was 6 to 9 members and duration was approximately an hour. Data was collected during July 1999, the peak season of snail harvesting in the *beel* areas.

6) Snail traders

One important snail market was selected for each zone (Table 2.5). There are 9 snail markets in the study area (Islam, 1998), out of which 4 important markets were selected after discussion with prawn farmers, local leaders and *Thana* Fisheries Officers, based on market history, number of snail traders and duration of trading season. About 15 to 20 snail traders were engaged in each market; among them 10 traders were randomly selected for questionnaire interviews. Interviews were conducted at the market centre in their shop. The time required for an interview was about 30 minutes. Data was collected during August 1999, the peak season of snail trading. After data collection, cross check interviews were conducted with key informants.

7) Prawn traders

Using a similar procedure to that described for snail traders, one important prawn market was selected for each zone (Table 2.5), out of a total 7 prawn markets in the study area (Islam, 1998). As with snail traders, discussions were held with prawn farmers, local leaders and *Thana* Fisheries Officers to select markets, based on market history, number of prawn traders and duration of trading season. For questionnaire interviews 10 prawn traders were selected in each market through simple random sampling, interviewed at the market centre in their trading premises. The time required for an interview was about an hour.

8) Others

Simplified approaches were used for data gathering from other groups associated with the prawn sector. Interviews were conducted with 5 managers of processing companies. There are total 44 companies (Khalek, 1999), all are located in Khulna, 30 km west from Bagerhat. A list of questions (not questionnaire) was used for interviews, covering prawn processing, market, price, export etc. Interviews were conducted at a time convenient to the managers. After interviews, prawn processing was observed and a visit was made to Mongla port, where prawns were loaded to ships for exporting to the international market. All of the interviews with prawn traders and company managers were conducted in the peak season (November – December).

Interviews of day labourers, brokers and moneylenders were conducted by using a list of questions (not questionnaire). Sample numbers were 25, 10 and 5 respectively (Table 2.5), selected through simple random sampling. Brokers were interviewed at the market centre and day labourers were interviewed in their working place. Moneylenders were interviewed at home and/or market place. Time required for interviewing a day labourer or broker was about half an hour. However, moneylenders were somewhat reluctant to talk and only allowed a few minutes.

2.9.2 Problems encountered

Several problems and difficulties can be noted:

1) Poorer road facilities: village roads are unfinished, making transportation difficult and time consuming, especially during the monsoon, and walking long distances caused unnecessary delays. This problem was partially overcome by using boats.

2) Partly stemming from the above, it was not always easy to locate sample prawn farmers. The database of farmers contains many errors as to the names and address. Coupled with road access problems, this caused the researcher additional loss of time. The assistance of local NGO workers was useful in correcting database.

3) As mentioned in pre-testing the questionnaire, it was very difficult to obtain reliable financial data. This was also found in previous research. For example, Unni (1981) wrote

" Though confidentiality of responses was assured, the pre-testing of the questionnaire revealed an unwillingness of small businessmen to specify their profit and sales over the last few years."

Harriss (1981) quoted the following from studies of Indian traders which reflected similar problems: *"they lie when it came to statements about wealth, business, capital, turnover and so forth which they never correctly told to anyone*" (Fox, 1969). Even if some farmers provided financial data, this was based on their 'guess-work' which might not be accurate. Extra attention was therefore paid and great care had to be taken in compiling financial information during using different data collection methods.

4) External communications difficult due to lack of telephone, e-mail and fax facilities in the study area, requiring travel to Dhaka for communications, etc.

2.10 Data processing and analysis

Data from various sources were coded and entered into a computer for analysis. Some of data were collected in local units such as *bigha*[19], *maund*[20] due to familiarity for respondents. These were converted into international units before transfer. Data were processed using Microsoft Excel and SPSS[21]. Preliminary data sheets were compared with the original coding sheets to ensure the accuracy of the data entered. At each stage of the survey, data were checked up, editing, coding and transferred into computer at the field level.

The nature of the data collected was both quantitative and qualitative. In analysing these data, however, one unresolved issue was the question of when parametric, non-parametric, or both tests should be done.

[19] A unit of land equivalent to 0.21 ha.
[20] A unit of weight measure equivalent to approximately 37.4 kg.
[21] Statistical Package for Social Science (SPSS) – a package programme for data analysis.

Parametric tests are based on the assumption that we know certain characteristics of the population from which the sample is drawn, while non-parametric or distribution-free tests do not depend on assumptions about distribution of specific characteristics in the population. Some authors have argued that it is only appropriate to use parametric tests when data fulfil three conditions, that: 1) the level or scale of measurement is of equal interval or ratio scaling, i.e., more than ordinal; 2) the distribution of the population is normal; and 3) variances of both variables are equal or homogenous (Bryman and Cramer, 1994).

Wimmer and Dominick (1987) noted that although non-parametric tests are appropriate for normal or ordinal data and parametric tests are appropriate for interval and ratio data, many researchers (Roscoe, 1975; Gay, 1976) no longer considered the two categories to be distinctly different and proposed that both methods could be used successfully with any type of data.

The present study deals with two group of dependent and independent variables. Therefore correlation tests were conducted between variables and comparison was made between the 'r' values. Other statistical tools such as chi-square test, histogram, descriptive statistics, tables, graphs etc. were used.

2.11 Structure of the results

Results are set out in the following three chapters, based on the three sub-elements of the overall hypothesis, as outlined:

Chapter 3: Description of prawn farming systems

Sub-hypothesis: "freshwater prawn production is capable of continuing; this would depend on inputs, production systems, markets, and technology development". This chapter describes key relationship between prawn production and its inputs, technology, markets etc. According to Jolly and Clonts (1993), production may be defined as the process of combining resources and forces in the creation of some valuable good or services, and the purpose of production is to satisfy human wants and needs. Prawn production is primarily biological, technological, economical and environmental concerns (Bjorndal, 1990; New, 1995). A typical prawn production system has subsystem of procurement, transformation and delivery (Hulse *et al.*, 1981). The procurement subsystem includes the factor markets for stocking materials (seed or fry) and other inputs, such as land, labour, feed, fertiliser, and managerial expertise (Smith, 1981). All of these factors are important and described for prawn production in this chapter.

Chapter 4: Economic analysis

Sub-hypothesis: "the sufficient economic benefits from prawn farming are retained within the community depends on market chain and on resource ownership". This chapter provides an economic analysis of prawn production, based on resource and markets. The primary motivation of a prawn farm may be profit making (Lee, 1981; Chen, 1994), and also domestic consumption, export, employment opportunities, income distribution, or a combination of these (Singh and Vijiarungam, 1992; Shang, 1990; Lee, 1994). Prawn production in *gher* systems, like many economic decisions, involves benefits and costs that are expected to occur during the operation. Sebastian *et al.*, (1992) noted that the economic viability of prawn culture has never been in doubt, where there is a high market demand.

Chapter 5: Social analysis

Sub-hypothesis: "that benefits are sufficiently distributed; this would depend on allocation of benefits and relative power relationships within the community". This chapter describes social and economic benefits of farmers and associated groups on prawn farming. Socio-economic aspects of prawn farming play an important role in maintaining the productivity of the sector. However, for sustainable aquaculture, socio-economic factors must be identified (Lee, 1994), and there are several specific areas of socio-economic research needed (Pomeroy and Bimbao, 1992).

CHAPTER 3

CURRENT PRACTICE IN FRESHWATER PRAWN FARMING IN BANGLADESH

3.1 Introduction

Freshwater prawn cultivation practice has developed as an indigenous technology, with no planning and little support or assistance from any outside sources, including the government (Jahangir, 1998). The Department of Fisheries (DOF) and other agencies have been slow to respond to the opportunities of the sector, but there have been encouraging indications that some of the large NGOs are beginning to show interest. For example, Proshika, a large national NGO, has been exploring options for working with prawn farmers in the Khulna area (Rahman, 1998), and BRAC[1] has established a prawn hatchery in Jessore (Hossain, 1996). Recently the DFID-funded CARE GOLDA Project has been working with prawn farmers in Bagerhat and surrounding districts.

While there is great potential for increasing family incomes and creating security through engaging in prawn cultivation in *gher* systems, a number of factors might contribute to the vulnerability of *gher* farmers and those associated with the activity. Wealthier and more established interests may develop at a greater pace, and hence acquire further opportunities to profit from the growth of the industry. There may be a great difference in the financial and other risks faced by different groups, and in the choices available for each. The aim of this chapter is therefore to describe the practice

[1] Bangladesh Rural Advancement Committee (BRAC) – a large NGO has been working since 1972 after the liberation war (1971). The organisation's objectives are now defined as alleviation of poverty and empowerment of the poor.

of freshwater prawn farming in *gher* systems, the constraints of prawn farming and the role of prawn farmers and associated groups in prawn production. This description is based on published sources, together with the results of primary data collected in Bagerhat district during the initial period of field visits.

3.2 *Gher* based prawn farming

3.2.1 History of development

By around 1987, a few local farmers first converted their low-lying lands and rice fields into *ghers* for freshwater prawn cultivation (Kendrick, 1994). By 1990 some *ghers* were doing well enough to convince most farmers that they should convert, and the pace of conversions increased rapidly (Kamp and Brand, 1994).

As *ghers* have commonly been converted from rice fields, their boundaries often follow existing rice fields, although some farmers may choice to sub-divide a field. Sometimes there are canals between neighbouring *ghers*, but in the intensively developed areas *ghers* are often laid out back to back, uninterruptedly covering hundreds of hectares (New, 1995). Many are provided with a small thatched shelter, perched on the dike, where a night guard can be stationed, since theft or the fear of it – is rampant.

According to the questionnaire of 400 interviewees, 43 (10.75%) prawn farmers started *gher* farming in or before 1991. Sixty (15%) farmers started *gher* farming in 1992, 99 (24.75%) in 1993, 127 (31.75%) in 1994 and 71 (17.75%) in or after 1995 in the study area. As Table 3.1 shows, 18% of farmers started *gher* farming in 1991 or before in

Fakirhat-Mollahat zone, followed by 13% in Bagerhat Sadar, 7% in Chitalmari and 5% in Kachua. The highest percentage of prawn farmers started *gher* farming in 1994, with 34% in Chitalmari zone, 33% in Kachua, 32% in Bagerhat Sadar and 28% in Fakirhat-Mollahat. Almost all interviewed farmers stated that the primary reason for converting their land into *ghers* was for freshwater prawn cultivation, and most farmers believed prawn farming to be more profitable than agriculture. The great majority of respondents, 366 (91.5%) mentioned that if they had more agricultural land, they would convert it into *gher*, though 34 (8.5%) farmers would not like to do so, considering prawn farming to be much more risky than agriculture.

Table 3.1 Starting date of *gher* farmers by zone.

Starting year	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
1991 or before	13 (13)	18 (18)	7 (7)	5 (5)	43 (10.75)
1992	15 (15)	18 (18)	11 (11)	16 (16)	60 (15)
1993	22 (22)	22 (22)	25 (25)	30 (30)	99 (24.75)
1994	32 (32)	28 (28)	34 (34)	33 (33)	127 (31.75)
1995 or after	18 (18)	14 (14)	23 (23)	16 (16)	71 (17.75)

n: sample size; figures in parenthesises indicate percentage

It is indicating that more than 80% of farmers had been in operation for more than 4 or 5 years, suggesting that expansion of the sector in recent years has not been as pronounced as described.

Gher size was also found to vary with the date of starting prawn farming. A greater percentage of farmers starting in the two earliest year categories had large farm sizes. Those starting in the latest two year categories (1994, 1995 or after) tended to have a smaller *gher* sizes (Table 3.2). A local leader in Fakirhat (Abul Kalam, pers. comm.) noted that early innovators were able to converted larger *ghers* than new farmers.

Table 3.2 Starting date of farmers by *gher* size category.

Starting year	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
1991 or before	7 (3.91)	14 (10.29)	9 (18.37)	13 (36.11)	43 (10.75)
1992	16 (8.94)	26 (19.12)	10 (20.41)	8 (22.22)	60 (15)
1993	39 (21.79)	46 (33.82)	10 (20.41)	4 (11.11)	99 (24.75)
1994	69 (38.55)	32 (23.53)	16 (32.65)	10 (27.78)	127 (31.75)
1995 or after	48 (26.81)	18 (13.24)	4 (8.16)	1 (2.78)	71 (17.75)

n: sample size; figures in parenthesises indicate percentage

3.2.2 *Gher* ownership

In the study area, most *ghers* were owned by farmers themselves. Of the total (400) interviewed, 354 (88.5%) owned their *gher*, the remainder (11.5%) being leased (Table 3.3). The highest percentage of farmers owning their *gher* were in Kachua zone (91%) followed by Chitalmari (90%), Fakirhat-Mollahat (88%) and Bagerhat Sadar (85%). According to lease farmers, leases are usually for three to five years, the lessee agreeing to pay a sum of Tk 25,000 to 35,000 (US$ 521 to 729) ha^{-1} $year^{-1}$ to the landowner. Lease arrangements are common as a means for those without land to enter into prawn cultivation. A school teacher in Fakirhat (Abul Kashem, pers. comm.) noted that land values have risen considerably (average 65% $year^{-1}$) since starting of *gher* farming, where land that would have sold for Tk 100,000 to 150,000 (US$ 2,083 to 3,125) ha^{-1} few years ago (1994-95) is worth Tk 475,000 to 500,000 (US$ 9,896 to 10,417) ha^{-1} today (1999).

Table 3.3 ***Gher* ownership by zone.**

Farmers category	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Owner	85 (85)	88 (88)	90 (90)	91 (91)	354 (88.5)
Lease	15 (15)	12 (12)	10 (10)	9 (9)	46 (11.5)

n: sample size; figures in parenthesises indicate percentage

Gher ownership was also found to increase with *gher* size (Table 3.4), and no leased *gher* farmer had a *gher* size above 0.4 ha. There was a significant relationship ($P < 0.05$) between ownership status and *gher* size, but insignificant relationship ($P > 0.05$) between zones.

Table 3.4 ***Gher* ownership by *gher* size category.**

Farmers category	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Owner	147 (82.1)	122 (89.7)	49 (100)	36 (100)	354 (88.5)
Lease	32 (17.9)	14 (10.3)	0 (0)	0 (0)	46 (11.5)

n: sample size; figures in parenthesises indicate percentage

3.2.3 Changes of *gher* ownership

Data on changes of *gher* ownership were collected from those farmers who have owned *ghers*. Two main ways were found in which *gher* ownership is changed: 1) by inheritance and 2) by selling. Of the total (354) *gher* owners interviewed, 271 (76.6%) obtained their *gher*, or land for *gher* development, through inheritance. In old age, owners typically distribute their *gher* and land to descendants. A few farmers noted that they obtained their *gher* after the death of their father or grand father, through the Muslim law as practised in Bangladesh. *Gher* ownership is also changed by inheritance due to the division of larger joint families into nuclear families. However, 83 (23.5%) farmers obtained their *gher* by purchase from neighbours, relatives or others. According to these farmers, 55 (66.3%) of *gher* owners sold their land or *gher* due to poverty, while 12 (14.5%), 5 (6.0%) and 11 (13.3%) sold to migrate to India, to town or elsewhere abroad for work, or other reasons (social conflicts, high price of *gher*, unsuitability for prawn farming etc.) respectively.

Farmers also sold their *ghers* due to poverty, which may in turn also be associated with demand for dowries, loan default, children's education, or serious health problems. In rural Bangladesh, the granting of a dowry is still common for the marriage of a daughter. Several families complained of increases in dowry payments due to prawn farming. Families of bridegrooms that formerly would have received a bicycle from the bride's family are now demanding a motorcycle, large amounts of cash money, gold jewellery, wristwatches etc. This then obliges poor farmers to sell their *gher* and land.

Ghers are also sold for the education of children. A *gher* owner in Fakirhat-Mollahat zone (Abdul Jalil, pers. comm.) noted that he bought a 0.21 ha *gher* from a school teacher who wanted to continue his brilliant son's education at the university level. However, this was a rare case.

Some of the minority Hindu people feel insecure due to conflict with Muslims, and a number have migrated to India, especially West Bengal, selling their land, *ghers* and other properties to others. *Gher* ownership has also changed due to migration into town or abroad for job opportunities. A *gher* owner in Chitalmari zone (Ranjon Das, pers. comm.) noted that he bought a *gher* from his neighbour who went to Malaysia for work, and sold his *gher* to pay for his air ticket and other costs such as passport, visa etc.

In some cases, rich prawn farmers and wealthy people forced poor farmers to sell their *gher*. Friction between the two sides sometimes led to scuffles involving villagers and hired enforcers employed by the wealthy. A farmer of Kachua zone (Abdul Malek, pers. comm.) stated that he had to sell his one portion of land to a rich neighbour due to village politics against him. However, such farmers may be able to profit by selling, as land and *gher* prices have increased greatly with the start of prawn farming. In some locations, *ghers* are also sold due to the intrusion of saline water through canals, which reduces prawn production and makes land unsuitable for agriculture.

3.2.4 *Gher* size

The size of *gher* may play an important role as it may reflect the availability of capital, managerial ability, and the potential to operate and use resources efficiently. The average *gher* size in the study area was found to be 0.23 ha (median 0.21 ha), with thousands of tiny *ghers* and only a few large units. The largest *gher* size was 1.01 ha and the smallest was 0.06 ha. This compares with an average 0.35 ha in Bagerhat district noted by Rutherford (1994), and an average in Fakirhat of 0.30 ha described by Kendrick (1994). Table 3.5 shows that the largest average *gher* size was found in Fakirhat-Mollahat and the smallest in Kachua. There was a significant difference ($P < 0.05$) between gher size and zones.

Table 3.5 Average *gher* size (ha) by zone.

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Gher size (ha)	0.25	0.29	0.21	0.17	0.23	0.16

SD: Standard deviation

As Figure 3.1 shows, the highest percentage of farmers with smallest *ghers* (less than 0.21 ha) are in the Chitalmari zone (53%) followed by Kachua (48%), Bagerhat Sadar (44%) and Fakirhat-Mollahat (34%). The highest percentage of largest *ghers* (more than 0.61 ha) was found in Fakirhat-Mollahat (11%) followed by Bagerhat Sadar (10%), Chitalmari (8%) and Kachua (7%).

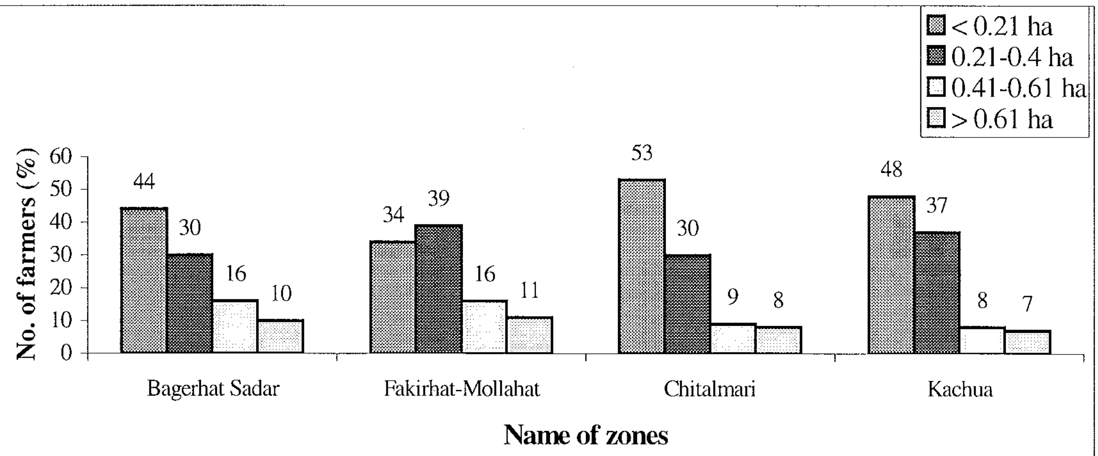

Figure 3.1 Distribution of prawn farmers by *gher* size categories.

Source: From survey data.

3.2.5 *Gher* construction

To begin producing prawns, farmers need a large amount of money for converting low-lying lands and rice fields into *ghers*. The dry months of February to April are the peak season for *gher* construction, which involves earth cutting for an encircling canal, perhaps two meters wide and a meter and a half deep, dug just inside the perimeter of the field, the soil used to build up dikes, on the outer side. In the study area, the average *gher* construction cost per ha was reported at Tk 55,646[2] (US$ 1,159). As Table 3.6 shows, the highest average construction cost was found in Fakirhat-Mollahat zone followed by Bagerhat Sadar, Chitalmari and Kachua. However, there was no significant difference ($P > 0.05$) between *gher* construction cost and zones. Construction cost is mainly associated with labour cost, where the normal wage rate is Tk 80 to 120 (US$ 1.7 to 2.5) day^{-1}, depending on *gher* size, location, number of labourer required, and season. The size, shape and depth of the *gher* also affects the cost of construction. The peak labour demand between February to April, coincides with rice weeding and later harvesting. However, during the early monsoon months of June to August when little work is available, the normal wage rate drops to Tk 40 to 50 (US$ 0.8 to 1) day^{-1}.

Table 3.6 Initial *gher* construction cost (Tk ha^{-1}) by zone.

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Gher construction cost (Tk ha^{-1})	58,140	58,283	54,388	51,775	55,646	14,071

SD: Standard deviation

A significant relationship ($P < 0.05$) was found between *gher* construction cost and *gher* size. As shown in Table 3.7, average gher construction cost (Tk ha^{-1}) was found to

[2] US$ 1 = Tk 48, during the data collection period in 1998-99.

increase with increased *gher* size.

Table 3.7 Initial *gher* construction cost (Tk ha^{-1}) by *gher* size.

Gher size categories	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Gher construction cost (Tk ha^{-1})	47,920	54,223	58,317	62,125	55,646	14,071

SD: Standard deviation

3.3 Experience and training for prawn farming

3.3.1 Acquired experience

It appears to be true, as suggested by Chapman (1997), that prawn cultivation in *ghers* has genuinely originated from the farmers in the study area. According to the survey, 102 (25.5%) farmers acquired their experience by self-study and the remaining 298 (74.5%) gained experience from friends and neighbours. No one claimed to have obtained experience from DOF, NGOs or other institutes. As Table 3.8 shows, the highest percentage of self-taught prawn farmers was in Fakirhat-Mollahat zone (28%) followed by Chitalmari (27%), Bagerhat Sadar (24%) and Kachua (23%).

Table 3.8 Source of prawn farmer's acquired experience, by zone.

Acquired experience	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Self-study	24 (24)	28 (28)	27 (27)	23 (23)	102 (25.5)
Friends and neighbours	76 (76)	72 (72)	73 (73)	77 (77)	298 (74.5)

n: sample size; figures in parenthesises indicate percentage

A significant relationship ($P < 0.05$ by chi-square test) was found between *gher* size and reported means of acquiring experience (Table 3.9), the percentage of self-taught farmers increasing with increased *gher* size. Most of the larger owners (78%) claimed not to have acquired experience from others.

Table 3.9 Source of acquired experience by *gher* size category.

Acquired experience	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Self study	21 (11.73)	32 (23.53)	21 (42.86)	28 (77.78)	102 (25.50)
Friends and neighbours	158 (88.27)	104 (76.47)	28 (57.14)	8 (22.22)	298 (74.50)

n: sample size; figures in parenthesises indicate percentage

3.3.2 Training

In recent years, DOF, BAFRU[3], NGOs, and other institutes have been providing training to the prawn farmers. In particular, the DFID-funded CARE GOLDA Project has been working with the prawn farmers in Bagerhat and its surrounding districts since 1997. Training and technical assistance (e.g. rearing post-larvae, applying feed and fertiliser, maintain water quality etc.) are the main components of the project. However, of the total (400) interviewed, only 43 (10.75%) received formal training (Table 3.10), the highest percentage in Fakirhat-Mollahat zone (14%) followed by Chitalmari (11%), Bagerhat Sadar (10%) and Kachua (8%). Other farmers mentioned that neighbours and friends who received training are the main source of technical assistance.

[3] Bangladesh Aquaculture and Fisheries Resource Unit (BAFRU) – DFID project.

Table 3.10 Training received by prawn farmer, by zone.

Received training	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Yes	10 (10)	14 (14)	11 (11)	8 (8)	43 (10.75)
No	90 (90)	86 (86)	89 (89)	92 (92)	357 (89.25)

n: sample size; figures in parenthesises indicate percentage

A significant relationship ($P < 0.05$) was found between farmers receiving training and *gher* size. A key informant, *Thana* Fisheries Officer of Bagerhat Sadar (Md. Faridul Islam, pers. comm.) stated that early innovators, large owners with higher socio-economic status were able to get more training facilities. As Table 3.11 shows that the percentage of prawn farmers who received training was found to increase with increased *gher* size. However, there was an insignificant relationship ($P > 0.05$) between training and zone.

Table 3.11 Receipt of training and *gher* size.

Received training	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Yes	7 (3.9)	9 (6.6)	10 (20.4)	17 (47.2)	43 (10.75)
No	172 (96.1)	127 (93.4)	39 (79.6)	19 (52.8)	357 (89.25)

n: sample size; figures in parenthesises indicate percentage

3.4 Production systems

3.4.1 Culture season and methods

In the study area, the peak season of prawn farming is from May to January. Prawn post-larvae are stocked when they become available in May to June and are harvested primarily from November to January, a culture period of around nine months (Figure

3.2). The principal water sources for *ghers* are rainfall, ground water (i.e. through tube-wells), and sometimes river water, through canals.

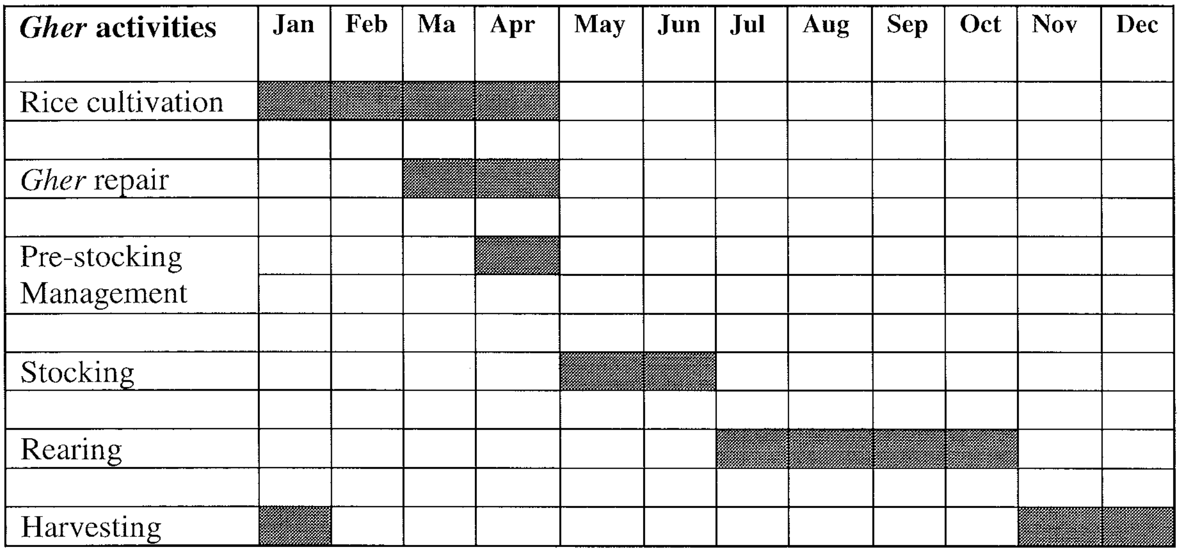

Figure 3.2 Time schedule of integrated prawn farming in *gher* systems.

The *gher* design potentially provides good opportunities for diversified production, with primary dependence on prawn, fish and rice; 86.25% of respondents integrated prawn farming with fish and rice. Only 10.75%, 1% and 2% of farmers cultured prawn-fish, prawn-rice and only prawn respectively. As shown in Table 3.12, the highest percentage of fully integrated *ghers* was found in Fakirhat-Mollahat zone (89%) followed by those of Bagerhat Sadar (87%), Kachua (85%) and Chitalmari (84%).

Table 3.12 Type of integration in *ghers* by zone.

Culture methods	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Prawn-fish	10 (10)	8 (8)	12 (12)	13 (13)	43 (10.75)
Prawn-rice	1 (1)	1 (1)	1 (1)	1 (1)	4 (1)
Prawn-fish-rice	87 (87)	89 (89)	84 (84)	85 (85)	345 (86.25)
Prawn	2 (2)	2 (2)	3 (3)	1 (1)	8 (2)

n: sample size; figures in parenthesises indicate percentage

Culture methods are also associated with *gher* size (Table 3.13). The highest percentage of farmers (98%) preferred prawn-fish-rice culture in the 0.41 - 0.61 ha *gher* size category and the lowest (83.2%) in the < 0.21 ha category. This relationship was significant ($P < 0.05$) while that between integration and zone was insignificant ($P > 0.05$).

Table 3.13 Level of integration and *gher* size.

Culture methods	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Prawn-fish	21 (11.7)	19 (14)	1 (2)	2 (5.6)	43 (10.75)
Prawn-rice	1 (0.6)	3 (2.2)	0 (0)	0 (0)	4 (1)
Prawn-fish-rice	149 (83.2)	114 (83.8)	48 (98)	34 (94.4)	345 (86.25)
Prawn	8 (4.5)	0 (0)	0 (0)	0 (0)	8 (2)

n: sample size; figures in parenthesises indicate percentage

Some 349 (87.25%) farmers were involved in rice production in 1998, and only 51 (12.75%) farmers did not cultivate rice in their *gher*, due to low production, infertile soil and/or saline water intrusion. In *gher* systems, rice is generally cultivated in the central plateau of the *ghers* during the dry season from January to April. Almost all prawn farmers cultivated *boro*[4] rice inside the *gher*, but they generally avoided cultivating *aman*[5] rice during the monsoon when the prawns are in the *gher*. Farmers suggested that the *aman* rice competed with the prawns for living space, and placed demands on their limited capital during the prawn growing season. It was also thought to pollute the water when the stalks are left to rot. In addition farmers believe that the use of pesticides for rice negatively effects prawn growth.

A range of carp species is cultured with the prawns, but harvested throughout the year. Most (388 or 97%) farmers produced fish in their *gher*, only 12 (3%) not doing so due to low production of both prawn and fish, and/or considering that fish competes with prawn for feed, space and their limited capital. Farmers stocked Common carp, *Cyprinus carpio* L., Silver carp, *Hypophthalmichthys molitrix* (Val.), Indian major carp, *Catla catla*, *Labeo rohita, Cirrhinus mrigala* and Grass carp, *Ctenopharyngodon idellus*. However, they grow very small quantities. In general, stocking densities were 1,000 to 1,200 fry ha^{-1} *gher*, and farmers did not attempt to stock any specific ratio of different carp species.

3.4.2 Pre-stocking management and stocking density

A variety of unwanted aquatic plants grow in *gher* systems, which are considered harmful for prawn cultivation. Dikes become narrow and fragile due to rain, floods and pedestrian traffic. Farmers therefore repaired their dikes and removed aquatic weeds in the dry season. After *gher* repair, farmers generally used 100 to 150 kg ha^{-1} of cow-dung

[4] *Boro* rice grown in the dry season from January to April.
[5] *Aman* rice planted during the monsoon beginning in June and harvested in November-December.

in their *gher*, this being relatively cheap and available in the study area. The use of chemical fertiliser is not widespread; only few farmers use a mixture of chemical fertiliser such as urea, TSP together with cow-dung.

Prawn culture in *ghers* was fully dependent on wild fry. Farmers stocked these rather than hatchery produced stock as production of the latter is limited and farmers considered them to be of lower quality. Farmers also mentioned that the survival of wild post-larvae was much higher than that of hatchery-reared post-larvae.

The average stocking density of post-larvae was found to be 20,680 ha^{-1} *gher* (range 12,500 - 30,000 and median 20,500 ha^{-1}) in 1998. Juvenile[6] stocking rate was found average 6,218 ha^{-1} *gher* (range 3,500 - 9,500 and median 6,000 ha^{-1}). As Table 3.14 shows, the highest average post-larval stocking rate was found in Bagerhat Sadar followed by Fakirhat-Mollahat, Chitalmari and Kachua, while the highest average juvenile stocking rate was found in Fakirhat-Mollahat followed by Bagerhat Sadar, Chitalmari and Kachua. There was a significant difference ($P < 0.05$) between stocking rates and zones. No one reported stocking both post-larvae and juvenile in their *gher*. These figures compare with stocking rates of 10,000 to 30,000 post-larvae ha^{-1} (Rosenberry, 1990) or 7,000 to 10,000 juvenile ha^{-1} (Akand and Hasan, 1992) - several years earlier.

[6] After completion of the larval life cycle (60 days), freshwater prawns metamorphose into post-larvae and then juvenile. From this point onwards juvenile resemble miniature adult prawns and become mainly crawling rather than free swimming (New and Singholka, 1985).

Table 3.14 Prawn farmer's average stocking rate per ha *gher* by zone.

Stocking fry	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Post-larvae (PL)	21,183	20,988	20,716	19,835	20,680	1,945
Juvenile	6,307	6,833	5,992	5,740	6,218	889

SD: Standard deviation

Farmers were observed to prefer post-larvae to juveniles for stocking, due to their low price and availability in local markets. Some 347 (86.75%) farmers stocked post-larvae, whereas only 53 (13.25%) stocked juveniles in the reference year (1998). The stocking size of post-larvae was 9 to 10 mm length and 9 to 10 mg weight, while juvenile size was 4 to 6 cm length, 1.5 to 1.8 g weight. During post-larval stocking a few farmers used pocket *ghers* to improve survival rate. A pocket *gher* is a net covering small *gher* from 200 to 400 m^2 in a *gher*. In general, farmers reared post-larvae for 4 to 6 weeks in the pocket *gher* where stocking rate was 50 to 100 post-larvae per m^2. Its use has increased in recent years due to getting better results.

There was also a significant relationship ($P < 0.05$) between stocking rate and *gher* size. It was found that larger farmers were able to stock more fry due to higher economic status. As shown in Table 3.15, average stocking rate was found to increase with increased *gher* size.

Table 3.15 Prawn farmer's average stocking rate per ha *gher* by *gher* size.

Stocking fry	< 0.21 ha	0.21 – 0.4 ha	0.41 – 0.61 ha	> 0.61 ha	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Post-larvae (PL)	17,682	19,646	21,532	23,860	20,680	1,945
Juvenile	4,843	5,621	6,574	7,832	6,218	889

SD: Standard deviation

3.4.3 Feed and feeding rate

A variety of feeds were used but the preferred feed is the freshwater snail, *Pila globosa* (Swainson). However, in the first week of post-larval stocking, 50 g of wheat flour is applied per one thousand post-larvae, and the following week a double quantity is given, as suggested by BAFRU training. When the post-larvae become juvenile farmers start to apply snail meat. An average 66.5 kg ha^{-1} day^{-1} (range 42 - 80 and median 65 kg ha^{-1} day^{-1}) of snail meat is given during June to October. As Table 3.16 shows, the highest average daily amounts are given in Fakirhat-Mollahat zone followed by those of Bagerhat Sadar, Chitalmari and Kachua. However, there was no significant difference ($P > 0.05$) between feeding rate of snail meat and zones.

In general, chopped snail meat is given twice a day in the morning and in the evening. If excessive snail meat floats up in the water, feed supply is reduced. It is increased if it does not float in the water. It is clear that farmers have little knowledge on which to base their decisions about feeding practices. The snail population has declined in the study area due to excessive harvesting, and they are now harvested from neighbouring districts. The supply of snail is not regular, and therefore farmers also use home made feed made by mixing cooked rice, rice bran, oil cake, and fishmeal, or sometimes also use Saudi-Bangla[7] fish feed. However, according to the prawn farmers the production of prawn is higher and production cost is lower, when snails are used rather than home made or other feed.

Table 3.16 Average use of snail meat (kg ha^{-1} day^{-1}) as prawn feed by zone.

Zones	**Bagerhat Sadar**	**Fakirhat-Mollahat**	**Chitalmari**	**Kachua**	**Total**	
	Mean	Mean	Mean	Mean	Mean	SD
Snail meat (Kg ha^{-1} day^{-1})	65.2	69.5	64.8	62.8	66.5	16.8

SD: Standard deviation

Feeding rate of snail meat was also found to vary with *gher* size. As Table 3.17 shows, increased *gher* size was associated with increased feeding rate. There was a significant relationship ($P < 0.05$) between applying snail meat and *gher* size.

Table 3.17 Average use of snail meat (kg ha^{-1} day^{-1}) as prawn feed by *gher* size.

Gher size categories	**< 0.21 ha**	**0.21 – 0.4 ha**	**0.41 – 0.61 ha**	**> 0.61 ha**	**Total**	
	Mean	Mean	Mean	Mean	Mean	SD
Snail meat (Kg ha^{-1} day^{-1})	60.4	64.8	67.6	71.5	66.5	16.8

SD: Standard deviation

[7] A commercial prawn feed manufactured in Bangladesh, but it is expensive (Tk 40 to 60 or US$ 0.8 to 1.25 kg^{-1}).

3.4.4 Harvesting of prawn

The peak season of prawn harvesting is from November to January. Farmers harvest their prawns by using a cast net (*khepla jal*) and barrier net (*goga jal*), usually netting several times at a few weeks' interval. Cast nets are generally used for small *ghers* and barrier nets are used for big *ghers*. The first harvest is typically 60% of the stock, the next around 30% and the last about 10%. A few farmers harvest at the rate of 60%, 20%, and 20%. Harvested prawns are kept in aluminium containers or bamboo baskets. After harvesting farmers grade all head-on prawn by size and weight (see Table 3.18) and sell them to the local markets. According to the farmers, about 50% of production would be grade 20, less than 10% would be grade 5 and 10; the rest would be equally split between grades 30 and 50. Anything smaller than grade 50 would be restocked rather than harvesting.

According to interviewees, almost all prawns are sold to the local markets. Farmers commonly use 'vans[8]' to transport the prawns from the *gher* to the local markets, which takes 30 minutes to an hour depending on market distance. Sometimes small traders '*foria*' buy prawns from the farmers at the *gher* side, carrying them to the prawn traders in local markets. Of the total interviewed, 82% of farmers sold directly to prawn traders, and only 18% sold via *foria* to the prawn traders. The average price of prawns depends on grade and varies between Tk 110 and 375 (US$ 2.3 to 7.8) kg^{-1} (Table 3.18). Problems mentioned by farmers in marketing of prawn were lack of knowledge of grading, problems due to inaccurate weighing, and the lack of transport facilities.

[8] Pedal tricycle with a flat wooden load deck at the rear.

Table 3.18 Grade and average price of head-on prawns for local markets.

Grade	No. of head-on prawns kg^{-1}	Average weight per prawn (g)	Average price	
			Tk kg^{-1}	US$ kg^{-1}
5	5 or less	200	375	7.8
10	6-10	100	310	6.5
20	11-20	50	250	5.2
30	21-30	30	210	4.4
50	31-50	20	110	2.3

Source: From survey data (December 1998).

3.5 Financing prawn farming

From the study it seems that investment in prawn cultivation within *gher* systems is quite large. The first year of prawn farming is the period in which large amounts of money are needed due to *gher* construction. Costs of prawn cultivation were reported to have increased significantly in recent years as a result of increased labour wage rates, and increased costs prawn stock and feed. The main problem for farmers is the shortage of operating capital, and the prices of both prawn fry and snail have increased dramatically since prawn farming has become widespread. The months from July to October are when prawn feeding demands what seems to be an unlimited amount of daily expenditure to buy snail meats as well as other feeds. Inadequate and costly finance can therefore be a significant constraint.

3.5.1 Own finance

From the survey, it was found that 68.25% farmers used their own money for prawn farming, while the rest received loans (Table 3.19). Farmers appear to use a wide variety of strategies. Small farmers entering *gher* operation typically employ an incremental strategy in which they begin with small *ghers* on only part of their land, and stock and feed them at minimal level. This allows them to stay as far as possible within their own resources. The finance comes mainly from a broad mix of personal and informal sources. Farmers primarily finance prawn farming by disposing of household assets. Some have their own capital, either savings or proceeds from sales of personal assets, especially cows, gold jewellery or timber, some sell land. Although actual sale of land to finance *gher* construction now appears to be extremely rare, leasing out a portion of land for *gher* development to finance the building of *gher* is common.

Cattle were the most common assets to be sold for developing a *gher* and the most commonly reported. They are a common store of value for paddy farming households, and so most households had a pair. If the family is serious about becoming *gher* operators, they may no longer need their cows for ploughing. The number of cattle has therefore decreased significantly since *ghers* have become widespread. Farmers interviewed stated that they had decided against re-investing in cattle with profits from prawn farming. A few farmers noted that they also not like to raise cattle due to decreased grazing land as a result of its conversion into *ghers*. Moreover farmers stated that cattle are less profitable then investing money in the *ghers*.

3.5.2 Credit

Use of credit

Access to credit is considered to be one of the important factors influencing prawn production. However, of the total interviewed farmers, only 127 (31.75%) have received a formal loan for prawn farming in 1998. As presented in Table 3.19, the highest percentages of prawn farmers receiving loans were in Bagerhat Sadar (38%) followed by Kachua (35%), Fakirhat-Mollahat (29%) and Chitalmari (25%). A key informant, *Thana* Fisheries Officer of Bagerhat Sadar (Md. Faridul Islam, pers. comm.) stated that farmers with higher socio-economic status in respect of prawn cultivation were able to get more credit facilities. He also stated that variations of credit facilities depend on farmer's socio-economic status, access to credit institutions and linkage of the concerned farmers with the rural power elite.

Table 3.19 Source of finance for farmers by zone.

Finance of prawn farming	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Loan	38 (38)	29 (29)	25 (25)	35 (35)	127 (31.75)
Own finance	62 (62)	71 (71)	75 (75)	65 (65)	273 (68.25)

n: sample size; figures in parenthesises indicate percentage

The percentages of farmers receiving loans varied with *gher* size (Table 3.20), decreasing with increased *gher* size. This relationship was statistically significant ($P < 0.05$) but differences due to zone were insignificant ($P > 0.05$).

Table 3.20 Source of finance for prawn farmers by *gher* size.

Finance of prawn farming	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Loan	78 (43.6)	46 (33.8)	2 (4)	1 (2.8)	127 (31.75)
Own finance	101 (56.4)	90 (66.2)	47 (96)	35 (97.2)	273 (68.25)

n: sample size; figures in parenthesises indicate percentage

Source of credit

Many prawn farmers are unable to finance their season's activities, and therefore look to various sources of credit. Over recent years several institutions for providing credit to the farmers have been developed, chief of which have been banks, NGOs, prawn traders (*depot malik*[9]) and indigenous moneylenders (Figure 3.3). The most common source of credit is through moneylenders, who appear to be the preferred source of borrowed capital at *gher* development, and at stocking stage. Local moneylenders appear to operate in the normal fashion within the area, with no noticeable changes to suit the particular needs of prawn farming. Actual interest paid is from 20 to 25% a month in most cases, though borrowers are sometimes quoted a higher rate (30%).

[9] Depot or shop owner.

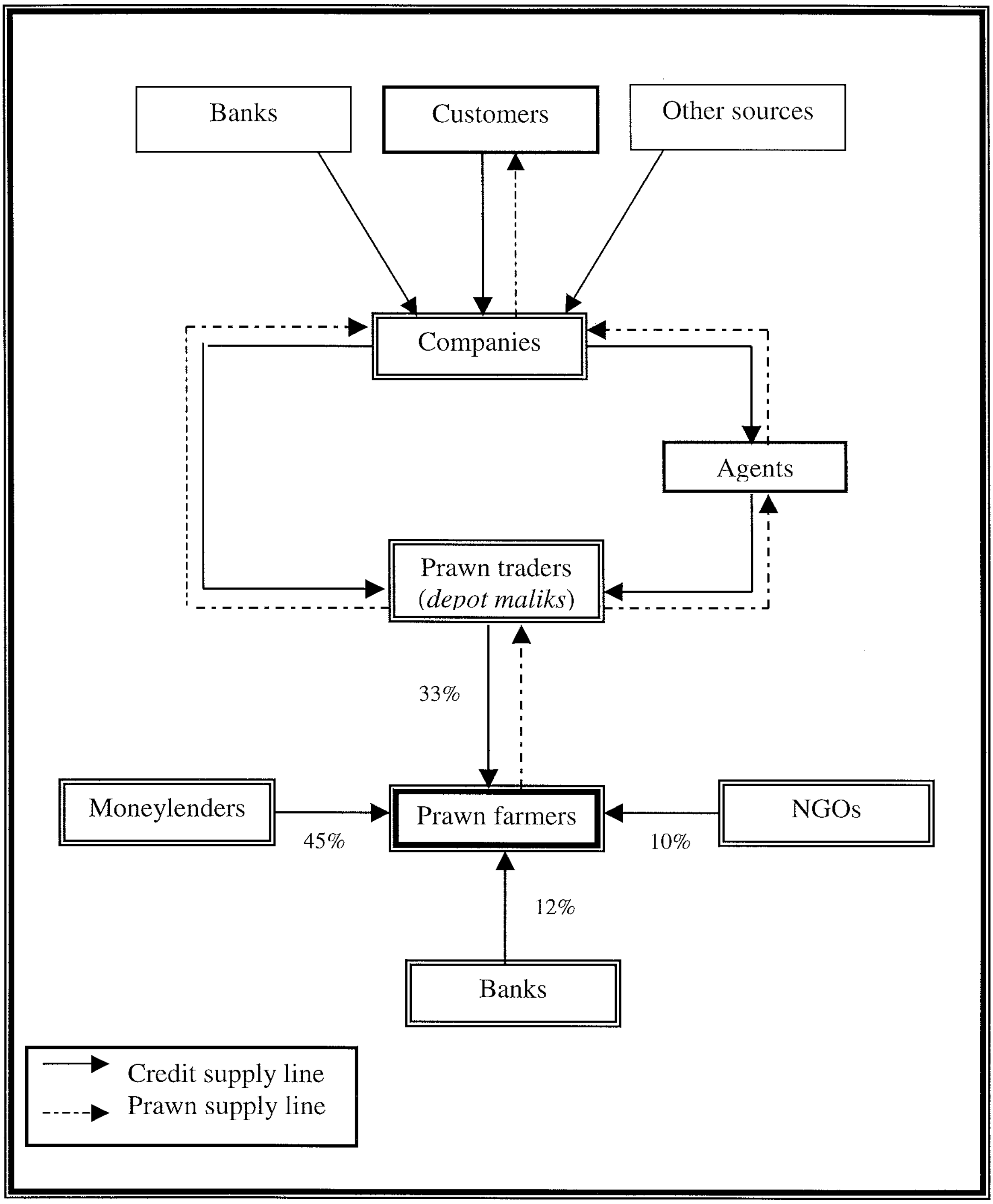

Figure 3.3 Credit supply chain from different sources to prawn farmers in the study area (developed from survey).

Local branches of national banks provide credit to the prawn farmers secured against land at a 12% monthly interest rate. Grameen Bank, Bangladesh Krishi Bank (BKB) and other national banks (Sonali Bank, Agrani Bank etc.) have all provided loans for developing prawn farming in the study area. The Grameen Bank, a specialised bank for small loans to poorer farmers, is active in several villages of Bagerhat district. According to key informants, NGOs also provide a little credit for prawn farming and several local NGOs are active in the study area, providing small loans (Tk 1,000 to 3,000 or US$ 21 to 62.5 year^{-1}) to members of their groups. Some small and marginal prawn farmers do make use of these NGO credit programmes. There are numerous local NGOs with small loan portfolios, many of which are searching for alternative income generating activities for the rural poor and/or for the means to obtain an appropriate return on their own resources. As awareness of the potential of *gher* farming as a lending sector spreads, more of these NGOs may be attracted to working in prawn farming areas.

The prawn traders are also a major supplier of capital to the prawn farmers by '*dadon*' credit, which is widely practised in the study area. *Dadon* is a system of tied credit through which the prawn traders advance money to the prawn farmers in exchange for the assured sale of prawns. Under *dadon*, a *depot malik* receives a cash loan from an agent or company in return for a promise to sell all his prawns. Usually, the *depot maliks* will receive their *dadon* advance towards the beginning of the buying season from processing companies. These companies are located in Khulna (west of Bagerhat district) which buy prawns, grade and freeze them, and export them to the international market through Mongla port. Companies contact with commission (or purchasing) agencies – known simply as agents – who pay suppliers for their prawns on behalf of the companies in return for a commission. The companies' capital installations and much of their working capital is provided by the banks. Companies typically enjoy a very close working relationship with their banks, for which this sector is big business.

According to these farmers who received loans, 50 (39.37%) obtained these from *depot maliks* as *dadon* credit, 41 (32.28%) from moneylenders, 22 (17.32%) from NGOs, and only 14 (11.02%) from banks (Table 3.21). Farmers who got loans from non-bank sources were asked why they had not obtained a bank loan. Sixty-seven (59.3%) stated that they would not like to go to a bank due to lack of education, and 34 (30.1%) and 12 (10.6%) considered there to be too much official and paper work, and too small amounts of loan respectively.

Table 3.21 Loan sources by farmers by zone.

Sources of loan	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
Banks	5	4	2	3	14 (11.02)
Depot maliks (prawn traders)	14	10	9	17	50 (39.37)
Moneylenders	11	11	9	10	41 (32.28)
NGOs	8	4	5	5	22 (17.32)

Parenthesises indicate percentages of total

Amount of loan

The amount of loan for prawn farming varies from farmer to farmer, and zone to zone depending on production costs, production systems, *gher* size and *gher* management. The average amount of credit received by a farmer was estimated at Tk 6,134.9 (US$

128) in the reference year of 1998 (Table 3.22). The highest average amount of loan per person was received in Fakirhat-Mollahat zone followed by Bagerhat Sadar, Chitalmari and Kachua, though variation was high. There was a significant difference ($P < 0.05$) between received loan and zones.

Table 3.22 Prawn farmer's average received loan (Tk farmer^{-1}) by zone.

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Received loan (Tk farmer^{-1})	5,890.3	7,849.5	5,579.5	5,220.3	6,134.9	1,274.2

SD: Standard deviation

The amount of loan was also found to vary with *gher* size (Table 3.23), increased *gher* size was associated with increased receiving loan. There was a significant relationship ($P < 0.05$) between amount of loan and *gher* size.

Table 3.23 Prawn farmer's average received loan (Tk farmer^{-1}) by *gher* size.

***Gher* size categories**	**< 0.21 ha**	**0.21 – 0.4 ha**	**0.41 – 0.61 ha**	**> 0.61 ha**	**Total**	
	Mean	Mean	Mean	Mean	Mean	SD
Received loan (Tk farmer^{-1})	5,235.5	5,833.6	6,455.2	7,015.2	6,134.9	1,274.2

SD: Standard deviation

Cost of credit

Sources of credit may be simply described as higher or lower cost types, the farmer being moneylenders and *depot maliks*, and the latter including banks and NGOs. As

Table 3.21 shows, 71.65% of borrowing farmers took loans from high cost sources, while only 28.34% borrowed from less expensive sources. A school teacher in Bagerhat Sadar (Jalal Uddin, pers. comm.) stated that the poor farmers generally took loans from highly expensive sources. This might be due to their inability to offer collateral securities to the NGOs and formal banking institutes or to the traditional dependence on other sources.

The average rate of interest varied that on high cost debt ranged from 20 to 25% monthly, while that for low cost debt ranged from 10 to 12% monthly. The lowest amount of interest charged by NGOs was estimated at 10% monthly, while the average interest rate charged by banks was estimated at 12% a month.

Loan default

Most poor farmers were found to go to moneylenders for *gher* finance, and many have no option but to take a moneylender's loan. Such loans are available because of the security offered by the profitability of the *ghers*. In general, rich farmers and local businessmen act as moneylenders. Farmers may use their principal asset – land, which is often used as collateral. Small loans are usually made without any documentation, while bigger ones require either a written description of terms, which might include a lien on assets, or the signing or thumb-printing of a blank sheet of revenue stamp paper. Some farmers noted that they were able to pay their loans to the moneylenders and become financially self-sufficient within the first one to two years. However, others sometimes have harvest failures due to flood, outbreak of disease or other unavoidable reasons, and as a result they can fall into continuing cycle of debt. If this does not recover, moneylenders may take the land of *gher* owners who default on their loan. A school teacher in Fakirhat (Abul Kashem, pers. comm.) stated that the numbers of farmers who defaulted on their loans and lost land has increased during last few years. A farmer in Bagerhat Sadar zone (Md. Kashem, pers. comm.) stated that he lost his 0.2 ha land (out of total 0.5 ha) after his first prawn harvest failed in order to pay off the moneylender.

3.6 Other constraints in prawn farming

Aside from the issues already discussed, a number of other constraints were reported, including dike overflow, water pollution, poor water quality, harvest grade problems, natural disasters (flood, drought), excessive rainfall, theft, poisoning etc. Sometimes 'jealous people[10]' throw poison into *ghers* at night, after which all the prawns may die. Poaching of prawns is also a common problem in the study area, and is one of the biggest problems for the small farmers. A few rich farmers tend to recruit guards or night watchmen to protect against theft and poisoning, whose wages range from Tk 800 (US$ 16.7) month^{-1} with food to Tk 2,000 (US$ 41.7) month^{-1} without food, usually paid monthly. They are typically contracted for six to nine months, the period of prawn production. Those who do not hire guards often patrol or sleep at their *ghers* at night.

Prawn farmers were requested to state their single most important constraint. Here, 176 (44%) of respondents identified this as lack of money. The proportion of respondents identifying lack of post-larvae was 170 (42.5%). These farmers noted that last year

[10] Rich farmers, wealthy people, and moneylenders were reported to 'feel jealous' about small farmers who improved their conditions through prawn farming.

(1998) the supply of wild post-larvae was about 50% of demand, and in 1999 demand has increased due to expansion of *ghers*, while fry supply is 30 to 50% less than last year. Only 38 (9.5%) and 16 (4%) noted flood and lack of snail meat to be the most important constraint (Table 3.24).

Table 3.24 Key constraints for prawn farmers by zone.

Constraints	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Lack of money	45 (45)	41 (41)	46 (46)	44 (44)	176 (44)
Lack of post-larvae	42 (42)	45 (45)	43 (43)	40 (40)	170 (42.5)
Flood	9 (9)	8 (8)	10 (10)	11 (11)	38 (9.5)
Lack of snail	4 (4)	6 (6)	1 (1)	5 (5)	16 (4)

n: sample size; figures in parenthesises indicate percentage

The proportion of farmer's key constraints varied with *gher* size. As Table 3.25 shows, the percentage of farmers having lack of money was found to decrease with increased *gher* size, while constraint lack of post-larvae increased. There was a significant difference ($P < 0.05$) between key constraints and *gher* size, however insignificant difference ($P > 0.05$) between zones.

Table 3.25 Key constraints for prawn farmers by *gher* size.

Constraints	< 0.21 ha	0.21 – 0.4 ha	0.41 – 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Lack of money	108 (60.3)	52 (38.2)	11 (22.4)	5 (13.9)	176 (44)
Lack of post-larvae	55 (30.7)	65 (47.8)	28 (57.1)	22 (61.1)	170 (42.5)
Flood	14 (7.8)	14 (10.3)	4 (8.2)	6 (16.7)	38 (9.5)
Lack of snail	2 (1.1)	5 (3.7)	6 (12.2)	3 (8.3)	16 (4)

n: sample size; figures in parenthesises indicate percentage

3.7 Catching, marketing and transporting of prawn post-larvae

3.7.1 Introduction

Bangladesh has a small coastal zone of 480 km coast line length and 25,000 km^2 of coastal area with a huge population, supporting a variety of land use practices (Rahman, 1994a; Mahmood *et al.*, 1997). The coastal belt of Bangladesh extends over 76 *thanas*, where large numbers of people depend for their livelihood on fishing and fishery exploitation (Feroze-Ahmed, 1997). More than a decade ago, thousands of people in the coastal areas were reported to make a living collecting prawn fry (Angell, 1990). For many fishermen, prawn post-larval catching is a seasonal activity. According to Rahman (1994b), these fishermen are socially, economically and educationally disadvantaged and, lack their own financial resources. It was considered that fry collectors contribute substantially to the economy and to a part of the foreign exchange earnings, though they benefited little (BOBP, 1990).

3.7.2 Catching of post-larvae

Many fishing people are involved in prawn post-larvae catching on the Pasur river from Mongla through to Heron Point on the coast during April to June. Islam and Chowdhury (1999) noted an average daily number of post-larvae catchers of 1,550 during the season. According to the present survey, fishermen (post-larvae catchers) are mostly from the rural poor, and catching of post-larvae is a substantial part of their income. Fishermen operate their nets twice a day during high tide when post-larvae are available. Fishermen start fry catching at 10 am to 2 pm during the day and 7 pm to 10 pm at night, an average 5.33 hours in a day.

Two types of nets are used for post-larvae collection, 'the *behundi* net' and 'the pull net'. The length of *behundi* net varies from 12 to 25 m and its width from 6 to 10 m, while the length of a pull net varies from 3 to 5 m and width from 2 to 3 m. For equipment, fishermen use boats (typical size 3 to 5 m length and 1 to 1.5 m width), bamboo, floating materials, aluminium containers, and white plates for post-larval identification. Each boat and net is operated by a single fisherman. Both types of net are set in the surface layers against the tidal water and collect a large range of by-catch species[11] along with the *M. rosenbergii* post-larvae due to the fine mesh used (Table 3.26). The *behundi* net tends to be used close to the shore-line since it is fixed to the bottom by a bamboo pole, while the pull nets can be used in deeper water, usually set off the back of boat.

During operation, nets are emptied at intervals of every 25 to 30 minutes. Fishermen keep all the fry in a container. Later they identify and separate the prawn post-larvae by using a white plate, and release other fry into the river (this is also recommended by the Fisheries Department). A huge number of other larvae are caught and discarded, and with unknown mortality effects, may have severe long term impacts on coastal fish, prawn and shrimp populations. According to Islam and Chowdhury (1999), fry catchers destroyed an average 1,340 of other fry for every prawn post-larva caught. However, this may greatly overstate the damage, as prawn and shrimp larval survival is relatively good, and it might be assumed that some of these other larvae will receive the same sequence of capture, storage and sorting, before release back to the river.

[11] Fry species were collected from fishermen and identified under a dissecting microscope with the help of postgraduate students of Khulna University who were carrying out a field visit at the same time.

Table 3. 26 By-catch species caught in *Behundi* net and Pull net on a single sampling on the Pasur river at Mongla.

English name	Scientific name	Bengali name
Giant Freshwater prawn	*Macrobrachium rosenbergii*	Golda Chingri
Monsoon River Prawn	*Macrobrachium malcolmsonii*	Chotka Icha
Freshwater Prawn	*Macrobrachium villosimanus*	Dimua Icha
Freshwater Prawn	*Macrobrachium mirabilis*	Lutia Icha
Freshwater prawn	*Macrobrachium birmanicus*	Thengua Icha
Freshwater prawn	*Macrobrachium rude*	Goda Icha
Freshwater prawn	*Macrobrachium dayanus*	Kaira Icha
Black Tiger Prawn	*Penaeus monodon*	Bagda Chingri
White Shrimp	*Penaeus indicus*	Sada Icha
Shrimp	*Penaeus merguiensis*	Bagha Chingri
Shrimp	*Metapenaeus monoceros*	Horina Chingri
Indian River Shad	*Gadusia chapra*	Chapila

Fishing effort is high during the season but is particularly concentrated during the daily high tides and monthly full moons when numbers of post-larvae in surface layers are high. However, overall post-larval catching rate is very low. According to the survey, each fisherman caught an average 79 post-larvae daily during the season, while some years previously the rate was from 85 to 100 per day (Nuruzzaman, 1993).

3.7.3 Marketing of post-larvae

Fishermen sell their fry at Digraj market in Mongla, which is particularly well known for this activity, during April to June. The market starts from early morning and up to around noon. Large numbers of fishermen and middlemen are involved in post-larvae marketing. According to the fishermen, the average price of post-larvae varied from Tk 700 to 800 (US$ 14.5 to 16.7) per 1000 fry in 1999, which compares with an average price of Tk 1,000 to 1,200 (US$ 20.8 to 25) paid by prawn farmers. The market chain from fishermen (catchers) to the prawn farmers (growers) passes through a number of intermediaries: brokers (*baperies*), fry traders and field agents (*forias*) (Figure 3.4). The demand for post-larvae is high within coastal markets but supply is limited, and a strong network has developed with brokers and fry traders intervening between farmers at one end and the suppliers of wild caught post-larvae – the fishermen, at the other end. This market separation is reinforced by geographical separation in that fry collection areas are typically 25 km from prawn production areas.

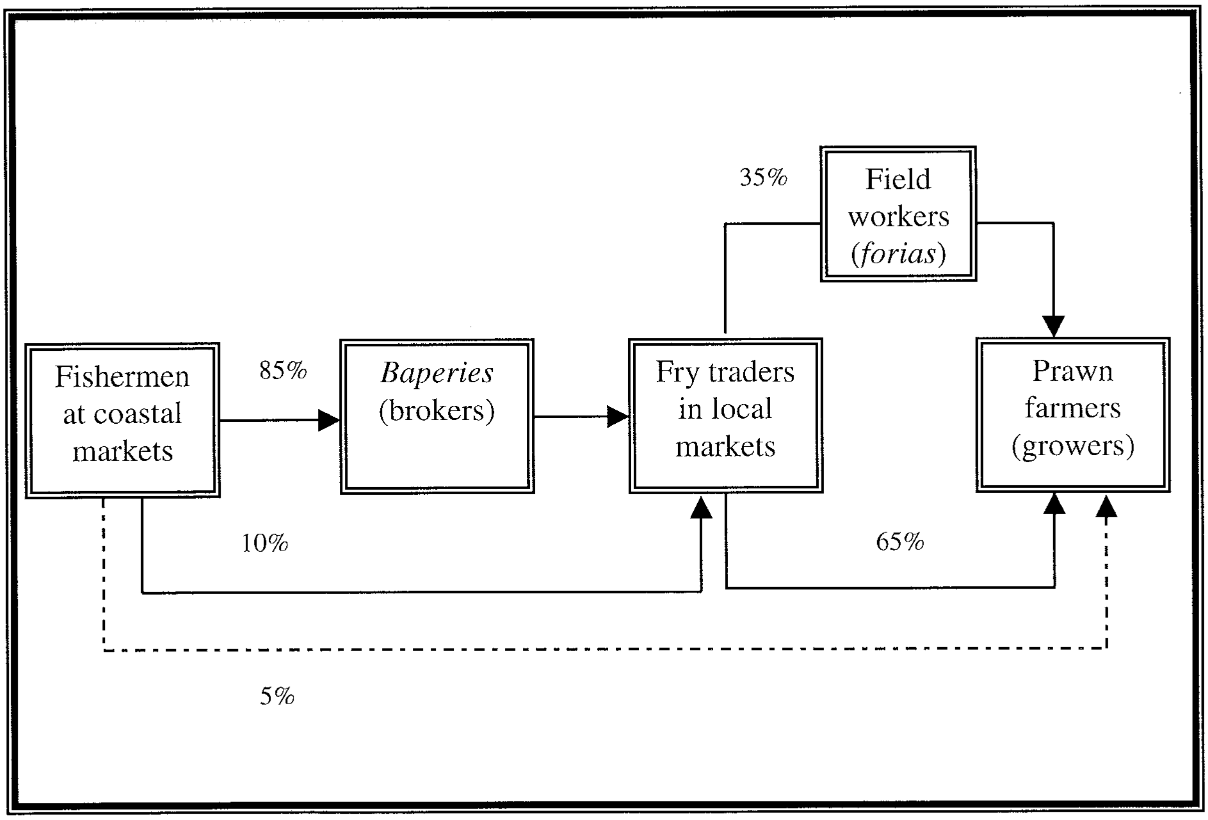

Figure 3.4 Freshwater prawn (*M. rosenbergii*) fry supply chain from fishermen in coastal area to prawn farming areas in Bagerhat district (based on survey).

With a few exceptions, the fishermen never directly communicate with prawn farmers, market communication normally being made through *baperies* and fry traders. The role of *baperies* is to buy prawn post-larvae from fishermen in coastal markets and carry them to fry traders in prawn farming areas. Fry traders sell their post-larvae directly to the prawn farmers or via *forias* to the prawn farmers. *Forias* carry prawn fry from fry traders to prawn farmers, and carry market size prawn from farmers to prawn traders. They work with small amounts of capital, and often take temporary credit from fry traders, buying fry one day, paying the next day or the day after that. They typically work from a boat, *rickshaw* or van (i.e. cargo-carrying tricycle).

3.7.4 Transport of post-larvae

A large number of *baperies*, including women, are involved in the transport of post-larvae from Digraj market to prawn farming areas in Bagerhat district. Transport of live post-larvae to fry traders takes place at night or in the very early morning hours, to take advantage of cooler temperatures. Taxis, microbuses and vans are used for transportation, with aluminium containers of 10 to 20 litres with rope handle and a net cover commonly used for post-larvae carrying. Saline water with 10 to 15 ppt is used, normally at a ratio of two litres per 1,000 post-larvae for 8 hours transportation. According to *baperies*, the post-larvae mortality rate is very low, less than 10%. Dayue (1988) noted that loading density, packing and transporting affected survival rate of prawn fry during transport. At a loading density of 5,000 fry per litre of water at 18 to 23 ppt and 15 to 20 ^{0}C temperature, the survival rate can be above 95% over 20 hours of transport. Venkataswamy *et al.*, (1992) noted that at 26 ^{0}C packing in oxygenated bags could help in increasing survival rate, but this is not used.

3.7.5 Fry trading in local markets

Based on local information during market surveys, one important fry market was chosen for each zone, these were:

1) Baroipara market, Bagerhat Sadar
2) Faltita market, Fakirhat-Mollahat
3) Babugonj market, Chitalmari and
4) Sinebord market, Kachua.

There are 15 to 20 fry traders involved in each market, except for Faltita where there are more than 20. A number of people also work with the traders as day labourers. Fry trading is a seasonal business and traders are involved in prawn trading, fish trading and prawn farming the rest of the time.

The wild fry come from Mongla, and also neighbouring coastal districts such as Noakhali, Satkhira, Barisal, Patuakhali, and Borguna. *Baperies* carry these fry to the fry traders in prawn farming areas. They typically operate with capital of around Tk 5,000 to 15,000 (US$ 104 to 312.5) and often take advance money from fry traders to ensure the supply of fry. Prawn farmers are also often linked to fry traders who may advance them *dadon* credit against future supplies of marketable size prawns, when these traders act as prawn traders – buying prawns for the processing companies. These fry traders possess capital and have the means to control fry fishermen, suppliers of other raw materials, and prawn farmers as producers of the final product. The following paragraphs address comparative fry trading in four different markets –

History of fry trading

The survey results indicated that trading first started at Faltita market in 1991 at the start of prawn farming, after which it spread throughout other parts of Bagerhat district. In Baroipara and Babugonj markets, fry trading first started in 1993 and in Sinebord market, in 1994. Over this time, fry trading has become a profitable business for its participants and has generated new employment. Before fry trading 14 (35%) traders had no job; of the rest 16 (40%), 9 (22.5%) and 1 (2.5%) were involved in agriculture, small business and prawn farming respectively.

Season and time of fry trading

The peak season of fry trading is from April to June when farmers stock post-larvae in their *gher*. In Faltita market, traders are engaged in fry trading from early morning (7 am) to evening (5 pm), while those in Babugonj and Sinebord are engaged from 8 to 12 am and Baroipara from 8 am to 2 pm. Traders in Faltita spend more time due to greater fry supply from coastal markets, and greater numbers of farmers in the Fakirhat-Mollahat zone. The numbers of fry traders, *baperies*, *forias* and day labourers are also higher in this market.

Quantities sold

Results showed that fry traders of Faltita market sell an average 32,000 (range, 21,500 -

55,000, median 30,000) fry daily during the season, compared with 12,100 (range 7,500 - 16,000, median 12,000), 9,500 (range 5,000 - 15,000, median 9,000) and 8,300 (range 4,500 - 12,000, median 8,000) fry in Baroipara, Babugonj and Sinebord markets respectively. From the above fry supplies data, median numbers are lower than averages indicating that a large number of small traders are involved in these markets.

Price of fry

The average price of post-larvae from traders to the farmers varied from Tk 1,000 to 1,200 (US$ 20.8 to 25) per 1000 fry depending on their availability. During the survey, the highest average price was at Baroipara market, at Tk 1,080 (US$ 22.5), followed by Faltita market at Tk 1,050 (US$ 21.8), Babugonj market at Tk 1,030 (US$ 21.5) and Sinebord market at Tk 1,020 (US$ 21.25). The price of juveniles was 4 to 6 times as high as that of post-larvae. The price of fry has increased notably over recent years, an average 24% per year. Akand and Hasan (1992) stated that in 1992 the price of post-larvae varied from Tk 300 to 500 per 1000, while Angell (1994b) noted the price of post-larvae in Bangladesh to be US$[12] 8 to 12 per 1000 (i.e. Tk 320 to 480) in 1993. Respondents reported that a few years ago (1994 - 95) post-larvae were sold at Tk 300 to 500 (US$ 7.5 to 12.5) per 1000, and even in the previous year (1998) the price ranged from Tk 700 to 800 (US$ 14.5 to 16.7) per 1000.

Income of fry traders

The average net profit of fry traders is higher in Faltita market than in the other three

[12] 1 US$ equivalent to Tk 40 in 1993.

markets, as quantities sold are higher. According to the survey, fry traders make an average net profit of Tk 27 (US$ 0.6) (range Tk 20 to 35 or US$ 0.4 to 0.7) per 1000 fry in the buying from *baperies* and selling to farmers. The average net profit of a fry trader in Faltita market was estimated at Tk 1,130 (US$ 23.5) day^{-1}, while that of traders in Baroipara, Babugonj and Sinebord markets were Tk 285 (US$ 6.0) Tk 220 (US$ 4.6) and Tk 205 (US$ 4.3) respectively. Fry traders noted that their income would be increased if more fry supply were available, because demand is high. However, fry trading is profitable and almost all fry traders reported that they have improved their social and economic conditions, now they have better feed, clothing, housing condition and children's education.

3.8 Supply of freshwater snail *Pila globosa*: as prawn feed

3.8.1 Introduction

In Bangladesh, there are about 450 species of snails of which 300 inhabit the coastal belt (Gain, 1998). However, only the freshwater snail P*ila globosa* (Swainson) is traditionally and commercially used as prawn feed in the study area. This snail is widely distributed in ponds, lakes, *beels*[13], *haors*[14], *baors*[15] and rivers of Bangladesh, and can easily be cultured in fertilised fish ponds and rice fields (Xoing *et al.*, 1987). They can be found gliding upside down beneath the surface film of the water body where they live (Khan, 1998).

[13] Open water bodies often containing low-lying agricultural land.
[14] Low-lying areas that are seasonally flooded, normally for 5 to 6 months per year.
[15] Closed water body equivalent to an ox-bow lake, up to several hundred hectares.

The snail is a valuable aquatic resource and low-lying marshland is their best habitat (Halwart, 1994). They feed mainly on leaves of aquatic plants, especially *Nymphea* sp., *Potamogeton* sp., *Pistia* sp., *Chara fragilis, Hydrilla verticillata* and *Ceratophyllum demersum* (Haniffa and Pandian, 1978; Ahmed, 1996). Removal of the snail is likely to result in an increase in the growth of at least some species of aquatic macrophytes. This could reduce light penetration as well as photosynthesis and could lead to eutrophication of water bodies (Gain, 1998).

The use of this snail meat as prawn feed is widespread in the study area, and snail populations are reported to have declined heavily in Bagerhat district due to excessive harvesting. Snails are now harvested from *beel* and river areas in Gopalgonj, Faridpur and Madaripur districts, north of Bagerhat district. A wide variety of people including women and children are involved in snail harvesting. Overall, the supply of snails has generated a number of new employment opportunities, in catching, processing, transport and trading activity.

3.8.2 Snail collection from the Chanda *beel*, Gopalgonj district

The Chanda *beel*, one of the largest freshwater wetlands in the country (Khan, 1998), lies at the Madhumati flood plain in Gopalgonj district, which includes Gopalgonj Sadar, Kashiyani and Muksedpur. The *beel* is estimated to cover an area of 10,870 hectares, and is famous for its rich reserve of aquatic life (Ali, 1998). Most of the year it remains under water, drying out only in a few months. From the month of June to October it remains inundated with flood water to a depth of up to 3 to 4 m (Hannan, 1999). At the end of October, the flood water starts to recede and by the end of December the entire area becomes dry, except for some natural deep pockets. A large number of people live in the *beel* area, whose livelihood, culture and daily activities are related and adapted to its aquatic environment. Boats are the main transport during monsoon, and fishing and snail harvesting is the main activity of the people, though a few are involved in rice cultivation in the dry season.

In the Chanda *beel*, snail collection first started in 1992. Of the sample group, 53.33% started snail collecting in 1992, 18.67% in 1993, 16% in 1994, 8% in 1995 and rest (4%) in or after 1996. It was estimated by the interviewees that more than 400 people are engaged in snail collection in this *beel* during the season (i.e. 27 people ha^{-1}), the main activity being the 4 months from June to October. On average, snail collectors are engaged for 5.43 hours (range 3 - 7 hours, median 5.5 hours) daily in their tasks. During the morning (dawn to 10 am) and late afternoon (2 to 5 pm), the snails float on submerged vegetation as well as on the surface of the water. During hot weather when there is strong sunshine, and during rainfall, the snails will drop from the surface and fall to the mud at the bottom.

The snails are collected using a triangular concave mesh attached to a short pole, used to scoop the snails off the surface. During the survey visit to the *beel*, hundreds of small boats (typical size 2 to 3 m length and 1 to 1.5 m width) were seen moving through the weeds and waters for snail harvesting. Each boat is operated by a single harvester. Collected snails are stored in the boats; when a boat is full with snails it heads towards assembly centres, of which there are 5 or 6 on the *beel*. Local *baperies* then carry snails to Bagerhat district using trawlers, trucks or boats and sell them to snail traders. From the survey, it was found that a snail collector harvests an average 22.3 kg (range 16 - 34 kg, median 21 kg) of snail daily during the season, earning an average TK 40 (US$ 0.8) (range Tk 25 - 65, median Tk 38). Respondents noted that earnings have decreased, due to declining availability of snails in the *beel* area. In addition, every year more and more people are involved in snail collection, as described by respondents:

- the snail harvesting technique is very easy, and only requires a boat (almost all have a boat that is common for monsoon transportation) and bamboo handled scoop net
- it is relatively easy to earn money with little investment or risk
- work loads in other activities are low during the monsoon, the peak season of snail harvesting
- fishermen are increasingly involved in snail harvesting due to declining numbers of small native fish in *beel* areas.

3.8.3 Processing of snail meat

Farmers noted that the snails are separated from their shells before feeding to prawns. Snail traders employ women and children as day labourers to do this. Processing involves breaking the operculum and removing the meat from the shells with a small curved knife. Day labourers involved in snail processing can earn around Tk 5 to 7 (US$ 0.1 to 0.15) per basket, each of which takes around one and half hours. Each basket of snails costs Tk 40 to 50 (US$ 0.8 to 1) (plus Tk 5 to 7 processing charge if required) and provides 8 to 10 kg of snail meat (average cost Tk 5 or US$ 0.1 kg^{-1}). The snails must be processed within two days of harvesting, or the meat begins to decay.

3.8.4 Use of snail shells

The intensive use of snail meat has generated a large amount of shells, which are discarded by the roadside, in the canals and any other place away from the processing locations or around the homesteads of farmers who process their own snails. In recent years, people have begun to collect and process the shells into lime, and snail shells have become increasingly popular in local lime factories. People in Bagerhat district now also process shells to use for poultry or fish feeds and fertiliser, for agriculture land or *ghers*. The local people also use snail shells as duck feed. According to the snail traders, the price of snail shells was Tk 8 to 10 (US$ 0.17 to 0.2) for a basket containing 15 kg (Tk 1.7 or US$ 0.03 kg^{-1}), which is sold to farmers and local lime factories. Khan (1998) noted that snail shells are a rich source of calcium carbonate, which enrich the soil and can meet the pre-breeding feed of aquatic animals, i.e. birds and their eggs.

3.8.5 Snail trading in local markets

One important snail market[16] was surveyed in each zone of the study area:

1) Haderhat market, Bagerhat Sadar
2) Faltita market, Fakirhat-Mollahat
3) Mativanga market, Chitalmari and
4) Khaserhat market, Kachua.

[16] Important markets were selected after discussion with farmers, local leaders and *Thana* Fisheries Officers, based on market history, number of traders and duration of trading season.

Snail trading is a seasonal business; for rest of the time the snail traders are involved in *gher* farming or other small businesses. During this period snail traders make their primary living buying and selling snails, using operating capital in the range of Tk 2,000 to 10,500 (US$ 42 to 219). There are 15 to 20 snail traders involved in each market except Faltita where there are more than 20. In addition a number of people is associated with the traders as day labourers.

Snail traders sell their snails or snail meat to the prawn farmers or via *foria* to the prawn farmers. Figure 3.5 shows the freshwater snail supply chain from collectors in *beel* areas to the prawn farmers in *gher* farming areas.

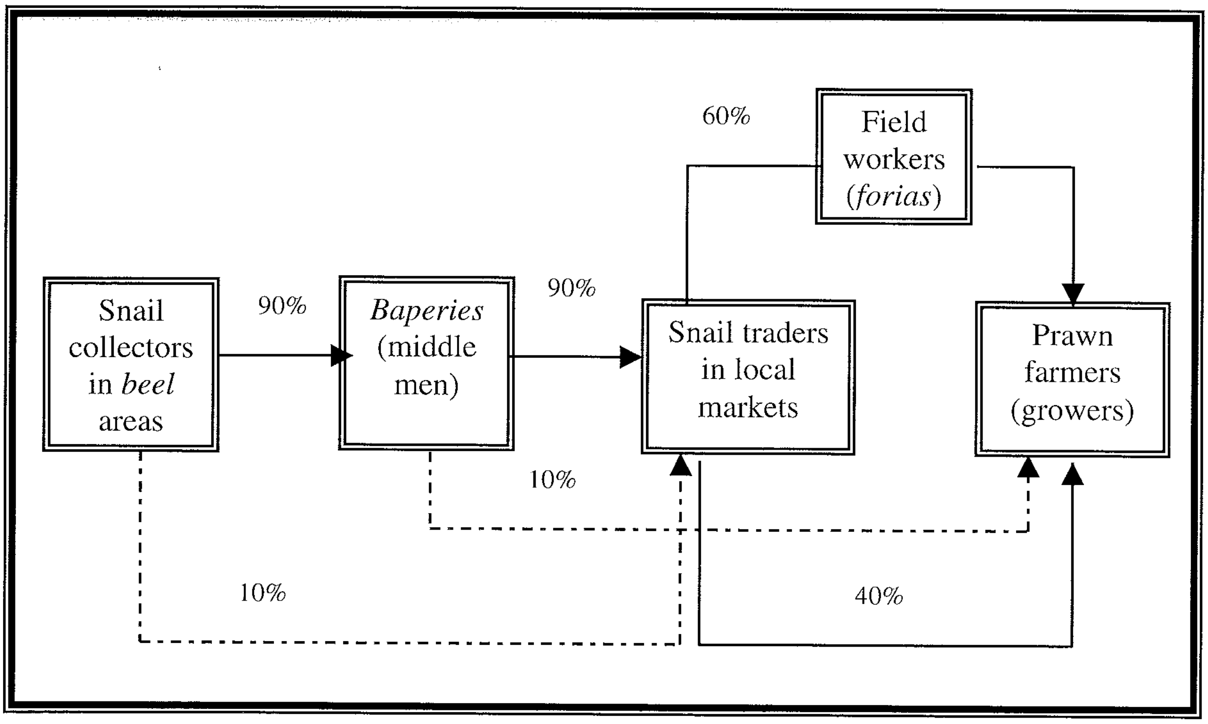

Figure 3.5 Freshwater snail supply chain from the Chanda *beel* of Gopalgonj district to the prawn farming areas in Bagerhat district (based on survey).

The snail traders sometimes sell their snails on credit to farmers. On the other hand, rich farmers may advance money to snail traders to ensure a regular supply of snail meat. However, the supplies of snail meat are irregular as the catch depends on weather conditions and has been subject to the considerable decrease of snail populations. The following paragraphs describe the comparative features of snail trading in the four different markets -

History of snail trading

According to the snail traders, snail trading first started at Faltita market in 1993, after which it spread throughout other markets of Bagerhat district. In Haderhat and Mativanga markets, snail trading first started in 1994 and Khaserhat market in 1995. Since then, snail trading has become profitable and has generated new employment. Before snail trading 14 (35%) of respondents had no job; of the rest 10 (25%), 12 (30%) and 4 (10%) were involved in agriculture, small business and *gher* farming respectively.

Season and time of snail trading

According to traders, the peak season of trading is from June to October, corresponding to the period when farmers grow prawn in their *gher*. Snail traders are engaged in snail trading from 6 to 10 am[17] at Haderhat market, 6 to 12 am at Faltita market, 6 to 11 am at Mativanga market and 6 to 10 am at Khaserhat market. Traders of Faltita and Mativanga markets work for longer because of the greater supply of snail from neighbouring

[17] Usually markets open from early morning (6 am) to evening (5 pm); however, snail traders sell their all snail or snail meat within a few hours due to limited supply.

districts. The numbers of snail traders, *baperies* and day labourers are also higher in these markets.

Quantities sold

During the season, traders in Faltita market sell an average 90 kg of snail meat daily (15 kg $hour^{-1}$), while an average 60.5 kg (15.13 kg $hour^{-1}$), 49 kg (12.25 kg $hour^{-1}$) and 48 kg (9.6 kg $hour^{-1}$) snail meat is sold by traders in Haderhat, Khaserhat, and Mativanga markets respectively. Faltita market traders sell more than other markets due to higher supply of snail from neighbouring districts. The number of farmers is also higher in the Fakirhat-Mollahat zone, served by the Faltita market, and therefore the demand of snail meat is higher.

Price of snail meat

According to the snail traders, the average price of snail meat varies from Tk 6 to 8 (US$ 0.13 to 0.17) kg^{-1} in the study area, with the highest in Faltita market (Tk 8 or US$ 0.17 kg^{-1}) and the lowest in Khaserhat market (Tk 6 or US$ 0.13 kg^{-1}). The average snail meat price was Tk 7 (US$ 0.15) kg^{-1} in both Haderhat and Mativanga markets. Snail traders pointed out that a few years ago (1994 - 95) the price of snail-meat was only Tk 2 to 3 (US$ 0.04 to 0.06) kg^{-1}, and its price has strongly increased (average 36% per year) due to decreased supply and continued demand.

Income of snail traders

The average net profit of snail traders is higher in Faltita than in the other markets, estimated at Tk 320 (US$ 6.7) day^{-1}, compared with Tk 173.50 (US$ 3.6), Tk 143 (US$ 3.0), and Tk 130 (US$ 2.7) in Haderhat, Mativanga and Khaserhat markets respectively. According to the survey, snail traders make an average net profit of Tk 3 (US$ 0.06) kg^{-1} of snail in the buying from *baperies* and selling to farmers. Most snail traders noted that they have improved their social and economic conditions as a result of snail trading, and have been able to spend money on improving their housing on better food, clothes, and children's education etc.

3.9 Export marketing of freshwater prawn

The freshwater prawn is a highly valued product for international markets, earning large amounts of foreign currency. Almost all prawns are therefore exported, particularly to the USA, Japan and Europe. In 1997, Bangladesh exported 25,742 t of prawns valued at US$ 246.94 million (US$ 9,593 t^{-1}) (FAO, 1999b).

3.9.1 Prawn trading in local markets

In local markets, prawn traders directly buy head-on prawns from farmers or through smaller traders (*forias*). Prawn traders are local small businessmen, or '*depot maliks*', normally based in local markets near to prawn farming areas. *Forias* carry head-on prawns (typically 25 to 30 kg day^{-1}) from remote villages to the prawn traders in market centres, and sometimes take small amounts of *dadon* credit from *depot maliks* to ensure the supply of prawns from farmers. *Forias* also often take temporary credit from the farmers, buying prawns one day and paying one or two days later.

From local markets, prawn traders supply these prawns directly, or via agents, to the processing companies within 1 or 2 days of purchase, during when they are held on ice. Consignments are sent once sufficient quantities have been obtained (average 225 kg day^{-1} $trader^{-1}$), though these quantities are determined by the credit available to the trader or agent. Trucks, pickups and microbuses are used to transport prawns to the processors. Bamboo containers with polythene covers are commonly used for keeping the prawns during the transport. Finally, companies export frozen headless prawns in individual or block frozen form by container to international markets through Mongla port (Figure 3.6).

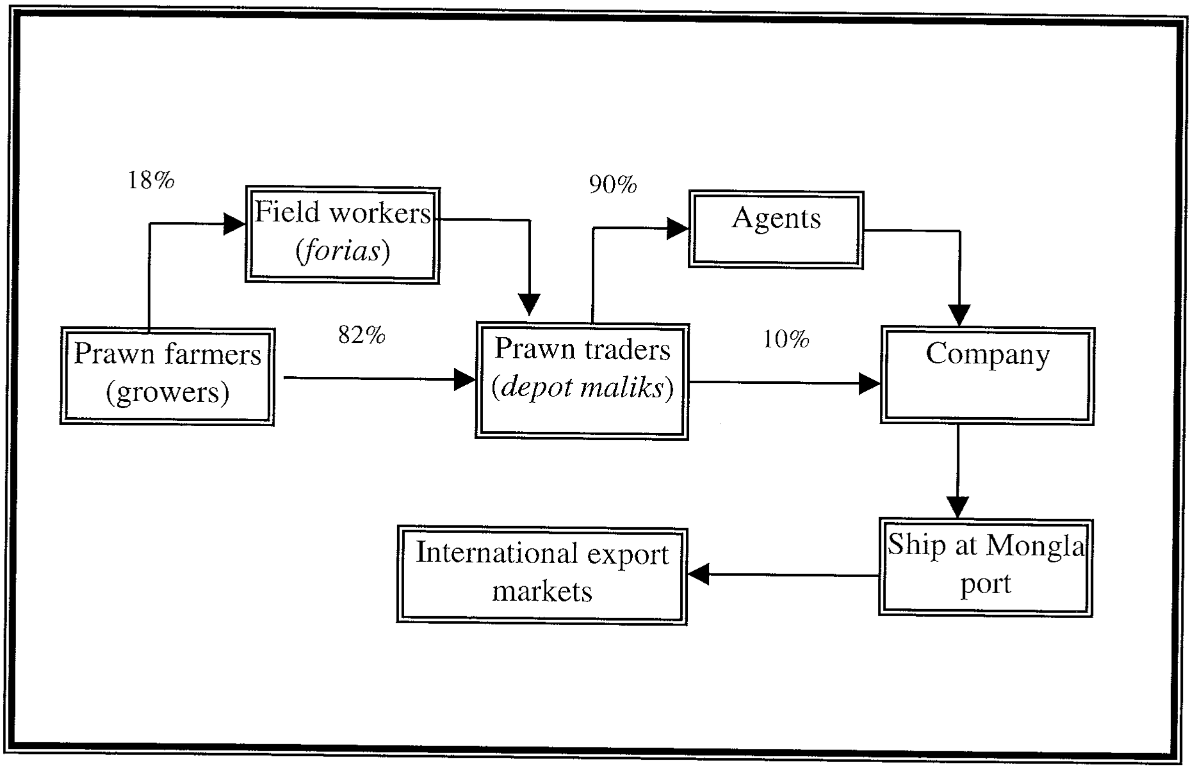

Figure 3.6 Freshwater prawn supply chain from Bagerhat prawn farmers to the international market (based on survey).

For the survey, one important prawn market of each zone were selected:

1) Baroipara market, Bagerhat Sadar
2) Faltita market, Fakirhat-Mollahat
3) Chitalmari market, Chitalmari and
4) Sinebord market, Kachua.

In each market around 15 to 20 individuals are associated with prawn trading, except for Faltita which is larger. Prawn trading is seasonal and traders are involved in fish trading, fry trading and other businesses during the rest of the year. According to the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.), prawn traders belong largely to the middle and upper class, as reflected in their access of capital, and most have been attracted by the particular opportunities to obtain high returns. Prawn traders pointed out that from Tk 100,000 to Tk 1 million (US$ 2,083 to 20,833) in cash transactions are conducted daily in each market during the peak marketing season. According to the prawn traders, large numbers of people involved as day labourers; their job is to carry ice from the ice factories in Bagerhat areas, break it up, mix ice with prawns, and load prawns on to the vehicles. The following paragraphs describe prawn trading in the four different markets of Bagerhat district -

History of prawn trading

According to respondents, prawn trading first started in 1991 at Faltita market, after which it spread throughout other markets of Bagerhat district. In Baroipara and Chitalmari markets, prawn trading first started in 1993 and in Sinebord market, in 1994.

Season and time of prawn trading

The peak season of prawn trading is from November to January. In Faltita market, trading is carried out from early morning (7 am) to evening (7 pm), while traders in the other three markets work from early morning to 2 pm. Traders in Faltita market work for longer because there is a greater supply of prawns, from the greater numbers of farmers in the Fakirhat-Mollahat zone which supplies to this market.

Supply of prawn

According to the survey, prawn traders in Faltita market supply an average 454 kg (range 300 - 625 kg, median 400 kg) of prawn daily to processors, while traders in Chitalmari, Baroipara and Sinebord markets supply an average of 187 kg (range 80 – 300 kg, median 160 kg), 170 kg (range 100 - 250 kg, median 155 kg) and 90 kg (range 50 - 150 kg, median 80 kg) respectively. From the above prawn supplies data, median numbers are lower than averages which indicate a large number of small traders are involved in these markets.

Price of prawn

The price of prawns depends on the quality as well as size and weight. Average prices of head-on prawns from local markets to the processing companies were estimated at Tk 382.5, Tk 312.5, Tk 262.5, Tk 222.5 and Tk 122.5 for grades 5, 10, 20, 30 and 50 respectively (Table 3.27). According to the prawn traders, the average price of prawn was lower in Faltita due to the shorter distance to processing companies, as a result of lower transport cost, while in Chitalmari and Sinebord was higher due to higher transport cost.

Table 3.27 The average prices of head-on prawns from local markets to the companies.

Grade	Average price in different markets ($Tk\ kg^{-1}$)				Total average	
	Baroipara	Faltita	Chitalmari	Sinebord	$Tk\ kg^{-1}$	$US\$\ kg^{-1}$
5	380	370	390	390	382.5	7.9
10	310	300	320	320	312.5	6.5
20	260	240	270	280	262.5	5.5
30	220	210	230	230	222.5	4.6
50	120	120	120	130	122.5	2.6

Source: From survey data (December 1998).

Income of prawn traders

The average net profit of prawn traders was higher in Faltita than in the other three markets primarily, because supply was higher. The average net profit of a prawn trader in Faltita market was estimated at Tk 3,632 (US\$ 75.7) day^{-1}, while those of traders in Baroipara, Chitalmari and Sinebord markets were Tk 1,496 (US\$ 31.2), Tk 1,360 (US\$ 28.3) and Tk 720 (US\$ 15.0) respectively. According to the survey, prawn traders make an average net profit of Tk 8 (US\$ 0.17) kg^{-1} of prawn in the buying from farmers and selling to processors. Although prawn traders can earn considerable amount of money in prawn trading, they spend a large portion for labour, transport cost, ice, and shop rent in market place.

3.9.2 Prawn processing and export

Around 44 companies are involved in processing and exporting of freshwater prawns from Mongla port to the international market (Khalek, 1999). Almost all are located in

Khulna district, some 30 km far from Bagerhat district. Three types of prawn products are sold: 1) block frozen whole 2) individual quick frozen (IQF) headless and 3) cooked frozen headless (ready to eat). The removal of the carapace and legs during processing leads to an average 45% decrease in weight. Process wastes are sold by the companies to local markets for human consumption at a price of Tk 8 to 10 (US$ 0.17 to 0.2) kg^{-1}. According to company managers, an average 500 to 600 contract workers are involved in a typical prawn processing company during the season (November to January). After processing, companies transport their prawns to Mongla port using their own refrigerated vehicles. Shipping agents load the prawns into freezer containers which are then loaded into ships destined for international markets. A standard container of 16,000 cubic ft contains about 16,000 to 18,000 kg of prawns. A typical company exports an average 4 to 5 t daily during the season. The average selling price of prawns varied from US$ 3.5 to 7 lb^{-1} (US$ 7.7 to 15.4 kg^{-1}) in 1998, depending on grade (Table 3.28), compared with the range of US$ 3.5 to 9 lb^{-1} (US$ 7.7 to 19.8 kg^{-1}) quoted by Borua (1996). This suggests that the export price of prawns has declined over recent years.

Table 3.28 Average price of IQF headless prawns from company to the international market.

Grade	No. of prawns lb^{-1}	Average price	
		US$ lb^{-1}	US$ kg^{-1}
U-5	Less than 5	7	15.4
5/7	5 - 7	6.5	14.3
8/12	8 - 12	6	13.2
13/15	13 - 15	5.5	12.1
16/20	16 - 20	5	11.0
21/25	21 - 25	4.5	9.9
26/30	26 - 30	4	8.8
31/50	31 - 50	3.5	7.7

Source: From export companies (December 1998).

3.9.3 Constraints in prawn marketing

Despite the potential of freshwater prawns delivery of benefits from successful commercialisation has been hindered due to number of factors. A major constraint at the farm level is that prawn farmers do not appear to understand the grading system or are likely to be misled. They are therefore likely to be disadvantaged in grading and in marketing. The lack of a common understanding of product requirements will not improve opportunities to raise and maintain quality. During the survey visits in local prawn markets, it was also observed that prawn traders did not use accurate weighing machines during grading, and did not maintain proper ratios of ice and prawns during handling, storage and transport. Prawn traders also noted that poor infrastructure facilities, especially transport, road, ice supplies etc. were major constraints for marketing. According to the company managers, labour unrest and political disturbances may also affect Mongla port during the prawn export period.

3.10 Role of women in prawn farming

3.10.1 Introduction

Rural society in Bangladesh is still characterised by traditional value systems, in which the position of men is hold to be superior to that of women (Morris, 1997). The social status of women, described as the place a woman occupies, and the dignity as well as privileges she enjoys in society (Mukherjee, 1972), is considered to be low within the family (Rahman and Sultana, 1999). Generally, household management in rural communities vests in the male head of the family, and female members of the family depend upon the earnings of men. As the main decision-makers in the family, almost all economic decisions are ordinarily done by men. In many if not most rural communities, the outside employment of women, especially Muslims, is not yet socially accepted, and the attitude of men discourages the participation of women in income generating activities. Both men and women are commonly reluctant to allow women to work with men.

There have, however, been more recent changes in the attitude of the people towards the role of women in various aspects of household decision making, household management, economic decision and income generating activities (King, 1989; Madhu, 1989), and a number of activities associated with the very new area of *gher* farming increasingly involve women. Almost all interviewed women (200) were involved in prawn farming activities in *gher* systems.

3.10.2 Prawn farming activities

According to Gupta (1990), "as an activity, aquaculture may bring benefits to farmers' families in the rural areas of Bangladesh, and may enhance the role of women in improving the quality of their families' lives". Although women in Bangladesh are not conspicuous in the formal industrial sector, their role in traditional prawn farming is quite significant. It was observed that the rapid development of this industry has provided employment opportunities for some women, and they are now able to contribute to household income. Some women interviewees in the study stated that at first their family members were not in favour of their participation in prawn farming. Now however, everyone realises the benefits, and wants to help. A large number of women work with men and help them in prawn farming, to earn more money and enhance their social and economic conditions. Women are involved in various facets of prawn farming, including collection of feed materials and preparation of feeds, *gher* construction, *gher* maintenance and post-harvest handling.

Job opportunities for women have also increased since prawn farming started. A school teacher (Abdul Jalil, Mollahat, pers. comm.) noted that migration of women has reduced due to economic changes brought about by prawn farming. In the past, women had to migrate to Khulna and Dhaka to seek jobs in garment manufacturing and fish processing industries, but more recently, they have returned to find work as wage labourers in *gher* farming activities.

Prawn farming activities of women at village level have enhanced their position in families. Almost all women interviewed noted that their position has improved due to such involvement. They now tend to play a stronger role in economic decisions for the management of their households, including those concerning education and careers of children, attending social functions, inviting guests, accepting family planning methods, attending religious functions, advising sons or daughters on selection of spouses, etc.

According to women interviewees who have *ghers*, all are directly or indirectly involved in prawn production as well as *gher* farming. The study reveals that their average daily involvement in prawn cultivation was 3.25 hours (2 to 5 hours), and women were engaged in prawn farming for an average of 31% of their total daily working hours.

Women noted that they would like to do more work in prawn farming due to its high economic return; however, it was not normally possible due to their household work obligations. The highest average daily working hours of women were found in Chitalmari zone (3.33 hours) followed by those of Fakirhat-Mollahat (3.27 hours), Bagerhat Sadar (3.26 hours) and Kachua (3.13 hours), though there was an insignificant difference ($P > 0.05$) between zones. Greater differences might have been expected as there are more Hindu families in Chitalmari and Fakirhat-Mollahat zones. From the survey, the highest percentage of Hindu women was found in Chitalmari (44%) followed by Fakirhat-Mollahat (38%), Kachua (30%) and Bagerhat Sadar (26%). During field visits, it was found that Hindu women were more active in prawn farming than Muslim women, as the latter face religious constraints.

Almost all interviewed women stated that prawn cultivation had increased their workload. Based on respondents descriptions, a woman's day typically begins with cleaning the house; from the morning until late at night she has to wash dishes and clothes, cook food, rear children, and carry out homestead gardening, poultry rearing, prawn farming and other agricultural work. The various roles of women in freshwater prawn farming are described as follows –

Feeding prawns

According to questionnaire responses, 96.5% of women in the study area were involved in making feed and feeding prawns. The highest percentage of women involved in this job were found in Fakirhat-Mollahat and Chitalmari zones (98%) followed by Kachua

(96%) and Bagerhat Sadar (94%), though differences between zones were insignificant ($P > 0.05$). Women stated that they were involved in making feed, feed processing and feeding the prawns in their *gher*. For home made prawn feed women mix rice bran, fishmeal, oil cake, and wheat flour etc., and also cook rice, which is widely used as a prawn feed. As earlier mentioned, snail meat is also a common prawn feed, and they are involved in breaking snail shells, extracting and mincing the snail meat and applying it in their *gher*. Some 7 (14%) women in Chitalmari zone also stated that they were involved in snail breaking as wage labour. During field visits, it was observed that the involvement of women in snail breaking was important in establishing their role in wage-earning employment. Men are generally involved in buying and transporting feed, although some Hindu women in Fakirhat area noted that they bought and transported prawn feed from Faltita market, which is half a mile to two miles distant from their houses.

Gher supervision and management

Of the total interviewed, 72% of women were involved in *gher* supervision and management. Only 28% could not do so due to heavy work, religious constraints or excessive distance of *ghers* from their houses. The highest percentages of women involved in *gher* activities in this job were found in Chitalmari zone (80%) followed by Fakirhat-Mollahat (74%), Bagerhat Sadar (68%) and Kachua (66%). There was a significant difference ($P < 0.05$) between zones. In general, women provided partial assistance in *gher* supervision and management, typically applying feed, lime and fertiliser. Most women said that they managed the *gher* regularly for two reasons: most routine operations such as fertilisation and feeding, could easily be managed by women, secondly, husbands were often busy in other work, away from the house for long hours, and hence the wife had to take the lead role in day-to-day operations.

Women are also involved in cleaning and re-excavating the channels of *ghers*, and some also manually irrigate the rice field in the *gher*. Most women who work in rice fields do so for their own household rather than for others, but in Chitalmari some women were found to transplant and weed rice as wage labourers. A key informant school teacher (Subul Das, pers. comm.) in Chitalmari stated that Hindu women were more prepared to work in the rice field than Muslim women. However, some Muslim women noted that they go out more now than they used to – which they themselves claimed to disapprove of, describing themselves as strict Muslims. Some interviewees stated that they worked as wage labourers building the embankments around *ghers* during the *gher* construction season. This work is done by both men and women; men load the clay and the women carry it on their heads. Women are also often involved in clearing the bottoms of *ghers* of aquatic weeds, and accumulated empty snail shells.

Harvesting of prawn

Of the respondents, 62% were involved in prawn harvesting, the rest (38%) found this work to be too heavy, or their *ghers* were too far from their houses. The highest percentages of women involved in prawn harvesting were in Fakirhat-Mollahat zone (68%) followed by Chitalmari (64%), Bagerhat Sadar (62%) and Kachua zone (54%). There was a significant difference ($P < 0.05$) between zones. Women help in catching the prawns and keeping them in aluminium containers or bamboo baskets during harvesting. After harvesting, women are also involved in sorting, grading and weighing of prawn for local markets. In general, sorting, grading and weighing of prawns is done in the house premises. Women also help in local marketing, especially where emergency harvests are required due to the threat of flood. In previous years, women have also exclusively been engaged in de-heading prawns at their house premises. However, in the year of the survey (1999) this was now done by in the premises of processing companies at the request of importers.

Women are also involved in fish harvesting from their *gher*. In several cases, daily harvest of fish for family consumption was done by women with the help of children. Husbands only helped when they were at home or when the *gher* water was too deep, requiring more specialised gear to be used for catching fish. A few women are involved in weaving of fishing nets, a traditional occupation of women. These nets are used for prawn harvesting and according to women, this has generated increased demand, increased prices of nets and has increased their earnings.

Working on dike crops

Prawn farmers are currently under utilising the potential for dike cropping on the walls of their *ghers*, partly because they lack knowledge of feasible options (Chapman, 1997). However, farmers are cultivating a variety of crops on a small scale, and dike cropping has been steadily increasing. As a result, local prices of common vegetables have dropped, with increased production. Dike crops are cultivated mainly for household consumption, though a few farmers sold their crops in local markets.

From the survey, it was found that 53.5% women were involved in dike cropping, the remainder either not cultivating the dike or not having their *gher* near enough to their houses. The highest percentage of women involved in dike cropping were found in Chitalmari zone (58%) followed by those of Fakirhat-Mollahat (56%), Bagerhat Sadar (52%) and Kachua (48%), with a significant difference ($P < 0.05$) between zones. In dike cultivation women are now involved in sowing crops, planting saplings, fertilisation, weeding, manual irrigation and harvesting. During the winter season, different types of crops such as carrot, tomato, onion, mustard, long yard bean etc. are produced, while crops produced in the summer season include potato, sweet gourd and other vegetables (Table 3.29).

Table 3.29 List of dike crops, vegetables and fruits.

English name	Scientific name	Culture season
Carrot	*Daucus carota*	Winter season (November to February)
Tomato	*Lycopersicon esculentum*	
Spinach	*Beta bengalensis*	
Onion	*Allium cepa*	
Cauliflower	*Brassica oleracea* var. botrytis	
Cabbage	*Brassica oleracea* var. capitata	
Pea	*Pisum sativum*	
Radish	*Raphanus sativus*	
Long yard bean	*Vigna sesquipedalis*	
Mustard	*Brassica napus*	
Potato	*Solanum tuberosum*	Summer season (March to June)
Ladies finger	*Hibiscus esculentus*	
Indian spinach	*Basella rubra*	
Cucumber	*Cucumis sativus*	
Chilli	*Capsicum esculentum*	
Sweet gourd	*Cucurbita moschata*	
Banana	*Musa paradisica*	Round the year
Papaya	*Carica papaya*	

Source: From survey data (September 1999).

Apart from these activities, a few women are also able to earn a cash income through working as brokers in fry trading, prawn trading and snail trading.

3.10.3 Constraints of women's participation

Many women appear to consider that they have benefited from *gher* development, with a big increase in opportunities for labouring and trading jobs. Almost all interviewed (98%) stated that their prawn-related cash income had given them some economic independence, raising their status in the family and in community. However, most of the Muslim women (76%) mentioned that they did not feel comfortable working in *ghers* due to their religious views. Some (5%) noted that they were sexually harassed by men and taunted by villagers who felt that Muslim women should not work away from home.

Others (15%) stated that they could not get proper wages in snail breaking or *gher* constructions, compared with their male counterparts.

According to CARE GOLDA Project staff, women in economically better-off families (middle or large farmers) were not allowed to work outside their households, while in poor families (small and marginal farmers) this was more evident. Almost all (96%) women noted that men generally did not like their wives to go to the market to work.

3.11 Environmental impact of prawn farming

3.11.1 Introduction

The development of *ghers* for prawn farming has brought about several environmental impacts. According to the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.), the major changes in the environment that have been noted include problems with decomposing snail meat, water pollution, damage of drainage systems etc. Environmental impacts associated with freshwater prawn farming are likely to occur in capture fisheries, agriculture, wetland flora and fauna including local snail population. Environmental impacts may arise from - 1) *gher* construction, 2) snail harvesting and 3) wild post-larvae collection. These are shown in Figure 3.7 and are discussed in turn, though quantitative and qualitative impacts require further assessment.

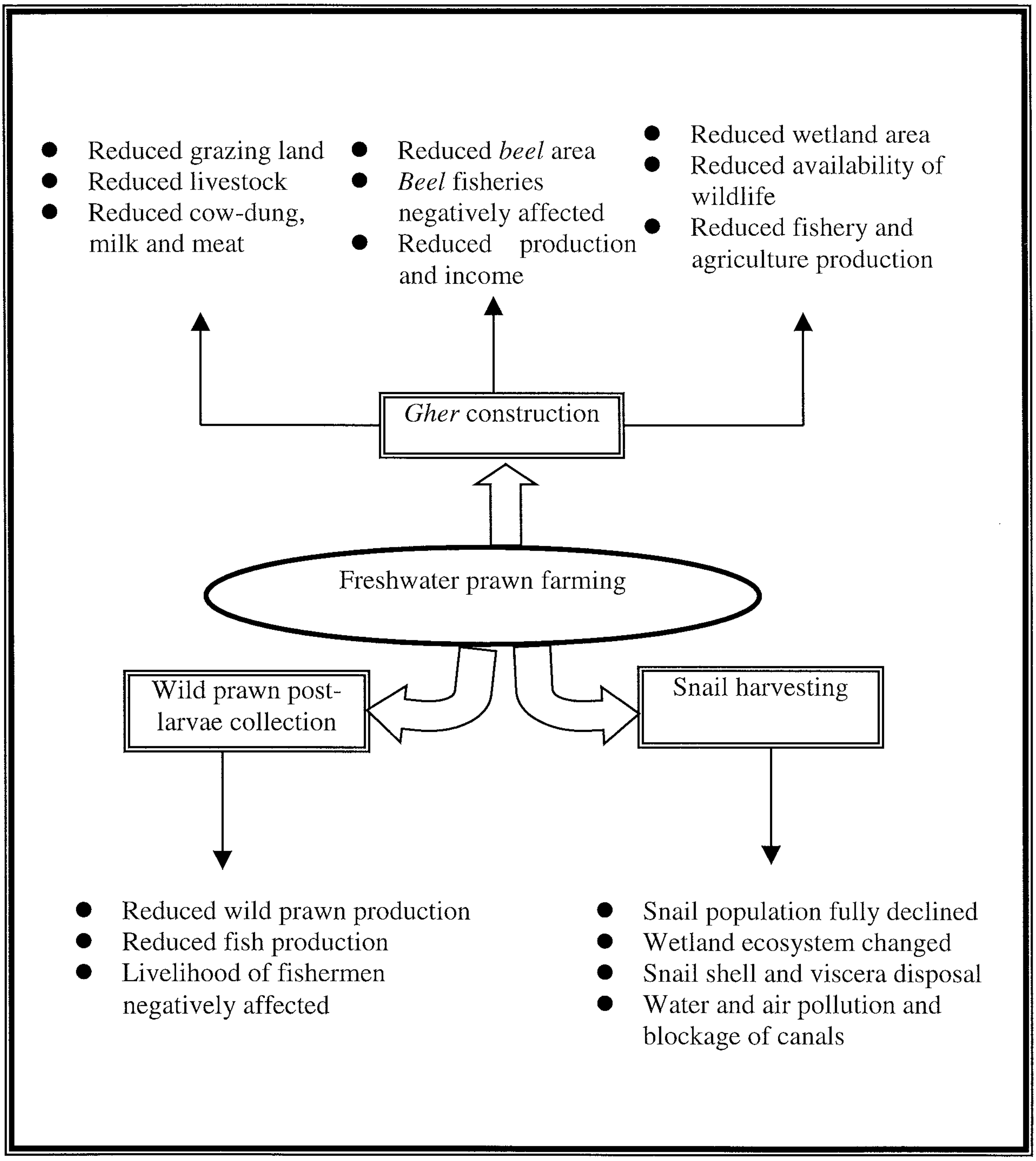

Figure 3.7 Environmental impact of freshwater prawn (*M. rosenbergii*) farming (developed from survey).

3.11.2 *Gher* construction

In the study area, large areas of wetland (*haor*, *baor* and *beels*) have been used for *gher* construction (CARE, 1997). According to key informants (Bagerhat *Thana* Fisheries Officers, NGO workers, and CARE GOLDA Project staff), the reduction in wetland areas associated with *gher* construction is likely to have negative impacts including reduced wetland biodiversity, reduced fish production, reduced wildlife, loss of local varieties of rice, loss of aquatic plants, decreased soil fertility, increased flood risks due to reduced area, and the near destruction of natural reservoirs. Agriculturists also noted that the reduction of wetland habitat negatively affected the population of the Indian bullfrog *Rana tigrina*. Nuruzzaman (1993) noted that *R. tigrina* play an important role in rice farming systems, regarded as the farmers friend, as they consume large quantities of insects. Rice production increases if bullfrogs are present in the rice fields (Chengjie, 1995).

The reduction in wetland habitat is also likely to have affected *beel* fisheries. According to fishermen, access to the fish resources in the *beel* has being restricted due to *gher* construction and therefore fish production as well as their income has reduced. Some community members stated that opportunities for raising ducks and other aquatic birds have decreased as a result of reduced access to *beel* and other open waters.

According to local people, construction of *ghers* has also resulted in a reduction of grazing land for livestock, especially cows and goats. They also noted that this land is an important habitat for wildlife, and so populations of livestock and wildlife have considerably decreased. Most of the local people also stated that rice production has fallen due to *gher* construction, and decreased rice production has meant decreased availability of paddy straw, used for both cooking fuel and as fodder for cattle. A school teacher (Abdul Jalil, Mollahat, pers. comm.) noted that as a result of decreasing cooking fuel and fodder, people began to collect branches and sticks for cooking, and leaves and grasses as fodder for their livestock, more intensively from the smaller remaining area of open *beel*. However, the impacts of this changing pressure could not be specified or quantified during the study.

3.11.3 Snail harvesting

According to key informants, the snail population has become extinct in most parts of Bagerhat district due to excessive harvesting during the monsoon when the peak season of their reproduction. As a result, snails are now harvested from *beel* and river areas from neighbouring districts. During field visits, it was observed that some canals had become blocked with snail waste and shells due to the use of snail meat as prawn feed. A school teacher (Subul Das, Chitalmari zone, pers. comm.) also noted that the canals have suffered from abuse and were neglected (i.e. not used for fishing or other purposes), as a result of the dumping of snail shells. A key informant (Md. Faridul Islam, Bagerhat Sadar *Thana* Fisheries Officer, pers. comm.) stated that the disposal of snail shells after the meat has been extracted poses environmental problem - the smell of rotting snails permeates the air, and the open waterways have become polluted.

3.11.4 Wild prawn post-larvae collection

As noted by fishermen, there have been significant decreases in *M. rosenbergii* catches in rivers in recent years. According to the Mongla *Thana* Fisheries Officer (Mr. Ronjit, pers. comm.), uncontrolled fishing of large freshwater prawns (210 to 250 mm in length) may pose a threat to their natural population. He also noted that large-scale collection of post-larvae is likely to affect the recruitment of other riverine species, which migrate to spawn at the same times as *M. rosenbergii.*

CHAPTER 4

FRESHWATER PRAWN PRODUCTION INTO *GHER* SYSTEMS: AN ECONOMIC ANALYSIS

4.1 Introduction

The objective of this chapter is to analyse the financial and economic features of *gher* systems. With suitable data and analysis it should be possible to evaluate the viability of investment, assess market potential, and determine the efficiency of resource allocation. There is time could lead to improvements of existing management practices, a better basis for evaluating new culture technology, and identify areas in which research success would have high potential payoffs.

4.2 Economic analysis

For the present study, data on production yield, costs and profitability of *gher* farming were collected to help clarify production costs of prawn and other crops and to assess their differences with zone and *gher* size. Specific objectives were:

i) to determine the costs and returns of *gher*,

ii) to find the cost contribution of the inputs,

iii) to determine the profitability of *gher* farming by *gher* size and zone.

The following elements were assessed:

i) Costs: including fixed and indirect operating costs, such as salary of staff[1], interest, and depreciation, which are usually independent of the level of production; and variable costs[2], such as seed, feed, fertiliser, labour, harvesting and marketing, and miscellaneous costs, which vary with outputs,

ii) Income: total production, total cost of production, gross revenue, net return, benefit-cost ratio (net return/ total cost), cost of input per unit of land (ha), cost of input per unit of output (kg), value of unit of output, and amount of output (kg) per unit of land (ha),

iii) Assessment of key factors affecting *gher* farming production.

Particular attention is directed to addressing such questions as: which inputs are significant in explaining variation in output from various zones or *gher* size categories? Are there economies of scale in *gher* production? Are farmers making optimal use of inputs? Are they technically and economically efficient? What constraints inhibit increased productivity and profitability of existing *gher* farming systems? Are there characteristics which make them more or less vulnerable?

It is essential to the development and management of a farm to know the production costs and their evolution, showing the main items on which the cost reduction is worth

[1] No staff were found in *gher* farming except security guards; however, a few technical persons visited *ghers* to examine water quality, disease etc. at the request of farmers and took fees for these success.
[2] Imputed opportunity costs of owned inputs, such as family labour and land use are not included.

effort. Production cost data also help the farmers in decision making and in adjusting to changes, and give the price level under which the product cannot be sold without losses. According to Bailly *et al.*, (1990) the production costs comprises all the expenses incurred during the production process. As Shang (1981) noted the major production costs in aquaculture are construction, feed, fertiliser, stocking materials, labour, water, marketing, and interest rates.

For economic analysis of *gher* farming, data were collected by using questionnaires. Primary data was obtained through personal interviews of prawn farmers, which were conducted to obtain information on resource used and the quantity of outputs (see Appendix 2, questionnaire for prawn farmer). As earlier mentioned, it was very difficult to obtain reliable financial data (i.e. costs, returns etc.) because most farmers did not have any proper notebooks of account. Even if some farmers provided financial data, this was based on their 'guess-work' which might not be accurate. Extra attention was therefore paid and great care had to be taken in compiling financial information by using different data collection methods (i.e. PRA, cross check interviews etc.).

4.3 The role of zone

4.3.1 Productivity of *gher* systems

Prawn productivity

According to the 400 prawn farmers, the average annual yield of prawn (head-on) was estimated at 432.6 kg ha^{-1} (range 220 – 650, median 425 kg ha^{-1}) in 1998. As Table 4.1 shows, the highest average prawn production per ha *gher* was found in Fakirhat-

Mollahat (453.9 kg ha^{-1}) followed by those of Bagerhat Sadar (440.1 kg ha^{-1}), Chitalmari (430.4 kg ha^{-1}) and Kachua (406.1 kg ha^{-1}). There was a significant difference ($P < 0.05$) of prawn yield in different zones, because of the differences of farm size, feed and seed inputs and management skill. Farmers in Fakirhat-Mollahat produced more prawn due to higher input of feed especially snail meat, larger *gher* size and longer experience of prawn farming than others.

Table 4.1 Average prawn yield (kg ha^{-1}) by zone in 1998 (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Prawn production (kg ha^{-1})	440.1 (102)	453.9 (105)	430.4 (99)	406.1 (94)	432.6 (100)	80.9

SD: Standard deviation

During field visits, it could be seen that a number of interdependent factors affected growth rate and productivity, including stocking rate, the quality and quantity of feed supply, water quality, and other aspects of *gher* management. The size of prawn at stocking, the duration of culture and the size at which the prawn are harvested also influence total yield. These levels suggest that the average productivity of prawn has increased in the study area over recent years. In 1996, Bagerhat District Fisheries Office estimated actual yields to vary between 150 and 350 kg ha^{-1} (DFO, 1998), while Hoq *et al.*, (1996) reported that prawn productivity varied from 162 to 428 kg ha^{-1} in Bangladesh after 10 months rearing with fish.

Of the total (400) prawn farmers interviewed, 245 (61.25%) stated that they were satisfied with prawn productivity in their *gher*. Of the 155 (38.75%) who were not satisfied, 66 (42.58%) mentioned the lack of post-larvae as a production constraint, while 59 (38.06%), 11 (7.10%), 10 (6.45%), and 9 (5.81%) identified lack of money, poor supply of snail meat, poor water quality and flood to have caused poor prawn productivity respectively.

Responses concerning the reasons for increased prawn productivity included an increased supply of quality fry, technical support in prawn cultivation, cheap cost of feed, the production of feed from local materials, cheap snails, reduced mortality of prawn, availability of credit etc.

Fish productivity

According to farmers (388) who produce fish in their *gher*, the average fish productivity was 392.2 kg ha^{-1} (range 175 – 600, median 380 kg ha^{-1}) in 1998. This was found to vary from one zone to another because of the differences, for example, in management skill, inputs and farm size. Farmers in Fakirhat-Mollahat and Chitalmari produced an average 429.9 and 400.5 kg ha^{-1} respectively, but farmers in Bagerhat Sadar and Kachua produced an average 380 and 358.2 kg ha^{-1} respectively (Table 4.2). There was a significant difference ($P < 0.05$) of fish productivity in different zones.

Table 4.2 Average fish productivity (kg ha^{-1}) by zone in 1998 (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Fish production (kg ha^{-1})	380.0 (97)	429.9 (110)	400.5 (102)	358.2 (91)	392.2 (100)	57.6

SD: Standard deviation

Rice productivity

In the study area, total rice production has probably decreased as a result of widespread conversion of rice fields into *ghers*. However, at the farm level, many farmers reported increased rice productivity as a result of *gher* construction, as the *gher's* dikes now keep fully saline water out of their fields. According to farmers (349) who produce rice in their *gher*, the average rice productivity was estimated at 2,352.1 kg ha^{-1} (range 1,050 – 4,200, median 2,200 kg ha^{-1}) in 1998. As Table 4.3 shows, the highest average rice production per ha *gher* was found in Chitalmari zone (2,586.6 kg ha^{-1}) followed by Kachua (2,327.2 kg ha^{-1}), Bagerhat Sadar (2,263.3 kg ha^{-1}), and Fakirhat-Mollahat (2,233.1 kg ha^{-1}). It is noted that productivity of rice in *gher* was estimated including the area of canal and water for prawn farming and so actual yields will be higher typically by 20 to 25%. The chi-square test shows significant difference ($P < 0.05$) of rice productivity in different zones, because of the differences of soil fertility, saline water intrusion, inputs and management skill.

Table 4.3 Average rice productivity (kg ha^{-1}) by zone in 1998 (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Rice production (kg ha^{-1})	2,263.3 (96)	2,233.1 (94)	2,586.6 (110)	2,327.2 (99)	2,352.1 (100)	673.3

SD: Standard deviation

4.3.2 Cost structure

Costs per ha

As Table 4.4 shows, total costs of *gher* farming of all sample farmers averaged Tk 69,826 (US$ 1,455) ha^{-1} (range Tk 45,720 – 91,525, median Tk 68,505 ha^{-1}), varying from Tk 64,049 (US$ 1,334) ha^{-1} in Kachua to Tk 69,903 (US$ 1,456) ha^{-1} in Chitalmari, Tk 70,421 (US$ 1,467) ha^{-1} in Bagerhat Sadar and Tk 74,809 (US$ 1,559) ha^{-1} in Fakirhat-Mollahat, with variable costs and fixed costs estimated at Tk 58,698 (US$ 1,223) ha^{-1} and Tk 11,128 (US$ 232) ha^{-1} respectively. Variable costs averaged 84.1% of total costs, varying from 83.5% in Fakirhat-Mollahat to 83.9% in Bagerhat Sadar, 84.2% in Kachua and 84.7% in Chitalmari. Within these, feed and seed dominated all other costs averaging 71.5% of total costs (85% of variable costs) varying from 70.4% in Bagerhat Sadar to 70.7% in Fakirhat-Mollahat, 72.1% in Chitalmari and 72.7% in Kachua. Cost of fertiliser averaged 1.2% of total costs, varying from 1.11% in Kachua to 1.14% in Chitalmari, 1.24% in Fakirhat-Mollahat and 1.27% in Bagerhat Sadar. The costs of labour, harvesting and marketing, and rice cultivation averaged 1.5%, 0.9% and 7.9% of total costs respectively. Fixed costs averaged 15.9% of the total costs, varying from 15.3% in Chitalmari to 15.8% in Kachua, 16.1% in Bagerhat Sadar and 16.5% in Fakirhat-Mollahat. The costs of staff inputs, interest and depreciation averaged 5.0%, 8.2% and 2.8% of total costs respectively.

Table 4.4 Variable and fixed costs per ha of sampled *gher* and their share in the zones.

Cost items	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Seed (prawn and fish)	28092.1 (39.9)	27988.1 (37.4)	26873.3 (38.4)	25563.0 (39.9)	27118.8 (38.8)	3993.4
Feed	21451 (30.5)	24906.6 (33.3)	23574.3 (33.7)	20985.5 (32.8)	22770.4 (32.6)	4554.7
Fertiliser	895.4 (1.27)	926.3 (1.24)	798 (1.14)	712.5 (1.11)	833.1 (1.2)	284.9
Labour	1425 (2.0)	1187.5 (1.6)	950 (1.4)	593.8 (0.9)	1039.1 (1.5)	312.7
Harvesting and marketing	950 (1.4)	712.5 (1.0)	475 (0.7)	356.25 (0.6)	623.44 (0.9)	213.9
Rice cultivation	5329.6 (7.6)	5956.2 (8.0)	5782.8 (8.3)	5072.2 (7.9)	5532.7 (7.9)	718.1
Miscellaneous	957.1 (1.4)	817 (1.1)	745.8 (1.1)	634.1 (1.0)	780.5 (1.1)	278.4
Total Variable Cost (TVC)	59100.2 (83.9)	62494.1 (83.5)	59199.2 (84.7)	53917.3 (84.2)	58697.9 (84.1)	10365.4
Management staff salary (a)	3552 (5.0)	3975 (5.3)	3288 (4.7)	3076 (4.8)	3482.75 (5.0)	954.3
Interest	5724 (8.1)	6075 (8.1)	5572 (8.0)	5420 (8.5)	5696.8 (8.2)	1543
Depreciation (b)	2045 (2.9)	2265 (3.0)	1844 (2.6)	1636 (2.6)	1948.5 (2.8)	586.3
Total Fixed Cost (TFC)	11321 (16.1)	12315 (16.5)	10704 (15.3)	10132 (15.8)	11128 (15.9)	2065
Total Cost (TC)	70421.2 (100)	74809.1 (100)	69903.2 (100)	64049.3 (100)	69825.9 (100)	13803.1

Parenthesises indicate as a percent of each zone
(a): Include guard salary
(b): Derived from initial cost based on the economic life of each item.

Almost all interviewed farmers (400) said that the production costs had increased notably over recent years. In response to question about how the costs of *gher* farming could be reduced, key factors stated were the supply of quality fry and snail meat and the use of home made or cheap locally produced compound feed.

There is little difference in the major input costs per ha of *gher* between zones. As reported in Table 4.5, farmers in both Bagerhat Sadar and Kachua paid 3% more than the average for seed, while their counterparts in Fakirhat-Mollahat and Chitalmari paid 4% and 1% less than the average respectively. In Chitalmari and Fakirhat-Mollahat, farmers paid 3% and 2% more than the average for feed respectively, while Bagerhat Sadar paid 6% less than the average. Cost for rice cultivation is also 4% higher than the average in Chitalmari, but 4% less than the average in Bagerhat Sadar.

Table 4.5 Percentage of total costs per ha by major groups of input in the different zones (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Seed	39.9 (103)	37.4 (96)	38.4 (99)	39.9 (103)	38.8 (100)	2.2
Feed	30.5 (94)	33.3 (102)	33.7 (103)	32.8 (100)	32.6 (100)	2.5
Rice cultivation	7.6 (96)	7.9 (100)	8.3 (104)	7.9 (100)	7.9 (100)	0.6

SD: Standard deviation

As Table 4.6 shows, total production costs (Tk ha^{-1}) of *gher* farming in Fakirhat-Mollahat and Bagerhat Sadar is 7% and 1% higher than average respectively, but in Kachua it is lower 8% than the average, while Chitalmari was at the average level. Average prawn production costs were estimated at Tk 61,584 (US$ 1,283) ha^{-1} (range Tk 41,132 – 79,853, median Tk 60,520 ha^{-1}), while the average fish and rice production costs were estimated at Tk 2,709 (US$ 57) ha^{-1} (range Tk 1,332 – 4,345, median Tk 2,570 ha^{-1}) and Tk 5,533 (US$ 115) ha^{-1} (range Tk 3,255 – 7,343, median Tk 5,420 ha^{-1}) respectively. Prawn production costs are mainly associated with prawn fry, feed, fertiliser, labour and harvesting and marketing cost, while the main fish production costs are fish fry, labour and miscellaneous cost, and the main production cost elements for rice include seed/seedling, fertiliser, pesticide, labour and cost of irrigation.

Table 4.6 Total production costs (Tk ha^{-1}) of prawn, fish and rice by zone (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Prawn	62329 (101)	66075 (107)	61394 (100)	56387 (92)	61584 (100)	11946
Fish	2763 (102)	2778 (103)	2727 (101)	2590 (95)	2709 (100)	578
Rice	5330 (96)	5956 (108)	5783 (104)	5072 (92)	5533 (100)	718
Total cost	70421 (101)	74809 (107)	69903 (100)	64049 (92)	69826 (100)	13803

SD: Standard deviation

As presented in Table 4.6, prawn, fish and rice production costs (Tk ha^{-1}) in Fakirhat-Mollahat are 7%, 3% and 8% higher than average respectively, but in Kachua it is 8%, 5% and 8% less than average respectively. In Bagerhat Sadar, prawn and fish production costs (Tk ha^{-1}) is higher 1% and 2% than the average respectively, but rice production costs are 4% less than the average. However in Chitalmari, rice production costs (Tk ha^{-1}) are 4% higher than average.

Costs per kg

As Table 4.7 shows, the average costs per kg of prawn, fish and rice production were Tk 142.4 (US$ 2.97) kg^{-1} (range Tk 125 – 175, median Tk 140 kg^{-1}), Tk 6.9 (US$ 0.14) kg^{-1} (range Tk 5.5 – 7.5 and median Tk 6.75 kg^{-1}), and Tk 2.4 (US$ 0.05) kg^{-1} (range Tk 2.2

– 2.9 and median Tk 2.4 kg^{-1}) respectively. The cost per kg of prawn production in Fakirhat-Mollahat is higher than in the other three zones, at Tk 145.6 (US$ 3.03) kg^{-1} followed by Chitalmari at Tk 142.7 (US$ 2.97) kg^{-1}, Bagerhat Sadar at Tk 141.6 (US$ 2.95) kg^{-1} and Kachua at Tk 138.8 (US$ 2.89) kg^{-1}, there being no significant difference ($P > 0.05$) between zones. The cost per kg of fish production in Bagerhat Sadar is higher than other three zones, at Tk 7.3 (US$ 0.15) kg^{-1} followed by Kachua at Tk 7.2 (US$ 0.15) kg^{-1}, Chitalmari at Tk 6.8 (US$ 0.14) kg^{-1} and Fakirhat-Mollahat at Tk 6.5 (US$ 0.13) kg^{-1}. The highest cost per kg of rice production in Fakirhat-Mollahat at Tk 2.7 (US$ 0.06) kg^{-1} and the lowest in Kachua at Tk 2.2 (US$ 0.04) kg^{-1}.

Table 4.7 Total production costs (Tk kg^{-1}) of prawn, fish and rice by zone (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Prawn	141.6 (99)	145.6 (102)	142.7 (100)	138.8 (98)	142.4 (100)	42.4
Fish	7.3 (105)	6.5 (93)	6.8 (98)	7.2 (104)	6.9 (100)	2.5
Rice	2.4 (100)	2.7 (112)	2.3 (96)	2.2 (92)	2.4 (100)	0.9

SD: Standard deviation

4.3.3 Profitability

Profitability per ha

The profitability per ha of *gher* farming was defined by the following measures:

- Net return, defined as gross revenue minus total costs. The gross or total revenue is total product or output multiplied by the market price of output.

- Benefit-cost ratio or profitability index, defined as net return for the *gher* divided by total costs.

- Rate of farm income, defined as net return divided by gross revenue, times 100. The larger the rate of farm income, the greater the production efficiency.

As Table 4.8 shows, total net return per ha of *gher* averaged Tk 76,856 (US$ 1,601) (range Tk 52,552 - 94,756, median Tk 75,507 ha^{-1}). Despite a higher costs per ha, the net return is higher in Fakirhat-Mollahat at Tk 78,445 (US$ 1,634) ha^{-1} compared with Tk 77,971 (US$ 1,624) ha^{-1} in Bagerhat Sadar, Tk 77,257 (US$ 1,609) ha^{-1} in Chitalmari and Tk 73,900 (US$ 1,540) ha^{-1} in Kachua. Comparing the four zones, Kachua produced at least cost having lower production, therefore having a lower net return. In Fakirhat-Mollahat, Bagerhat Sadar and Chitalmari, the net return (Tk ha^{-1}) of *gher* farming is 2%, 1% and 1% higher than average respectively, but in Kachua it is 4% less than average. There is no significant difference ($P > 0.05$) of net return in different zones. Almost all (100%) interviewed farmers stated that their returns had decreased as costs of *gher* farming had increased significantly while the price of prawns has not increased to a similar degree.

Table 4.8 Costs and return (Tk ha^{-1}) of *gher* farming in different zones (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Gross revenue	148392 (101)	153254 (104)	147160 (100)	137950 (94)	146682 (100)	27598
Total cost	70421 (101)	74809 (107)	69903 (100)	64049 (92)	69826 (100)	13803
Net return	77971 (101)	78445 (102)	77257 (101)	73900 (96)	76856 (100)	15908
Rate of income (%)	53 (100)	51 (98)	52 (100)	54 (102)	52 (100)	3.5
Benefit-cost ratio	1.11 (101)	1.05 (95)	1.11 (101)	1.15 (104)	1.1 (100)	0.08

SD: Standard deviation

The average rate of income for *gher* farming is 52%, the highest 54% for Kachua and the lowest 51% for Fakirhat-Mollahat. There is little difference of income rate between the zones. The average benefit-cost ratio per ha *gher* is found at 1.1. The benefit-cost ratio in Kachua is higher than elsewhere, at 1.15 compared with 1.11 both in Bagerhat Sadar and Chitalmari and 1.05 in Fakirhat-Mollahat.

The net return of prawn production averaged Tk 57,812 (US$ 1,204) ha^{-1} (range Tk 40,571 – 69,232, median Tk 56,542 ha^{-1}), while that of fish and rice production averaged Tk 9,655 (US$ 201) ha^{-1} (range Tk 6,420 – 13,210 and median Tk 9,562 ha^{-1}) and Tk 9,398 (US$ 196) ha^{-1} (range Tk 5,561 – 12,320 and median 9,403 ha^{-1}) respectively (Table 4.9, 4.10 and 4.11). The following paragraphs address profitability of prawn, fish and rice per ha in different zones:

1) Profitability of prawn per ha

Despite a higher prawn production cost per ha, the net return per unit of *gher* is higher in

Fakirhat-Mollahat at Tk 60,246 (US$ 1,255) ha^{-1} compared with Tk 59,079 (US$ 1,231) ha^{-1} in Bagerhat Sadar, Tk 56,615 (US$ 1,179) ha^{-1} in Chitalmari and Tk 55,451 (US$ 1,155) ha^{-1} in Kachua (Table 4.9). The highest rate of income and benefit-cost ratio is found in Kachua at 50% and 0.98 respectively, the lowest income rate is in both Fakirhat-Mollahat and Chitalmari at 48% and the lowest benefit-cost ratio is found in Fakirhat-Mollahat at 0.91.

Table 4.9 Costs and return (Tk ha^{-1}) of prawn production in different zones (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Gross revenue	121408 (102)	126322 (106)	118009 (99)	111839 (94)	119396 (100)	23856
Total cost	62329 (101)	66075 (107)	61394 (100)	56387 (92)	61584 (100)	11946
Net return	59079 (102)	60246 (104)	56615 (98)	55451 (96)	57812 (100)	12099
Rate of income (%)	49 (100)	48 (98)	48 (98)	50 (102)	48 (100)	1.84
Benefit-cost ratio	0.95 (101)	0.91 (97)	0.92 (98)	0.98 (105)	0.94 (100)	0.04

SD: Standard deviation

2) Profitability of fish per ha

As Table 4.10 shows, despite a higher fish production cost per ha, the net return per unit of *gher* is higher in Fakirhat-Mollahat at Tk 11,537 (US$ 240) ha^{-1} compared with Chitalmari at Tk 10,291 (US$ 214) ha^{-1}, Bagerhat Sadar at Tk 8,605 (US$ 179) ha^{-1} and Kachua at Tk 8,168 (US$ 170) ha^{-1}. The highest income rate and benefit-cost ratio is found in Fakirhat-Mollahat at 81% and 4.15 respectively, the lowest income rate in both Bagerhat Sadar and Kachua at 76%, and the lowest benefit-cost ratio is found in Bagerhat Sadar at 3.11.

Table 4.10 Costs and return (Tk ha^{-1}) of fish production in different zones (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Gross revenue	11368 (92)	14314 (116)	13018 (105)	10758 (87)	12365 (100)	2800
Total cost	2763 (102)	2778 (103)	2727 (101)	2590 (95)	2709 (100)	578
Net return	8605 (89)	11537 (119)	10291 (107)	8168 (85)	9655 (100)	2158
Rate of income (%)	76 (97)	81 (104)	79 (101)	76 (97)	78 (100)	2.4
Benefit-cost ratio	3.11 (87)	4.15 (117)	3.77 (106)	3.15 (89)	3.56 (100)	0.4

SD: Standard deviation

3) Profitability of rice per ha

The highest net return per ha *gher* of rice production is found in Chitalmari at Tk 10,351 (US$ 216) followed by Bagerhat Sadar at Tk 10,287 (US$ 214), Kachua at Tk 10,281 (US$ 214) and Fakirhat-Mollahat at Tk 6,662 (US$ 139) (Table 4.11). The highest income rate and benefit-cost ratio is found in Kachua at 67% and 2.02 respectively, the lowest in Fakirhat-Mollahat at 53% and 1.12 respectively.

Table 4.11 Costs and return (Tk ha^{-1}) of rice production in different zones (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Gross revenue	15616 (105)	12618 (85)	16133 (108)	15353 (103)	14930 (100)	1774
Total cost	5330 (96)	5956 (108)	5783 (104)	5072 (92)	5533 (100)	718
Net return	10287 (109)	6662 (71)	10351 (110)	10281 (109)	9398 (100)	1286
Rate of income (%)	66 (106)	53 (85)	64 (102)	67 (106)	63 (100)	5.53
Benefit-cost ratio	1.93 (114)	1.12 (66)	1.79 (105)	2.02 (119)	1.7 (100)	0.41

SD: Standard deviation

Profitability per kg

As Table 4.12 shows, the average net return from prawn, fish and rice is found at Tk 133.6 (US$ 2.8) kg^{-1} (range Tk 110 – 156.5, median Tk 130.5 kg^{-1}), Tk 24.6 (US$ 0.5) kg^{-1} (range Tk 18.5 – 32.7, median Tk 22.5 kg^{-1}) and Tk 4.0 (US$ 0.08) kg^{-1} (range Tk 2.5 – 5.75, median Tk 3.95 kg^{-1}) respectively in the study area. The net return per kg of prawn production in Kachua is higher than other three zones, at Tk 136.5 (US$ 2.84) kg^{-1} followed by Bagerhat Sadar with Tk 134.2 (US$ 2.79) kg^{-1}, Fakirhat-Mollahat Tk 132.7 (US$ 2.76) kg^{-1} and Chitalmari Tk 131.6 (US$ 2.74) kg^{-1}. The highest net return (Tk kg^{-1}) of fish and rice production is found in Fakirhat-Mollahat and Bagerhat Sadar at Tk 26.8 (US$ 0.56) kg^{-1} and Tk 4.6 (US$ 0.09) kg^{-1} respectively, and the lowest in Bagerhat Sadar and Fakirhat-Mollahat at Tk 22.7 (US$ 0.47) kg^{-1} and Tk 3.0 (US$ 0.06) kg^{-1} respectively.

Table 4.12 Net return (Tk kg^{-1}) of prawn, fish and rice production in different zones (% of mean in brackets).

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
					Mean	SD
Prawn	134.2 (100)	132.7 (99)	131.6 (98)	136.5 (102)	133.6 (100)	49.57
Fish	22.7 (92)	26.8 (109)	25.7 (104)	22.8 (93)	24.6 (100)	8.9
Rice	4.6 (114)	3.0 (75)	4.0 (100)	4.4 (111)	4.0 (100)	1.3

SD: Standard deviation

4.4 The role of *gher* size

4.4.1 Productivity of *gher* systems

Prawn productivity

As Table 4.13 shows, *gher* size appears to have a great influence on prawn productivity, the average (kg ha^{-1}) being found to increase with increased *gher* size. In the largest *gher* size category (> 0.61 ha), productivity of prawn (kg ha^{-1}) is higher than the average (+11%), but in the smallest *gher* size category (< 0.21 ha) it is less than the average (-11%). There was a significant difference ($P < 0.05$) in productivity with *gher* size, the correlation estimated at 0.70, statistically significant at 0.001 level.

Table 4.13 Average prawn productivity (kg ha^{-1}) by *gher* size (% of mean in brackets).

***Gher* size categories**	**< 0.21 ha**	**0.21 - 0.4 ha**	**0.41 - 0.61 ha**	**> 0.61 ha**	**Total**	
	Mean	Mean	Mean	Mean	Mean	SD
Prawn production (kg ha^{-1})	386.7 (89)	412.2 (95)	453.3 (105)	478.4 (111)	432.6 (100)	80.9

SD: Standard deviation

Fish productivity

As shown in Table 4.14, *gher* size also appears to have much influence on fish productivity. In the largest *gher* size category (> 0.61 ha), the productivity (kg ha^{-1}) of fish is higher than the average (+9%), but in the smallest *gher* size category (< 0.21 ha), it is less than the average (-11%). There was a significant relationship ($P < 0.05$) in productivity with *gher* size, the correlation estimated at 0.42, statistically significant at 0.001 level.

Table 4.14 Average fish productivity (kg ha^{-1}) by *gher* size (% of mean in brackets).

***Gher* size categories**	**< 0.21 ha**	**0.21 - 0.4 ha**	**0.41 - 0.61 ha**	**> 0.61 ha**	**Total**	
	Mean	Mean	Mean	Mean	Mean	SD
Fish production (kg ha^{-1})	348.9 (89)	383.3 (98)	407.9 (104)	428.4 (109)	392.2 (100)	57.6

SD: Standard deviation

Rice productivity

Similarly, *gher* size appears to influence rice productivity, as shown in Table 4.15. The highest average levels (kg ha^{-1}) was found in the largest *gher* size category (> 0.61 ha) at 2,622.1 kg ha^{-1}, whereas the lowest was found in 0.21 - 0.4 ha *gher* size category at 2,117.6 kg ha^{-1}. There was little association between rice productivity and *gher* size, the correlation estimated at 0.16, statistically significant at 0.01 level.

Table 4.15 Average rice productivity (kg ha^{-1}) by *gher* size (% of mean in brackets).

***Gher* size categories**	**< 0.21 ha**	**0.21 - 0.4 ha**	**0.41 - 0.61 ha**	**> 0.61 ha**	**Total**	
	Mean	Mean	Mean	Mean	Mean	SD
Rice production (kg ha^{-1})	2179.8 (93)	2117.6 (90)	2490.7 (106)	2622.1 (111)	2352.1 (100)	673.3

SD: Standard deviation

4.4.2 Cost structure

Costs per ha

As Table 4.16 shows, total production costs averaged Tk 69,826 (US$ 1,455) ha^{-1}, varying from Tk 63,604 (US$ 1,325) ha^{-1} in the *gher* size < 0.21 ha to Tk 76,807 (US$ 1,600) ha^{-1} in the *gher* size > 0.61 ha. Total costs per area increased significantly with size of *gher*. The major operating costs per area including seed, feed, fertiliser, labour, harvesting and marketing, all increase with *gher* size. However, the percent of total variable costs is found to decrease and total fixed costs to increase with increasing *gher* size. On average, the percentage of seed cost was highest (40.7%) in the smallest group (< 0.21 ha), but percentage of feed cost was highest (33.1%) in the 0.41 – 0.61 ha *gher* size. Fixed cost (Tk ha^{-1}) was the highest in the largest *gher* size (> 0.61 ha) category apparently due to higher cost of management staff salary, interest and depreciation.

Table 4.16 Variable and fixed costs per ha by *gher* size.

Cost items	< 0.21 ha	0.21 - 0.4 ha	0.4 1- 0.61 ha	> 0.61 ha	Total	
					Mean	SD
Seed (prawn and fish)	25892.3 (40.7)	26588.1 (39.8)	27073.2 (37.5)	28963.0 (37.7)	27118.8 (38.8)	3993.4
Feed	20555.8 (32.3)	22062.4 (33.0)	23919.1 (33.1)	24571.1 (32.0)	22770.4 (32.6)	4554.7
Fertiliser	732.6 (1.2)	789.2 (1.2)	857.2 (1.2)	953.2 (1.2)	833.1 (1.2)	284.7
Labour	917.5 (1.4)	970.3 (1.5)	1081.2 (1.5)	1187.3 (1.6)	1039.1 (1.5)	312.7
Harvesting and marketing	480.3 (0.8)	611.4 (0.9)	681.6 (0.9)	720.5 (0.9)	623.4 (0.9)	213.9
Rice cultivation	5457.4 (8.6)	4911.2 (7.4)	5537.5 (7.7)	6236.7 (8.1)	5532.7 (7.9)	718.1
Miscellaneous	627.8 (1.0)	795.3 (1.2)	879.7 (1.2)	851.2 (1.1)	780.5 (1.1)	278.4
Total Variable Cost (TVC)	54663.5 (85.9)	56727.9 (85.0)	60029.5 (83.2)	63482.8 (82.7)	58697.9 (84.1)	10365.4
Management staff salary (a)	2919 (4.6)	3154 (4.7)	3742.5 (5.2)	4075.5 (5.3)	3482.8 (5.0)	954.3
Interest	4512.5 (7.1)	5118.7 (7.7)	6281.0 (8.7)	6878.8 (9.0)	5696.8 (8.2)	1543
Depreciation (b)	1509 (2.4)	1771.3 (2.7)	2116.7 (2.9)	2370.0 (3.1)	1948.5 (2.8)	586.3
Total Fixed Cost (TFC)	8940.5 (14.1)	10044.0 (15.0)	12140.2 (16.8)	13324.3 (17.4)	11128 (15.9)	2065
Total Cost (TC)	63604.1 (100)	66771.9 (100)	72169.7 (100)	76807.1 (100)	69825.9 (100)	13803.1

Parenthesises indicate as a percent of each *gher* size categories
(a) Include guard salary;
(b) Derived from initial cost based on the economic life of each item.

There is little difference in the major input costs per ha among *gher* size categories. As reported in Table 4.17, farmers in < 0.21 ha and 0.21 - 0.4 ha paid 5% and 2% more than the average for seed respectively, while both 0.41 – 0.61 ha and > 0.61 ha paid 3% less than average. In 0.41 – 0.61 ha and 0.21 – 0.4 ha categories, farmers paid 2% and 1% more than the average for feed respectively. Cost for rice cultivation is 8% and 3% higher than average in the smallest and largest *gher* size categories respectively.

Table 4.17 Percentage of total costs per ha by major groups of input in the different *gher* size categories (% of mean in brackets).

Gher size categories	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total	
					Mean	SD
Seed	40.7 (105)	39.8 (102)	37.5 (97)	37.7 (97)	38.8 (100)	2.2
Feed	32.3 (99)	33.0 (101)	33.1 (102)	32.0 (98)	32.6 (100)	2.5
Rice cultivation	8.6 (108)	7.4 (93)	7.7 (97)	8.1 (103)	7.9 (100)	0.6

SD: Standard deviation

As shown in Table 4.18, total production costs (Tk ha^{-1}) in the < 0.21 ha and 0.21 – 0.4 ha size categories is lower by 9% and 4% than the average respectively, but in the 0.41-0.61 ha and > 0.61 ha size categories it is higher by 3% and 10% than average respectively. There is a significant difference ($P < 0.05$) of total production costs per ha in different size categories. The highest prawn production costs per ha is in the largest group at Tk 67,413 (US$ 1,404) ha^{-1} and the lowest in the smallest group at Tk 55,792 (US$ 1,162) ha^{-1}. In the < 0.21 ha and 0.21 – 0.4 ha categories, costs are lower by 9% and 4% than average respectively, while in the 0.41 – 0.61 ha and > 0.61 ha categories it is higher by 4% and 9% than average respectively. The highest fish production costs per ha are also found in the largest group at Tk 3,158 (US$ 66) ha^{-1} (16% more than average), and the lowest in the smallest group at Tk 2,355 (US$ 49) ha^{-1} (13% lower than average). The highest rice production costs per ha are also found in the largest group. However the lowest is found in the 0.21 – 0.4 ha group.

Table 4.18 Total production costs (Tk ha^{-1}) of prawn, fish and rice by *gher* size (% of mean in brackets).

Gher size categories	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total	
					Mean	SD
Prawn	55792 (91)	59228 (96)	63920 (104)	67413 (109)	61584 (100)	11946
Fish	2355 (87)	2633 (97)	2712 (100)	3158 (116)	2710 (100)	578
Rice	5457 (99)	4911 (89)	5538 (100)	6237 (113)	5533 (100)	718
Total cost	63604 (91)	66772 (96)	72170 (103)	76807 (110)	69826 (100)	13803

SD: Standard deviation

Costs per kg

As Table 4.19 shows, the cost per kg of prawn production decreased with increased *gher* size, the highest found in the smallest group at Tk 144.3 (US$ 3.0) kg^{-1} and the lowest in the largest group at Tk 140.9 (US$ 2.9) kg^{-1}. However, there is no significant difference ($P > 0.05$) in cost per kg with size categories. The highest fish production cost per kg is found in the largest group at Tk 7.4 (US$ 0.15) kg^{-1} followed by Tk 6.8 (US$ 0.14) kg^{-1} in 0.21 - 0.4 ha, Tk 6.7 (US$ 0.14) kg^{-1} in < 0.21 ha and Tk 6.6 (US$ 0.13) kg^{-1} in 0.41 – 0.61 ha. The highest rice production cost per kg is found in the smallest group at Tk 2.5 (US$ 0.05) kg^{-1} and the lowest is found in 0.41 – 0.61 ha at Tk 2.2 (US$ 0.04) kg^{-1}.

Table 4.19 Total production costs (Tk kg^{-1}) of prawn, fish and rice by *gher* size (% of mean in brackets).

Gher size categories	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total	
					Mean	SD
Prawn	144.3 (101)	143.7 (101)	141.0 (99)	140.9 (99)	142.4 (100)	42.4
Fish	6.7 (97)	6.8 (99)	6.6 (96)	7.4 (107)	6.9 (100)	2.5
Rice	2.5 (106)	2.3 (99)	2.2 (95)	2.4 (101)	2.4 (100)	0.96

SD: Standard deviation

4.4.3 Profitability

Profitability per ha

Despite a higher cost per ha, total net return per area is higher in the > 0.61 ha size at Tk 79,586 (US$ 1,658) ha^{-1} (104% of average) compared with Tk 77,680 (US$ 1,618) ha^{-1} in 0.41 – 0.61 ha, Tk 75,984 (US$ 1,583) ha^{-1} in 0.21 – 0.4 ha and Tk 74,163 (US$ 1,545) ha^{-1} in the < 0.21 ha (96% of average) category (Table 4.20). However, there was no significant difference ($P > 0.05$) with size categories. The income rate (%) and benefit-cost ratio decreased with increased *gher* size. The highest income rate was 54% in the smallest group and the lowest was 51%, in the largest group. The highest benefit-cost ratio is also found at 1.17 in < 0.21 ha category followed by 1.14 in 0.21-0.4 ha, 1.08 in 0.41-0.61 ha and 1.04 in > 0.61 ha. There is a significant ($p < 0.05$) difference of benefit-cost ratio with *gher* size.

Table 4.20 Costs and return (Tk ha^{-1}) of *gher* farming in different size categories (% of mean in brackets).

***Gher* size categories**	**< 0.21 ha**	**0.21 - 0.4 ha**	**0.41 - 0.61 ha**	**> 0.61 ha**	**Total**	
					Mean	**SD**
Gross revenue	137767 (94)	142756 (97)	149849 (102)	156393 (107)	146682 (100)	27598
Total cost	63604 (91)	66772 (96)	72170 (103)	76807 (110)	69826 (100)	13803
Net return	74163 (96)	75984 (99)	77680 (101)	79586 (104)	76856 (100)	15908
Rate of income (%)	54 (103)	53 (101)	52 (100)	51 (97)	52 (100)	3.5
Benefit-cost ratio	1.17 (106)	1.14 (103)	1.08 (98)	1.04 (94)	1.1 (100)	0.08

SD: Standard deviation

The following paragraphs address separate profitability of prawn, fish and rice per ha in different *gher* size categories:

1) Profitability of prawn per ha

The profitability of prawn production per ha *gher* is found to increase with increased size. Despite a higher cost per ha, the net return per unit of *gher* is higher in the largest group (> 0.61 ha) at Tk 58,844 (US$ 1,226) ha^{-1} compared with Tk 58,794 (US$ 1,225) ha^{-1} in 0.41 – 0.61 ha, Tk 57,361 (US$ 1,195) ha^{-1} in 0.21 – 0.4 ha and Tk 56,349 (US$ 1,174) ha^{-1} in < 0.21 ha category (Table 4.21), though there is no significant difference ($P > 0.05$) with size category. The highest income rate and benefit-cost ratio is found in the < 0.21 ha category at 50% and 1.00 respectively, while the lowest is found in the > 0.61 ha category at 47% and 0.87 respectively.

Table 4.21 Costs and return (Tk ha^{-1}) of prawn production in different *gher* size categories (% of mean in brackets).

***Gher* size categories**	**< 0.21 ha**	**0.21 - 0.4 ha**	**0.41 - 0.61 ha**	**> 0.61 ha**	**Total**	
					Mean	**SD**
Gross revenue	112141 (94)	116589 (98)	122714 (103)	126256 (106)	119396 (100)	23856
Total cost	55792 (91)	59228 (96)	63920 (104)	67413 (109)	61584 (100)	11946
Net return	56349 (97)	57361 (99)	58794 (102)	58844 (102)	57812 (100)	12099
Rate of income (%)	50 (104)	49 (102)	48 (99)	47 (96)	48 (100)	1.84
Benefit-cost ratio	1.00 (107)	0.97 (103)	0.92 (98)	0.87 (93)	0.94 (100)	0.04

SD: Standard deviation

2) Profitability of fish per ha

As Table 4.22 shows, despite a higher production cost per ha, the net return for fish is highest in the largest group at Tk 10,010 (US$ 209) ha^{-1} followed by Tk 9,895 (US$ 206) ha^{-1} in the 0.41 – 0.61 ha, Tk 9,682 (US$ 202) ha^{-1} in the 0.21 – 0.4 ha and Tk 8,932 (US$ 186) ha^{-1} in the < 0.21 ha category, with a significant ($P < 0.05$) increase in net return per ha with size. The highest income rate and benefit-cost ratio is found in the < 0.21 ha category at 79% and 3.79 respectively, while the lowest is found in the > 0.61 ha category at 76% and 3.17 respectively.

Table 4.22 Costs and return (Tk ha^{-1}) of fish production in different *gher* size categories (% of mean in brackets).

Gher sizes categories	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total	
					Mean	SD
Gross revenue	11287 (91)	12315 (100)	12607 (102)	13169 (106)	12365 (100)	2800
Total cost	2355 (87)	2633 (97)	2712 (100)	3158 (116)	2709 (100)	578
Net return	8932 (93)	9682 (100)	9895 (102)	10010 (104)	9655 (100)	2158
Rate of income (%)	79 (102)	78 (101)	78 (101)	76 (97)	78 (100)	2.4
Benefit-cost ratio	3.79 (107)	3.68 (103)	3.65 (102)	3.17 (89)	3.56 (100)	0.4

SD: Standard deviation

3) Profitability of rice per ha

As Table 4.23 shows, the net return for rice is highest in the largest group at Tk 10,733 (US$ 224) ha^{-1} followed by Tk 8,990 (US$ 187) ha^{-1} in the 0.41 – 0.61 ha, Tk 8,942 (US$ 186) ha^{-1} in the 0.21 – 0.4 ha and Tk 8,882 (US$ 185) ha^{-1} in the < 0.21 ha category, suggesting that net return significantly increases with size. The highest net return and benefit-cost ratio is found in the 0.21 - 0.4 ha category at 65% and 1.82 respectively, while the lowest is found in the 0.41 - 0.61 ha category at 62% and 1.62 respectively

Table 4.23 Costs and return (Tk ha^{-1}) of rice production in different *gher* size categories (% of mean in brackets).

Gher size categories	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total	
					Mean	SD
Gross revenue	14340 (96)	13853 (93)	14528 (97)	16970 (114)	14930 (100)	1774
Total cost	5458 (99)	4911 (89)	5538 (100)	6237 (113)	5533 (100)	718
Net return	8882 (94)	8942 (95)	8990 (96)	10733 (114)	9398 (100)	1286
Rate of income (%)	62 (98)	65 (103)	62 (98)	63 (100)	63 (100)	5.53
Benefit-cost ratio	1.63 (96)	1.82 (107)	1.62 (96)	1.72 (101)	1.7 (100)	0.41

SD: Standard deviation

Profitability per kg

As shown in Table 4.24, the net return per kg of prawn in the < 0.21 ha group is higher than other categories, at Tk 145.7 (US$ 3.0) kg^{-1} followed by 0.21 - 0.4 ha with Tk 139.2 (US$ 2.9) kg^{-1}, 0.41 - 0.61 ha Tk 129.7 (US$ 2.7) kg^{-1} and > 0.61 ha Tk 123.0 (US$ 2.6) kg^{-1}, with a significant ($P < 0.05$) increase with smaller *gher* size. The highest net return (Tk kg^{-1}) of fish and rice is found in < 0.21 ha and 0.21 – 0.4 ha at Tk 25.6 (US$ 0.53) kg^{-1} and Tk 4.2 (US$ 0.09) kg^{-1} respectively, while the lowest is found in > 0.61 ha and 0.41 – 0.61 ha at Tk 23.4 (US$ 0.49) kg^{-1} and Tk 3.6 (US$ 0.07) kg^{-1} respectively.

Table 4.24 Net return (Tk kg^{-1}) of prawn, fish and rice in different *gher* size categories (% of mean in brackets).

Gher size categories	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total	
					Mean	SD
Prawn	145.7 (108)	139.2 (103)	129.7 (97)	123.0 (92)	133.6 (100)	49.6
Fish	25.6 (104)	25.3 (103)	24.3 (99)	23.4 (95)	24.6 (100)	9.0
Rice	4.1 (102)	4.2 (106)	3.6 (90)	4.1 (102)	4.0 (100)	1.3

SD: Standard deviation

4.5 Overview of cost structure and profitability of *gher* farming

Although there are broad similarities across the study area, results showed that different zones have different cost structures, depending on the availability and quality of inputs, mainly feed and seed, *gher* management and other factors. The production costs varying from Tk 64,049 (US$ 1,334) ha^{-1} in Kachua to Tk 69,903 (US$ 1,456) ha^{-1} in Chitalmari, Tk 70,421 (US$ 1,467) ha^{-1} in Bagerhat Sadar and Tk 74,809 (US$ 1,559) ha^{-1} in Fakirhat-Mollahat, there being significant difference ($P < 0.05$). The total production costs per ha *gher* in Fakirhat-Mollahat was higher than elsewhere, apparently due to both higher variable cost and fixed cost. The relatively higher cost of feed in Fakirhat-Mollahat appears to be due to the use of higher levels of snail meat, mainly coming from neighbouring districts of Gopalgonj, Faridpur and Madaripur. This also related to higher number of larger and more established farmers in Fakirhat-Mollahat zone, who have better ability to pay such inputs.

In Bagerhat Sadar seed prices, mainly prawn fry, are higher as the average stocking rate is higher and as most fry come from longer distance of coastal areas, thus include transport cost. The increased cost of harvesting and marketing in Bagerhat Sadar may be higher probably due to the longer distance to markets. The market distance from *ghers* in Bagerhat Sadar is around 2 to 10 km, compared with 1 to 5 km in other zones.

Comparing the four zones, farmers in Kachua, having a lower production (kg ha^{-1}) of prawn and fish, produced at lowest costs. Yield of prawns averaged 432.6 kg ha^{-1}, ranging from 406.1 kg ha^{-1} in Kachua to 453.9 kg ha^{-1} in Fakirhat-Mollahat. In Fakirhat-Mollahat, increased feed supply resulted in increased per ha prawn production. However, additional costs and lower revenue per kg reduced profitability.

On average, the rate of total *gher* income and the benefit-cost ratio is closely related to zones (Table 4.25). In Kachua, the most profitable zone, *gher* income per ha is slightly higher than others, followed by Bagerhat Sadar. The most expensive producer and least profitable zone is Fakirhat-Mollahat. It appears that farmers in Kachua can take advantage of management with reduced cost of inputs especially feed and seed.

Table 4.25 Productivity, rate of income and benefit-cost ratio of prawn, fish and rice by zone (% of mean in brackets).

Zones		Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total Mean	Total SD
Prawn	Productivity (kg ha^{-1})	440.1 (102)	453.9 (105)	430.4 (99)	406.1 (94)	432.6 (100)	80.9
	Rate of income (%)	49 (100)	48 (98)	48 (98)	50 (102)	48 (100)	1.84
	Benefit-cost ratio	0.95 (101)	0.91 (97)	0.92 (98)	0.98 (105)	0.94 (100)	0.04
Fish	Productivity (kg ha^{-1})	380.0 (97)	429.9 (110)	400.5 (102)	358.2 (91)	392.2 (100)	57.6
	Rate of income (%)	76 (97)	81 (104)	79 (101)	76 (97)	78 (100)	2.4
	Benefit-cost ratio	3.11 (87)	4.15 (117)	3.77 (106)	3.15 (89)	3.56 (100)	0.4
Rice	Productivity (kg ha^{-1})	2263.3 (96)	2233.1 (95)	2586.6 (110)	2327.2 (99)	2352.1 (100)	673.3
	Rate of income (%)	66 (106)	53 (85)	64 (102)	67 (106)	63 (100)	5.53
	Benefit-cost ratio	1.93 (114)	1.12 (66)	1.79 (105)	2.02 (119)	1.7 (100)	0.41
Total	Rate of income (%)	53 (100)	51 (98)	52 (100)	54 (102)	52 (100)	3.5
	Benefit-cost ratio	1.11 (101)	1.05 (95)	1.11 (101)	1.15 (104)	1.1 (100)	0.08

SD: Standard deviation

On average, farmers in all zones made a profit from *gher* farming. The development of the sector depends on its profitability, and increase in yield were the major means of increasing profit in all zones. Factors such as feed, seed, fertiliser and *gher* management all influence yield and profitability. Reduction in major variable costs, increased production per unit of *gher*, associated with increased survival rate, growth rate, good management and increased price per quantity of prawn by aiming at higher valued production may all increase profit. Despite higher production per unit of *gher*, the present profitability of prawn farming in Fakirhat-Mollahat may not be acceptable in the longer term, because of higher production costs.

Overall, comparing *ghers* of < 0.21 ha with *ghers* of > 0.61 ha, smaller *ghers* had lower costs per ha than others. Production costs vary from Tk 63,604 (US$ 1,325) ha^{-1} in < 0.21 ha to Tk 66,772 (US$ 1,391) ha^{-1} in 0.21 – 0.4 ha, Tk 72,170 (US$ 1504) ha^{-1} in 0.41 – 0.61 ha and Tk 76,807 (US$ 1,600) ha^{-1} in > 0.61 ha, there being significant difference ($P < 0.05$). Seed, feed, fertiliser, labour, harvesting and marketing costs all increased as *gher* size increased. Despite the highest production costs per ha, the highest net return is found in the > 0.61 ha category, mainly due to the highest yield of prawn, fish and rice, as larger *gher* produces appear to be able to afford more inputs, such as seed, feed and labour. However, due to the risk levels, the profitability of *ghers* of > 0.61 ha may not be acceptable over the longer term and it may be necessary to increase profitability by decreasing production costs.

On average, the rate of total *gher* income and the benefit-cost ratio is closely related to *gher* size categories (Table 4.26). Despite the lower yield (kg ha^{-1}), the rate of income and benefit-cost ratio is higher in the smaller size category than in others. The most profitable, < 0.21 ha *gher* size, is due to lower production costs per ha, and it appears that farmers in the < 0.21 ha category can take advantage of management at reduced cost due to reducing their risks.

Table 4.26 Productivity, rate of income and benefit-cost ratio of prawn, fish and rice by *gher* size (% of mean in brackets).

Gher size categories		< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total Mean	Total SD
Prawn	Productivity (kg ha^{-1})	386.7 (89)	412.2 (95)	453.3 (105)	478.4 (111)	432.6 (100)	89.9
	Rate of income (%)	50 (104)	49 (102)	48 (99)	47 (96)	48 (100)	1.84
	Benefit-cost ratio	1.00 (107)	0.97 (103)	0.92 (98)	0.87 (93)	0.94 (100)	0.04
Fish	Productivity (kg ha^{-1})	348.9 (89)	383.3 (98)	407.9 (104)	428.4 (109)	392.2 (100)	57.6
	Rate of income (%)	79 (102)	78 (101)	78 (101)	76 (97)	78 (100)	2.4
	Benefit-cost ratio	3.79 (107)	3.68 (103)	3.65 (102)	3.17 (89)	3.56 (100)	0.4
Rice	Productivity (kg ha^{-1})	2179.8 (93)	2117.6 (90)	2490.7 (106)	2622.1 (111)	2352.5 (100)	673.3
	Rate of income (%)	62 (98)	65 (103)	62 (98)	63 (100)	63 (100)	5.53
	Benefit-cost ratio	1.63 (96)	1.82 (107)	1.62 (96)	1.72 (101)	1.7 (100)	0.41
Total	Rate of income (%)	54 (103)	53 (101)	52 (100)	51 (97)	52 (100)	3.5
	Benefit-cost ratio	1.17 (106)	1.14 (103)	1.08 (98)	1.04 (94)	1.1 (100)	0.08

SD: Standard deviation

The present practice of prawn farming in *gher* systems brings a higher returns than fish and rice. The net return of prawn production averaged Tk 57,812 (US$ 1,204) ha^{-1}, while that of fish and rice production averaged Tk 9,655 (US$ 201) ha^{-1} and Tk 9,398 (US$ 196) ha^{-1} respectively. The combination of prawn, fish and rice cultivation in *gher* systems gave particularly good potential returns.

CHAPTER 5

SOCIAL AND ECONOMIC CONDITIONS OF PRAWN FARMERS AND ASSOCIATED GROUPS

5.1 Introduction

The successful development of aquaculture requires receptive and supportive socio-economic conditions (Tisdell, 1994). The social and economic conditions of the households of prawn farmers and associated agents are of much significance in planning of development activities, whose nature and extent is influenced largely by such issues. The aim of this chapter is to describe the social and economic conditions of prawn farmers and associated groups, analysis specific constraints, identify disadvantaged groups, and consider the nature and dynamic of the social and economic impact of changes associated with prawn farming.

It is hoped improving their status to understand the essential relationships and factors, thereby testing the relevant parts of the overall research hypothesis and to identify ways in which the status of disadvantaged groups could be improved. The findings of social and economic conditions of associated groups set out by group assessed (e.g. prawn farmers, women, traders etc.) and different issues (religion, education, family size, income, social status etc.). This description is based on the results of primary data collected in the study area during the field visits by using different data collection methods, such as transect walk, questionnaire interviews, PRA and cross check interviews with key informants.

5.2 Prawn farmer's socio-economic conditions

5.2.1 Personal information

Religious status

Religion can play a very important role in the socio-cultural environmental life of people of a given area, and can act as a notable constraint or modifies in social change (Cernada and Rob, 1993). Thus, Woolly (2000) noted that amongst other influences, social changes are related not just to economic factors, but also to religious factors.

In the study area, 61.75% of interviewed prawn farmers were Muslims and the remainder (38.25%) were Hindus, with no Buddhists or Christians. This compares with national percentages of 88.3% Muslim, 10.5% Hindu and 1.2% of Buddhist, Christian and others (Chakraborty, 1998; Coutsoukis, 1999). There was a significant ($P < 0.05$) difference between prawn farmer's religious status and zones. As Table 5.1 shows, Muslim farmers predominated in all zones except Chitalmari, the highest percentage being in Kachua zone (79%) followed by Bagerhat Sadar (66%), Fakirhat-Mollahat (62%) and Chitalmari (40%). A few local leaders noted that large numbers of Hindu farmers were lived in Bagerhat district especially Chitalmari zone due to traditional settlement.

Table 5.1 Religious status of prawn farmers by zone.

Religious status	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Muslims	66 (66)	62 (62)	40 (40)	79 (79)	247 (61.75)
Hindus	34 (34)	38 (38)	60 (60)	21 (21)	153 (38.25)

n: sample size; figures in parenthesises indicate percentage

The highest percentage of Muslim prawn farmers (73.5%) belonged to the 0.41 - 0.61 ha *gher* size category, compared with 66.9% in < 0.21 ha, 60.3% in 0.21 - 0.4 ha and 55.6% in the > 0.61 ha categories (Table 5.2), though this difference was insignificant (P > 0.05). A school teacher in Fakirhat (Surendro Nath, pers. comm.) stated that large numbers of Hindu farmers were involved in prawn farming with large *gher* size due to disadvantage of other activities as religious minorities.

Table 5.2 Religious status of prawn farmers by *gher* size.

Religious status	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Muslims	109 (66.9)	82 (60.3)	36 (73.5)	20 (55.6)	247 (61.75)
Hindus	70 (39.1)	54 (39.7)	13 (26.5)	16 (44.4)	153 (38.25)

n: sample size; figures in parenthesises indicate percentage

Age structure

Knowledge of the age structure of farmers is important in estimating potential productive human resources. Planning of education, health and employment generation requires sufficient data on relevant age structures. The age distribution of farmers has an important influence on labour (Mandima, 1995), and also on their perceptions of the future (Khan and Hashemzadeh, 1985). According to Singh *et al.*, (1972) the age of farmers and the size of cultivated land holdings are key influences on adoption of new farming practices.

In the study area, most prawn farmers were quite young, with an average age estimated at 35.31 with a range from 25 to 56. There was very little difference between the zones, the highest average found in Fakirhat-Mollahat (36.3) followed by Bagerhat Sadar (35.5), Chitalmari (34.8) and Kachua (34.6). Of these 18% were up to 30 years, 60.75% between 31 to 40, 16.75% between 41 and 50, and 4.5% more than 50 (Table 5.3). The highest percentage in all zones were in the 31 to 40 age group, Fakirhat-Mollahat having the highest numbers in this group (63%) and Bagerhat Sadar the lowest (58%). However there was no significant difference (P > 0.05) between age groups and zones. It was reported that prawn farming first started in Fakirhat-Mollahat area and therefore Fakirhat-Mollahat farmers were more experienced and slightly older than others.

Table 5.3 Distribution of prawn farmer's age groups by zone.

Age groups	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Up to 30	16 (16)	15 (15)	20 (20)	21 (21)	72 (18.0)
31-40	58 (58)	63 (63)	62 (62)	60 (60)	243 (60.75)
41-50	18 (18)	18 (18)	14 (14)	17 (17)	67 (16.75)
>50	8 (8)	4 (4)	4 (4)	2 (2)	18 (4.5)

n: sample size; figures in parenthesises indicate percentage

Age structure was found to vary with *gher* size. As Table 5.4 shows, increased *gher* size was associated with a lower percentage of farmer's age group up to 30 and a higher percentage of the > 50 age group, with a significant difference (P < 0.05).

Table 5.4 Distribution of prawn farmer's age groups by *gher* size category.

Age groups	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Up to 30	47 (26.26)	19 (13.97)	4 (8.16)	2 (5.56)	72 (18.0)
31-40	113 (63.13)	85 (62.50)	25 (51.02)	20 (55.55)	243 (60.75)
41-50	17 (9.50)	25 (18.38)	16 (32.65)	9 (25.0)	67 (16.75)
>50	2 (1.11)	7 (5.15)	4 (8.16)	5 (13.89)	18 (4.5)

n: sample size; figures in parenthesises indicate percentage

Literacy and education

There is a strong relationship between society and education (Malassis, 1976). Human resource development is largely a function of literacy and educational attainment. Amongst farmers, literacy and education attainments help develop conceptual skill and also facilitate the acquisition of technical skill, which can have direct bearing on income generation, expenditure and saving activities. Veerina *et al.*, (1999) noted that factors such as literacy have a role in influencing yields through production decisions. Education and farming efficiency are closely related, and education generally has a positive effect on farm productivity (Phillips, 1987; Phillips, 1994b), a high rate of illiteracy resulting in low farm efficiency (Ali *et al.*, 1982). Atapattu (1994) stated that fish farmers should be properly educated with respect to the importance of management. Education of farmers was also reported to help improve the efficiency of rural household's in production (Wang *et al.*, 1996).

Amongst the surveyed group of prawn farmers, the reported literacy rate was found to be 30.25%, which was lower than national adult literacy level of 39% (CIHI, 1999). However, in recent years (1997-98) certain NGOs, especially *Gono Milon*, World

Vision, Life etc. have been working with prawn farmers to increase their literacy. Results of this study showed almost no differences in literacy levels across zones. A key informant, the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.) stated that the literacy rate of prawn farmers was lower than shrimp farmers in nearby Khulna area (34%) due to lower education facilities.

Five categories were used to define education level: 1) Primary level – 1 to 5 class education, 2) Secondary level – 6 to 10 class education, 3) Secondary School Certificate (S.S.C.) – class 10 pass, 4) Higher Secondary Certificate (H.S.C) – class 12 pass, and 5) Bachelor. From the total (400) interviewed, 89 (22.25%) farmers had primary level of education, 16 (4%) had secondary, 9 (2.25%) had S.S.C, 5 (1.25%) had H.S.C and only 2 (0.5%) had bachelor level of education (Table 5.5). There was insignificant difference ($P > 0.05$) between farmer's education level and zones. The highest number of prawn farmers with only primary education was found in Chitalmari zone (25%) followed by Kachua (24%) and both Fakirhat-Mollahat and Bagerhat Sadar (20%). Only 8% of post-primary educated farmers in Bagerhat Sadar and Fakirhat-Mollahat had bachelor level education. It was observed that comparatively more schools and madrashas[1] were situated in Bagerhat Sadar zone being the administrative centre of Bagerhat district, but little difference in education level.

[1] Madrasha, a religious school where Arabic and religious studies are taught.

Table 5.5 Distribution of prawn farmer's education level by zone.

Education level	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
No education (Illiterate)	69 (69)	70 (70)	70 (70)	70 (70)	279 (69.75)
Primary	20 (20)	20 (20)	25 (25)	24 (24)	89 (22.25)
Secondary	5 (5)	5 (5)	2 (2)	4 (4)	16 (4)
S.S.C	3 (3)	3 (3)	2 (2)	1 (1)	9 (2.25)
H.S.C	2 (2)	1 (1)	1 (1)	1 (1)	5 (1.25)
Bachelor	1 (1)	1 (1)	0 (0)	0 (0)	2 (0.5)
Post-primary	11 (11)	10 (10)	5 (5)	6 (6)	32 (8)

n: sample size; figures in parenthesises indicate percentage

However, there was a significant difference ($P < 0.05$) between farmers education and *gher* size categories. As Table 5.6 shows, the percentage of illiterate farmers decreased and the percentage of secondary, S.S.C, H.S.C and bachelor level of education increased with increased *gher* size. No one was found at above secondary level of education in the < 0.21 ha category, or above S.S.C level in the 0.21 – 0.4 ha category.

Table 5.6 Distribution of prawn farmer's education level by *gher* size category.

Education level	< 0.21 ha	0.21 -0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
No education (Illiterate)	136 (75.96)	96 (70.59)	27 (55.1)	20 (55.56)	279 (69.75)
Primary	41 (22.91)	34 (25)	10 (20.41)	4 (11.11)	89 (22.25)
Secondary	2 (1.12)	5 (3.68)	5 (10.2)	4 (11.11)	16 (4)
S.S.C	0 (0)	1 (0.74)	4 (8.16)	4 (11.11)	9 (2.25)
H.S.C	0 (0)	0 (0)	2 (4.08)	3 (8.33)	5 (1.25)
Bachelor	0 (0)	0 (0)	1 (2.04)	1 (2.78)	2 (0.5)
Post-primary	2 (1.12)	6 (4.42)	12 (24.48)	12 (33.33)	32 (8)

n: sample size; figures in parenthesises indicate percentage

Family status

1) Family type

In rural Bangladesh, families are classified into two types: 1) nuclear family – married couple with children, and 2) joint family – group of people related by blood and/or by law (Sarker, 1993). The family functions as a unit for income generation, consumption, reproduction and social interaction; however, extensive commingling and intermixing occurs among separate nuclear households (Haider, 1997). Khuda (1985) noted that nuclear families in rural Bangladesh had diminished, which was attributed to agricultural innovations that have raised labour demands, and good economic conditions that maintain joint family stability. According to Ansari (1981), if joint family structures are replaced by nuclear families, women have more authority, have greater freedom of movement and economic opportunities, dress better, and are better educated.

In the prawn farming community of the study area, it was found that 77.75% of farmers lived with joint families, and only 22.25% lived with nuclear families (Table 5.7). The highest percentage of prawn farmers with joint family structures was found in Bagerhat Sadar (81%) followed by those of Chitalmari (79%), Fakirhat-Mollahat (76%) and Kachua (75%), though there was no significant difference ($P > 0.05$) across zones. Results also showed that 79.5% of Muslim farmers lived with joint families, which was higher than Hindus (76%). A few local leaders stated that higher numbers of Muslim farmers lived with joint families due to their religious views.

Table 5.7 Family type of prawn farmers by zone.

Family type	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Joint	81 (81)	76 (76)	79 (79)	75 (75)	311 (77.75)
Nuclear	19 (19)	24 (24)	21 (21)	25 (25)	89 (22.25)

n: sample size; figures in parenthesises indicate percentage

Family type was found to vary with *gher* size as presented in Table 5.8, which shows that the highest percentage of joint families associated with > 0.61 ha *gher* size category (83.33%) followed by 0.21 – 0.4 ha (79.41%), < 0.21 ha (77.01%) and 0.41 – 0.61 ha (71.43%). However, these associations were also insignificant ($P > 0.05$) statistically.

Table 5.8 Family type of prawn farmers by *gher* size.

Family type	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Joint	138 (77.01)	108 (79.41)	35 (71.43)	30 (83.33)	311 (77.75)
Nuclear	41 (22.91)	28 (20.59)	14 (28.57)	6 (16.67)	89 (22.25)

n: sample size; figures in parenthesises indicate percentage

2) Family size

This was defined as the number of persons, either working or not, belonging to the same family (Habib *et al.*, 1994). The family size and its composition are related to occupation and income (Islam, 1995), and are likely to have an important influence on farming practice. As noted by Gill and Motahar (1982), large family sizes may make it difficult for the household to invest in fish farming, because of financial constraints and incorporation of family members. Chang (1994) noted that the family size of farmers in developing countries is high because of the high birth rate and reducing child mortality, and large families, high populations result in high levels of unemployment and other socio-economic ills (Ignacy, 1994).

The average family size of prawn farmers was estimated at 5.5 in a single family, which was slightly lower than national household size reported in the Bangladesh Population Census: 1991, at 5.6 (BBS, 1998). The highest average family size was found in Chitalmari (5.8) followed by Kachua (5.4) and both Bagerhat Sadar and Fakirhat-Mollahat (5.3), though there was no significant difference ($P > 0.05$) between these. Based on farmers description, almost all members over 12 years in these families are directly engaged in agriculture and prawn farming activities, including prawn feeding, dike cropping, gher management, prawn harvesting, homestead gardening, poultry and livestock rearing to supplement the household income.

The proportion of prawn farmers having families of 5 to 7 members was 62.25%, while 26.75% and 11% had family sizes of less than 5 and above 7 respectively (Table 5.9). The highest number of farmers having 5 to 7 family members was 73% in Kachua followed by 62% in Chitalmari, 60% in Bagerhat Sadar and 54% in Fakirhat-Mollahat. There was no significant difference ($P > 0.05$) between family size and zones.

Table 5.9 Distribution of prawn farmer's family size by zone.

Family size	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
< 5 person	27 (27)	36 (36)	23 (23)	21 (21)	107 (26.75)
5-7 person	60 (60)	54 (54)	62 (62)	73 (73)	249 (62.25)
> 7 person	13 (13)	10 (10)	15 (15)	6 (6)	44 (11)

n: sample size; figures in parentheses indicate percentage

However, there was a significant difference (P < 0.05) between farmer's family size and *gher* size. As Table 5.10 shows, the percentage of farmers having family size of less than 5 was found to decrease with increased *gher* size. The highest percentage of farmers having 5 to 7 person families was found in the > 0.61 ha *gher* size category (69.4%), while the highest percentage of farmers having more than 7 person families was in the 0.41 - 0.61 ha category (30.6%). The *gher* size is significantly and positively related to the farmer's family size, the value of coefficient correlation was 0.34, which was significant at the 0.001 level. However, there is no significant relation between farmer's family size and educational level.

Table 5.10 Distribution of prawn farmer's family size by *gher* size.

Family size	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
< 5 person	65 (36.3)	32 (23.5)	8 (16.3)	2 (5.6)	107 (26.75)
5-7 person	107 (59.8)	91 (66.9)	26 (53.1)	25 (69.4)	249 (62.25)
> 7 person	7 (3.9)	13 (9.6)	15 (30.6)	9 (25)	44 (11)

n: sample size; figures in parenthesises indicate percentage

5.2.2 Economic conditions

Source of income

In the prawn farming area, farmers typically pursue more than one occupation to earn their livelihood. These can be classified into two groups on the basis of their relative importance, i.e.,

1) Major occupation: denoting an occupation on which a respondent primarily depends

for livelihood. Almost all respondents reported prawn farming to be their major occupation and their major incomes to come from prawn farming, on average 75.5% of their total income. The highest average income dependency from prawn farming was found in Fakirhat-Mollahat (82.9%) followed by those of Bagerhat Sadar (75.8%), Chitalmari (72.7%) and Kachua (70.6%).

2) Secondary occupation: prawn farming cannot provide full time employment, and the income derived therefrom may be insufficient to provide adequate means of livelihood. As such, secondary occupations are involved. Here, 82.25% of respondents stated that their secondary occupation was agriculture, while 10.75%, 3.5% and 3.5% were occupied in business, fishing and others[2] respectively. In business, farmers were involved in prawn trading, fry trading, snail trading and small shops in villages. A wide variation of secondary occupation was observed in different zones. As Table 5.11 shows, the highest percentage of involvement in agriculture was found in Bagerhat Sadar (84%) followed by Chitalmari (83%), Kachua (82%) and Fakirhat-Mollahat (80%), while the highest involvement in business was in Fakirhat-Mollahat (13%) compared with Chitalmari (11%), Kachua (10%) and Bagerhat Sadar (9%). However, there were no significant differences ($P > 0.05$) across zones. A key informant *Thana* Fisheries Officer of Bagerhat Sadar (Md. Faridul Islam, pers. comm.) stated that large numbers of farmers were involved in agriculture as secondary occupation due to their traditional involvement.

[2] Few farmers are seasonally worked as labourer and few are worked as part time job in NGOs.

Table 5.11 Distribution of secondary occupation by zone.

Secondary occupation	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Agriculture	84 (84)	80 (80)	83 (83)	82 (82)	329 (82.25)
Business	9 (9)	13 (13)	11 (11)	10 (10)	43 (10.75)
Fishing	4 (4)	2 (2)	3 (3)	5 (5)	14 (3.5)
Others (Job/labour)	3 (3)	5 (5)	3 (3)	3 (3)	14 (3.5)

n: sample size; figures in parenthesises indicate percentage

The proportion of farmers having secondary occupation varied with *gher* size. As reported in Table 5.12, the highest percentage of involvement in agriculture was found in the 0.21 - 0.4 ha *gher* size (90.44%) followed by 0.41 – 0.61 ha (85.7%), < 0.21 ha (85.5%) and > 0.61 ha (30.55%), while the highest percentage of involvement in business was found in the larger *gher* size (> 0.61 ha) group. No one was involved in fishing in the 0.41 – 0.61 ha and > 0.61 ha categories. The relationship between farmer's secondary occupation and *gher* size was statistically significant ($P < 0.05$).

Table 5.12 Distribution of secondary occupation by *gher* size.

Secondary occupation	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Agriculture	153 (85.5)	123 (90.44)	42 (85.7)	11 (30.55)	329 (82.25)
Business	4 (2.2)	8 (5.88)	7 (14.3)	24 (66.67)	43 (10.75)
Fishing	13 (7.3)	1 (0.74)	0 (0)	0 (0)	14 (3.5)
Others (Job/labour)	9 (5.0)	4 (2.94)	0 (0)	1 (2.78)	14 (3.5)

n: sample size; figures in parenthesises indicate percentage

Farmers income and expenditure

Farmer's income is a key measure reflecting economic security, to the extent of adequacy in income to meet basic needs of the household. A household is economically secure when it has the capacity to generate sufficient income to satisfy the basic needs of the family and to maintain or increase the goods necessary for the stability of the household economy (CARE, 1998b).

Across the study, the average annual income[3] of prawn farmers was estimated at Tk 35,519 (US$ 740) farmer^{-1} (range Tk 19,250 – 58,154, median Tk 34,550 farmer^{-1}), based on all income generating activities. As Table 5.13 shows, the highest average annual income per farmer was in Fakirhat-Mollahat at Tk 41,522 (US$ 865) compared with Bagerhat Sadar at Tk 36,487 (US$ 760), Chitalmari at Tk 34,305 (US$ 715) and Kachua at Tk 29,821 (US$ 621). There was a significant difference ($P < 0.05$) across zones. Almost all farmers noted that their income had decreased over the last 1 to 2 years due to decreased profit from prawn production, as a result of high production costs.

It was found that family size was significantly and positively related to farmer's income, the correlation estimated at 0.16, statistically significant at 0.01 level. The households of prawn farmers per capita income was estimated at Tk 6,458 (US$ 135). The highest average per capita income was in Fakirhat-Mollahat at Tk 7,834 (US$ 163) compared with Bagerhat Sadar at Tk 6,884 (US$ 143), Chitalmari at Tk 5,915 (US$ 123) and Kachua at Tk 5,522 (US$ 115).

[3] Gross income values.

Table 5.13 Prawn farmer's annual income (Tk farmer^{-1}) by zone.

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Farmers annual income (Tk farmer^{-1})	36,487	41,522	34,305	29,821	35,519	17,522

SD: Standard deviation

As shown in Table 5.14, average annual income was found to increase with increased *gher* size. The relationship between farmers income and *gher* size categories measured in terms of contingency co-efficient was estimated at 0.73 which was statistically significant at 0.001 level.

Table 5.14 Prawn farmer's annual income (Tk farmer^{-1}) by *gher* size category.

Gher size categories	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Farmers annual income (Tk farmer^{-1})	21,751	29,819	39,543	51,233	35,519	17,522

SD: Standard deviation

Expenditure in farmers' households was related to basic human needs – food, housing, clothing, education and medication. Farmers used most of their income on basic items. According to respondents, food is the single most important category of expenditure. Farmers also noted that expenditure is incurred on *gher* inputs, agricultural inputs, education of children and health care. Though primary education is being made compulsory in Bangladesh so that every child can become literate, the scope for taking advantage of universal primary education could often not be utilised due to poor household economic conditions, i.e. children contributing household labour, or earning outside, or simply that costs of schooling are too high.

Little information was obtained concerning surplus income. This may have been due to natural reticence and guardedness amongst traditional rural societies. Respondents may also have thought that if they stated nothing, it would possible to get some credit or financial support from the interviewers or their institutes. However, a few noted that their surplus annual income was used to repair their home, religious functions, marriage of their son and daughter, and buying some goods.

5.2.3 Social status

The social status of the households of prawn farmers is very important in planning of development activities. A household can be improved social conditions, when its members have adequate access through on-farm and off-farm activities, to income and resources to meet basic needs (CARE, 1998b). Basic needs would include food, housing conditions, health facilities, drinking water, sanitary facilities etc. The following paragraphs describe the social status of prawn farmers:

Housing conditions

1) Housing structures

In the study area, houses of prawn farmers are of three main types: 1) *katcha* (i.e., rough, rural) – houses are made of bamboo and palm especially *gol-pata*[4] (*Nypa fruticans*) with

[4] A kind of palm, widely used in prawn farming communities and coastal areas for house making.

mud flooring, 2) *semi pucca* – made of wood or/and tin, and 3) *pucca* (i.e., proper, good quality) – made of brick. *Katcha* houses do not prevent the entry of rainwater, whereas the others do. The study reveals that 51.75% of housing structures were *katcha*, while 41.5% were *semi-pucca* and only 6.75% were *pucca*. Housing structure varied with zones, but not at a significant level ($P > 0.05$). As Table 5.15 shows, the highest percentage of *katcha* housing was in Kachua (56%) followed by Chitalmari (53%) and both Bagerhat Sadar and Fakirhat-Mollahat (49%). Conversely the highest percentage of *pucca* housing was in Fakirhat-Mollahat (9%) compared with Chitalmari (7%), Bagerhat Sadar (6%) and Kachua (5%). It was observed that farmers *pucca* housing structure were higher in Fakirhat-Mollahat due to higher income.

Table 5.15 Distribution of prawn farmer's housing quality by zone.

Housing structures	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Katcha	49 (49)	49 (49)	53 (53)	56 (56)	207 (51.75)
Semi-pucca	45 (45)	42 (42)	40 (40)	39 (39)	166 (41.5)
Pucca	6 (6)	9 (9)	7 (7)	5 (5)	27 (6.75)

n: sample size; figures in parenthesises indicate percentage

However, there was a significant difference ($P < 0.05$) between farmer's housing and *gher* size. As Table 5.16 shows, the percentage of *katcha* housing structure decreased with increased *gher* size, while the percentage of *pucca* housing increased. The contingency co-efficient reflecting the relationship between housing structures and *gher* size was estimated at 0.66, which was significant at 0.001 level.

Table 5.16 Distribution of prawn farmer's housing structures by *gher* size.

Housing structures	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Katcha	145 (81)	55 (40.4)	5 (10.2)	2 (5.6)	207 (51.75)
Semi-pucca	34 (19)	79 (58.1)	42 (85.7)	11 (30.6)	166 (41.5)
Pucca	0 (0)	2 (1.5)	2 (4.1)	23 (63.9)	27 (6.75)

n: sample size; figures in parenthesises indicate percentage

2) House size

The size of house space is an important feature of livelihood quality. Here, houses of prawn farmers were relatively small, the average house size including premises and homestead gardens estimated at 580.3 m^2 (range 278 – 810 m^2, median 565 m^2) (Table 5.17). There was no significant differences ($P > 0.05$) between farmer's house size across zones.

Table 5.17 Distribution of prawn farmer's average house size (m^2) by zone.

Zones	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total	
	Mean	Mean	Mean	Mean	Mean	SD
Average house size (m^2)	568.2	620.0	575.1	557.7	580.3	230.3

SD: Standard deviation

However, there was a significant difference ($P < 0.05$) between house size and *gher* size category. As shown in Table 5.18, average house size increased with *gher* size, with a strong association between *gher* size and farmer's house size, the correlation being valued at 0.78, significant at 0.001 level.

Table 5.18 Distribution of prawn farmer's average house size (m^2) by *gher* size.

***Gher* size categories**	**< 0.21 ha**	**0.21-0.4 ha**	**0.41-0.61 ha**	**> 0.61 ha**	**Total**	
	Mean	Mean	Mean	Mean	Mean	SD
Average house size (m^2)	416.0	609.1	790.4	1001.6	580.3	230.3

SD: Standard deviation

Health facilities

A family may be said to be well served in health facilities when all of its members have sustainable access to the medical care needed to be free of debilitating, preventable health problems, and to have health problems addressed by component health care professional (Albrecht *et al.*, 1998). Here, respondents were requested to state the type of health services that they could afford for their family. The study showed that 86.75% of prawn farmers households were dependent on village 'doctors' (unqualified practitioners), who did not have any understanding and knowledge of medical science, while 5.5%, 5.25% and 2.5% got health service from the *thana* health complex, MBBS[5] doctors and government hospitals respectively. There was an insignificant difference ($P > 0.05$) between health facilities and zones. As shown in Table 5.19, the highest percentage of households using village doctors was in Chitalmari (92%) followed by Fakirhat-Mollahat (89%), and both Bagerhat Sadar and Kachua (83%).

[5] Bachelor of Medicine and Bachelor of Surgery (MBBS)

Table 5.19 Health services used by zone.

Health facilities	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Village doctor	83 (83)	89 (89)	92 (92)	83 (83)	347 (86.75)
Thana health complex	11 (11)	2 (2)	0 (0)	9 (9)	22 (5.5)
Hospital	1 (1)	2 (2)	1 (1)	6 (6)	10 (2.5)
MBBS doctor	5 (5)	7 (7)	7 (7)	2 (2)	21 (5.25)

n: sample size; figures in parenthesises indicate percentage

As Table 5.20 shows, the dependence on village doctors decreased with increased *gher* size, while the use of MBBS doctors increased. There was a significant statistical relationship ($P < 0.05$) between health facilities and *gher* size categories. A school teacher in Bagerhat Sadar (Nuzural Islam, pers. comm.) stated that wealthy farmers with higher socio-economic status were able to get more health facilities from MBBS doctors.

Table 5.20 Health services used by *gher* size.

Health facilities	< 0.21 ha	0.21 - 0.4 ha	0.41-0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Village doctor	173 (96.6)	122 (89.7)	39 (79.6)	13 (36.1)	347 (86.75)
Thana health complex	5 (2.8)	13 (9.6)	3 (6.1)	1 (2.8)	22 (5.5)
Hospital	1 (0.6)	0 (0)	3 (6.1)	6 (16.7)	10 (2.5)
MBBS doctor	0 (0)	1 (0.7)	4 (8.2)	16 (44.4)	21 (5.25)

n: sample size; figures in parenthesises indicate percentage

Water facilities

In the study area, prawn farm households have faced poor access to clean water facilities for drinking, washing clothes, dishes and bathing water.

1) Drinking water

The provision of clean and safe drinking water is considered to be the most valued elements in society (Tellegen *et al.*, 1996). Lack of drinking water hinders the development of a local economy and the removal of social marginality (Pasiak, 1995). In Bangladesh, traditional water supplies were based on collected rainwater, ponds, and simple pit walls, and more recently by shallow and deep tube-wells, etc. The study showed that 63.75% of the prawn farmers household used tube-wells for drinking water and the remaining 36.25% used ponds (Table 5.21). In general, women procure drinking water from ponds or tube-wells. There was a significant difference ($P < 0.05$) between drinking water supply and zones. The highest percentage of farmers household using tube-wells were found in Fakirhat-Mollahat (76%) followed by Bagerhat Sadar (64%), Kachua (61%) and Chitalmari (54%). There was a positive association between drinking water and farmers income, correlation being valued at 0.39, significant at 0.001 level.

According to the farmers, almost all drinking water was saline due to proximity to coastal areas. In recent years, some NGOs have been working on filtration of pond water, developing their own techniques. Those respondents who used pond water stated that they did so due to poor tube-well facilities. However, a few educated and informed farmers noted that they would prefer to use filtered pond water rather than arsenic contaminated tube-well water. Apart from salinity, arsenic is also a common problem for drinking water in the study area. In general pond water is used after boiling or filtration with coppersulphate.

Table 5.21 Use of drinking water by zone.

Drinking water	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Pond	36 (36)	24 (24)	46 (46)	39 (39)	145 (36.25)
Tube-well	64 (64)	76 (76)	54 (54)	61 (61)	255 (63.75)

n: sample size; figures in parenthesises indicate percentage

A significant relationship (P < 0.05) was found between drinking water facilities and *gher* size. The percentage of households using tube-wells increased with increased *gher* size. The highest number of farmers using tube-wells was found in the > 0.61 ha category at 91.7% compared with 0.41 – 0.61 ha at 75.5%, 0.21 – 0.4 ha at 70.6% and < 0.21 ha at 49.75% (Table 5.22).

Table 5.22 Use of drinking water by *gher* size.

Drinking water	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Pond	90 (50.25)	40 (29.4)	12 (24.5)	3 (8.3)	145 (36.25)
Tube-well	89 (49.75)	96 (70.6)	37 (75.5)	33 (91.7)	255 (63.75)

n: sample size; figures in parenthesises indicate percentage

2) Tube-well

Though 63.75% of farmers' households used tube-well drinking water, this did not mean that all had tube-wells. Only 8.25% were found to have their own tube-well, others using government tube-wells, or those belonging to schools, or neighbours. A number of schools had tube-wells in the survey area, and in addition government tube-wells were available, but situated a considerable distance away. As Table 5.23 shows, the highest percentages owning their tube-well were in Fakirhat-Mollahat (10%) followed by those of both Bagerhat Sadar and Kachua (8%) and Chitalmari (7%), though there was no significant difference (P > 0.05) across zones, and this was obviously a minor element.

Table 5.23 Prawn farmers having their own tube-well by zone.

Having own tube-well	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Yes	8 (8)	10 (10)	7 (7)	8 (8)	33 (8.25)
No	92 (92)	90 (90)	93 (93)	92 (92)	367 (91.75)

n: sample size; figures in parenthesises indicate percentage

There was a significant difference (P < 0.05) between tube-well ownership and *gher* size, with a distinct drop from 69.4% in the > 0.61 ha category to 6.1% at 0.41 – 0.61 ha, 2.2% at 0.21 – 0.4 ha and 1.1% at < 0.21 ha (Table 5.24). Tube-well ownership was also related to farmer's education, the correlation estimated at 0.15, significant at 0.01 level.

Table 5.24 Prawn farmers having own tube-well by *gher* size.

Having own tube-well	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Yes	2 (1.1)	3 (2.2)	3 (6.1)	25 (69.4)	33 (8.25)
No	177 (98.9)	133 (97.8)	46 (93.9)	11 (30.6)	367 (91.75)

n: sample size; figures in parenthesises indicate percentage

3) Washing clothes, dishes and bathing water

Three main types of water are used for these purposes: 1) pond water, 2) tube-well supplies and 3) canal/river water (canals are directly connected with the rivers). In the study 80.5% of respondents used pond water, while 7.25% and 12.25% used tube-well and canal/river respectively (Table 5.25). Farmers pointed out that almost all canals were polluted due to dumping of snail shells, and household members experienced rashes and itching as a result of use. The highest percentage of pond water use was observed in Chitalmari (86%) followed by Bagerhat Sadar (81%), Fakirhat-Mollahat (80%) and Kachua (75%), though there was no significant difference ($P > 0.05$) between zones.

Table 5.25 Water use by prawn farming households for washing clothes, dishes and bathing, by zone.

Water source	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Pond	81 (81)	80 (80)	86 (86)	75 (75)	322 (80.5)
Tube-well	8 (8)	8 (8)	6 (6)	7 (7)	29 (7.25)
River/Canal	11 (11)	12 (12)	8 (8)	18 (18)	49 (12.25)

n: sample size; figures in parenthesises indicate percentage

As with other apparent wealth factors, the relationship between water use and *gher* size was found to be statistically significant ($P < 0.05$). As reported in Table 5.26, the percentage of households using tube-well water increased with *gher* size, while the percentage of households use of canal/river water decreased.

Table 5.26 Use of washing clothes, dishes and bathing water by *gher* size.

Water source	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Pond	150 (83.8)	116 (85.3)	43 (87.8)	13 (36.1)	322 (80.5)
Tube-well	1 (0.6)	3 (2.2)	3 (6.1)	22 (61.1)	29 (7.25)
River/Canal	28 (15.6)	17 (12.5)	3 (6.1)	1 (2.8)	49 (12.25)

n: sample size; figures in parenthesises indicate percentage

Sanitary facilities

It was observed that farmers' sanitary conditions were very poor. Two types of toilets are used: 1) *katcha* toilet - made of bamboo with leaf shelter and inadequate drainage disposal, and 2) *pucca* toilet – made of brick with good drainage disposal. As indicated by farmers, *pucca* toilets are treated as good sanitation, but only 5% stated that they had these (Table 5.27). The highest access to good sanitation was in Bagerhat Sadar and Fakirhat-Mollahat (6%) followed by Chitalmari and Kachua zone (4%). A few NGO workers noted that the households of prawn farmers often suffered from diarrhoea and cholera due to lack of sanitary facilities.

Table 5.27 Good sanitation of prawn farmers by zone.

Good sanitation	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Yes	6 (6)	6 (6)	4 (4)	4 (4)	20 (5)
No	94 (94)	94 (94)	96 (96)	96 (96)	380 (95)

n: sample size; figures in parenthesises indicate percentage

There was a significant difference ($P < 0.05$) between good sanitation and *gher* size, the percentages having good sanitation increasing with size. The highest percentage was found in > 0.61 ha at 47.2% followed by 0.41 – 0.61 ha at 6.1% (Table 5.28). None of the smaller *gher* farmers had good sanitation.

Table 5.28 Sanitation facilities of prawn farmers by *gher* size.

Good sanitation	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Yes	0 (0)	0 (0)	3 (6.1)	17 (47.2)	20 (5)
No	179 (100)	136 (136)	46 (93.9)	19 (52.8)	380 (95)

n: sample size; figures in parenthesises indicate percentage

Electricity

In the study area electricity supply is limited despite the work of the rural electrification board (REB). Of the total (400) interviewed, only 11.25% stated that they had electricity (Table 5.29). This compares with national level around 14.8% of the population connected to the electricity (BBS, 1998). The highest percentage using electricity were in Bagerhat Sadar (15%) followed by Fakirhat-Mollahat (11%), Kachua (10%) and Chitalmari (9%), though there was no significant difference ($P > 0.05$) between zones. The households of Bagerhat Sadar zone had more electricity facilities being the administrative centre of Bagerhat district.

Table 5.29 Use of electricity of prawn farmers by zone.

Electricity facilities	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Yes	15 (15)	11 (11)	9 (9)	10 (10)	45 (11.25)
No	85 (85)	89 (89)	91 (91)	90 (90)	355 (88.75)

n: sample size; figures in parenthesises indicate percentage

There was a significant statistical relationship ($P < 0.05$) between access to electricity and *gher* size, the percentage having electricity increasing with *gher* size. The highest number of farmers using electricity was found in > 0.61 ha category at 69.44%, with a distinct drop at the 0.41 – 0.61 ha size at 20.41%, and a further drop 0.21 – 0.4 ha at 5.15% and < 0.21 ha at 1.68% (Table 5.30).

Table 5.30 Use of electricity of prawn farmers by *gher* size.

Electricity facilities	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Yes	3 (1.68)	7 (5.15)	10 (20.41)	25 (69.44)	45 (11.25)
No	176 (98.32)	129 (94.85)	39 (79.59)	11 (30.56)	355 (88.75)

n: sample size; figures in parenthesises indicate percentage

Cooking fuel

In the study area, three main types of cooking fuel are used: 1) cow-dung, 2) paddy-straw, and 3) wood including tree branches and dry leaves. Cow-dung can be mixed with straw and dried until hard to provide an odourless cooking fuel. In general, children go out to collect cow-dung and women are involved in processing this in their own premises. Here, 65.75% of respondents stated that they mainly used cow-dung, while 17.75% and 16.5% used paddy straw and wood respectively (Table 5.31). The highest percentage of households using cow-dung was found in Bagerhat Sadar (71%) followed by Fakirhat-Mollahat (68%), Chitalmari (64%) and Kachua (60%). However, there was no significant difference ($P > 0.05$) between cooking fuel and zones.

Almost all farmers noted that cattle raising has significantly decreased due to *gher* finance (e.g. particularly in small *ghers* where cattle have been sold), as a result decreased availability of cow-dung. Farmers also stated that rice production has fallen due to *gher* construction, and decreased rice production has meant decreased availability of paddy straw. A few local leaders noted that farmers were forced to purchase fuel wood from markets due to decreased cow-dung and paddy straw.

Table 5.31 Use of cooking fuels by zone.

Cooking fuels	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Cow-dung	71 (71)	68 (68)	64 (64)	60 (60)	263 (65.75)
Paddy straw	19 (19)	16 (16)	20 (20)	16 (16)	71 (17.75)
Wood	10 (10)	16 (16)	16 (16)	24 (24)	66 (16.50)

n: sample size; figures in parenthesises indicate percentage

There was a significant difference ($P < 0.05$) in use of cooking fuel and *gher* size, the percentage of households using cow-dung decreasing with increased *gher* size, and the percentage of households using of wood increasing (Table 5.32). A school teacher in Fakirhat (Abul Kashem, pers. comm.) noted that small farmers were used cow-dung as a cheaper fuel and larger farmers were able to buy wood due to higher income.

Table 5.32 Use of cooking fuels by *gher* size.

Cooking fuels	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Cow-dung	150 (83.8)	85 (62.5)	22 (44.9)	6 (16.7)	263 (65.75)
Paddy straw	21 (11.7)	32 (23.5)	15 (30.6)	3 (8.3)	71 (17.75)
Wood	8 (4.5)	19 (14.0)	12 (24.5)	27 (75.0)	66 (16.50)

n: sample size; figures in parenthesises indicate percentage

Recreational items

Three modern items are commonly acquired by households for recreational purposes – i.e. radios, cassette players and televisions. The acquisition of such goods can be used as an indirect measure of wealth and consumption, and is also associated with attributed to more 'modern' developing conditions, with wider access to outside influence and commonly, a departure from traditional forms of entertainment and rural social interaction.

The study showed that only 31.5% of prawn farmers had radio (Table 5.33), the highest percentage in Fakirhat-Mollahat (38%) followed by Bagerhat Sadar (37%), Kachua (26%) and Chitalmari (25%), with no significant difference ($P > 0.05$) across zones. Most of farmers with radios noted that they were interested in listening to folk-songs, though a few mentioned an interest in news, particularly as newspapers are not available, and many could not read them due to a lack of education. Mirkovic (1981) stated that the developing countries attach greater importance to education of farmers by radio.

The survey also showed that only 15.5% and 7% of farmers had cassette player and television (black and white) respectively. As shown in Table 5.33, the highest percentage of farmers having cassette player and television was in Fakirhat-Mollahat and the lowest in Chitalmari.

Table 5.33 Prawn farmers having own recreational items by zone.

Recreational items		Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
		n = 100	n = 100	n = 100	n = 100	n = 400
Radio	Yes	37 (37)	38 (38)	25 (25)	26 (26)	126 (31.5)
	No	63 (63)	62 (62)	75 (75)	74 (74)	274 (68.5)
Cassette player	Yes	15 (15)	21 (21)	13 (13)	13 (13)	62 (15.5)
	No	85 (85)	79 (79)	87 (87)	87 (87)	338 (84.5)
Television	Yes	6 (6)	11 (11)	5 (5)	6 (6)	28 (7.0)
	No	94 (94)	89 (89)	95 (95)	94 (94)	372 (93.0)

n: sample size; figures in parenthesises indicate percentage

There was a significant difference ($P < 0.05$) between farmers recreational items and *gher* size. The percentage of farmers having radio, cassette player and television increased with increased *gher* size (Table 5.34). However none of the smallest (< 0.21) farmers had television.

Table 5.34 Prawn farmers having own recreational items by *gher* size.

Recreational items		< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
		n = 179	n = 136	n = 49	n = 36	n = 400
Radio	Yes	25 (14.0)	39 (28.7)	32 (65.3)	30 (83.3)	126 (31.5)
	No	154 (86.0)	97 (71.3)	17 (34.7)	6 (16.7)	274 (68.5)
Cassette player	Yes	4 (2.2)	17 (12.5)	15 (30.6)	26 (72.2)	62 (15.5)
	No	175 (97.8)	119 (87.5)	34 (69.4)	10 (27.8)	338 (84.5)
Television	Yes	0 (0)	1 (0.7)	5 (10.2)	22 (61.1)	28 (7.0)
	No	179 (100)	135 (99.3)	44 (89.8)	14 (38.9)	372 (93.0)

n: sample size; figures in parenthesises indicate percentage

5.2.4 Improved socio-economic conditions

Though farmers' living conditions are poor, the survey suggests that they have improved these through prawn farming, as confirmed by 81% of prawn farmers. As Table 5.35 shows, the highest percentage of positive response was found in Fakirhat-Mollahat (86%) followed by Bagerhat Sadar (84%), Chitalmari (78%) and Kachua (76%). However, differences between zones were insignificant ($P > 0.05$).

Table 5.35 Improved socio-economic conditions by zone.

Improved socio-economic conditions	Bagerhat Sadar	Fakirhat-Mollahat	Chitalmari	Kachua	Total
	n = 100	n = 100	n = 100	n = 100	n = 400
Yes	84 (84)	86 (86)	78 (78)	76 (76)	324 (81)
No	16 (16)	14 (14)	22 (22)	24 (24)	76 (19)

n: sample size; figures in parenthesises indicate percentage

There was a significant increase (P < 0.05) of reported improvement with increased *gher* size. The highest positive response was found in > 0.61 ha category at 100% followed by 0.41 – 0.61 ha at 93.9%, 0.21 – 0.4 ha at 86.8% and < 0.21 ha at 69.3% (Table 5.36).

Table 5.36 Improved socio-economic conditions by *gher* size.

Improved socio-economic conditions	< 0.21 ha	0.21 - 0.4 ha	0.41 - 0.61 ha	> 0.61 ha	Total
	n = 179	n = 136	n = 49	n = 36	n = 400
Yes	124 (69.3)	118 (86.8)	46 (93.9)	36 (100)	324 (81)
No	55 (30.7)	18 (13.2)	3 (6.1)	0 (0)	76 (19)

n: sample size; figures in parenthesises indicate percentage

Such improved conditions may be described further on the basis of qualitative indicators. These could include increased food consumption, increased social status, involvement of women in prawn farming and associated activities, and the extent of success in other inputs of *gher* operation such as polyculture and dike cropping. Study results suggest that farmers have broadly improved their standards of living, purchasing power, choice, and ability as an economic sector. The most significant change was in food consumption. Almost all farmers who reported improved conditions noted that before prawn farming they took food only once or twice in a day. Now farmers households are able to eat rice three times a day and also eat better quality food. Almost everyone reported that they were now able to eat rice year round. One farmer in Bagerhat Sadar (Rahim Shek, pers. comm.) claimed "*before prawn farming we ate only once in a day, we had no clothes, no children's education – now that we have a gher we are becoming human.*" Based on farmers description, rice, vegetables are now more abundant, and are also cheaper or more available as a result of dike cropping and homestead gardening, fish consumption has increased, and prawn 'heads and legs'[6] are a supplemental protein source that practically the whole community enjoys during the prawn exporting season.

The second most important change in the standard of living was in home improvement. Farmers have improved their *katcha* houses, although many of the former can still be seen. Profits are used to replace bamboo roofs and walls with tin sheet and wood, to buy boats or canoes for monsoon transportation, and to send children to school. There have also been an increased number of boats and bicycles for transport. A few farmers have been constructed sanitary toilets. One farmer (Abu Taher, Kachua, pers. comm.) noted that he had built a tin shed kitchen at home and invested more money in banana cultivation. Another farmer (Netai Kundo, Bagerhat Sadar, pers. comm.) pointed out that he already improved his economic condition with prawn farming and he is now able to meet his daily needs. A few farmers who were slightly better off to begin with had reported less dramatic, but still significant, improvements in their standard of living.

5.2.5 Unsuccessful farmers

Within the survey, some 19% of farmers had not obtained any specific benefits from their involvement in prawn farming. Most of these less successful farmers explained that in various ways their prawn harvest had failed, which was the single most important reason for their disadvantaged situation. As a result, their social and economic

[6] All of our respondents reported that they never eat the prawns in their *gher* themselves. However they bought the heads and legs after de-heading by the processing companies.

conditions were still unchanged, and a few had become more impoverished. A number of contributing factors was suggested:

Small and marginal farmers

A vast majority (91%) of the prawn farmers are 'small and marginal'[7], of which a smaller, but significant number (21%) have become disadvantaged. These farmers noted that they had not improved their situations due to failed prawn harvest. Some noted that they converted all of their land to *ghers* at once, taken loans from moneylenders and had fallen into a continuous cycle of debt after a failed prawn harvest. With no other land or production opportunities, they then had to increase borrowing to continue in prawn farming. Farmers described "*we saw our relatives, neighbours and other farmers making money from prawn farming and we felt motivated to try making a gher ourselves, we are still hoping we can earn good money.*"

A local leader in Fakirhat (Abul Kalam, pers. comm.) noted that risks and debt were not new to small and marginal farmers, who still seem to be entering into prawn cultivation by taking loans from moneylenders. He suggested that there was no gain without risk in prawn farming, that almost small and marginal farmers were experienced in facing risk, especially in converting rice field into *ghers*, and that many had improved their conditions while only a few were disadvantaged.

One farmer in Chitalmari zone (Abdur Rahim, pers. comm.) stated that after converting

[7] According to Rutherford (1994) small and marginal farmers are those who have less than 0.81 ha (two acres) land.

his rice field into a *gher*, his prawn harvest failed due to flooding and it became hard to feed his large family. A school teacher in Bagerhat Sadar (Nuzural Islam, pers. comm.) noted that food security may be an issue for small and marginal farmers who converted to prawn cultivation, especially those who turned good rice field into *ghers*.

A few disadvantaged farmers in Chitalmari noted that in the first year of prawn farming they sold their cattle to finance *gher* construction and operation. However, they did not get optimum production due to poor inputs of seed and feed. Another marginal farmer in Kachua (Akkas Ali, pers. comm.) claimed that he sold his cows as he could not pay the moneylenders after his prawn harvest failed as a result of an outbreak of disease. A key informant, the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.) stated that the first year of prawn farming was the period of greatest insecurity for small and marginal farmers, because assets such as cows, gold jewellery, and timber are sold, loans taken out, and rice crops foregone in the rush to *gher* construction and operation. As a result of this many of them actually became poorer, or at least potentially more vulnerable.

Based on such descriptions, the debt assumed in order to finance prawn cultivation, accompanied by the disposal of assets, can place these small and marginal farmers in a position of extreme insecurity, especially in the initial years after converting their land to *ghers*. For those that do manage to enter, the declining profit margin over increasing production costs may mean that it will be even more difficult to break out of the debt cycle and that the risks of falling into poverty may increase.

Loan defaulters

The study showed that all unsuccessful farmers (76) took loans from moneylenders (52.6%) and *depot maliks* (47.4%) as *dadon* credit, but that no one did so from banks or NGOs. Some 22 farmers of the 76 (29%) noted that after getting loans from moneylenders and *depot maliks*, they were able to repay these, but their social and economic conditions were still unchanged. The rest of the farmers (71%) stated that after failed prawn harvests due to flood, drought, disease outbreak, water quality deterioration, poor feed or seed input, or lack of technical knowledge, they did not pay their loans. As a result they borrowed more money, again failed to get sufficient production and caught up in a continuous cycle of debt and fall down in poverty. Of these, 3 farmers[8] (4%) stated that they lost their land to moneylenders as a result of defaulting on their loans. One farmer in Bagerhat Sadar zone (Md. Kashem, pers. comm.) stated that he lost 0.2 ha of his land (out of total 0.5 ha) after his prawn harvest failed, in order to pay off the moneylender.

A few loan defaulters claimed "*the moneylenders will extend the loan for a second year with compounded interest in the event of a bad harvest, but if the loan can not be repaid after the second year they will take the land*". One farmer in Kachua (Zaman Shek, pers. comm.) described "*I feel very afraid after taking a loan from a moneylender. If I fail to get a good crop of prawns, I will have no profit. I have sold all our assets. If the prawn crop is lost I will lose everything*". A key informant NGO worker (Md. Kamruzzaman, BRAC, pers. comm.) noted that the numbers of farmers who defaulted on their loans and

[8] No farmer reported losing land to *depot maliks*, stating that *depot maliks* were less demanding than moneylenders when they failed to pay loans.

lost land have increased during last few years. A school teacher in Fakirhat (Abul Kashem, pers. comm.) stated that the prawn farming areas where few cases of losing land to moneylenders occurred where farmers were previously very poor and relatively powerless.

Lease farmers

The study showed that 46 (11.5%) farmers culture prawn in leased *ghers*, of whom 25 (54.3%) have become disadvantaged, i.e., having diminished rather increased benefits through their involvement with prawn farming. According to these farmers, leased *ghers* were much more profitable few years ago (1994-96); but more recently the costs of leases had increased significantly (25% $year^{-1}$) due to increased demand from the greater number of people wishing to participate in prawn farming. Returns had also decreased as the costs of *gher* farming had increased significantly (e.g. seed and feed prices increased 34% and 36% $year^{-1}$ respectively), while the price of prawns had not increased to a similar degree. A school teacher in Fakirhat (Abul Kashem, pers. comm.) claimed that land values in Bagerhat district had increased six times since starting *gher* farming, i.e. 1987. This suggests that lease *gher* farming may be becoming an increasingly risky investment and it may be difficult (particularly for less wealthy households), to improve social and economic conditions by taking up leases.

Those lease farmers stating that they were unsuccessful reported this to be a result of taking loans, and depleting other assets for *gher* construction and operation. Some 5 farmers (20%) stated that they did not make any profits from prawn harvests after paying their lease money. A lease farmer in Bagerhat Sadar (Ratan Pal, pers. comm.) stated that his economic condition had become worse due to taking a leased *gher*, and that he felt continued fear about how to pay the lease money if his prawn harvest failed due to natural disaster or any other unavoidable situation. However a few local leaders suggested that near landless people and poor farmers, even day labourers, had improved their social and economic conditions through prawn farming by leasing a *gher*.

Lack of technical knowledge

From the 76 disadvantaged farmers interviewed, 15 (19.7%) attributed their failure or insufficient production due to the lack of technical knowledge. However farmers noted that lack of knowledge of prawn farming was not the single most important reason for their disadvantage. In the study area only 10.75% farmers had obtained training for prawn farming. However many had gained experience in carrying out *gher* culture year after year.

Amongst the problems associated with the lack of knowledge were the following. A farmer in Kachua zone (Kabir Mollah, pers. comm.) described that in his first year of prawn farming, half of the post-larvae he stocked were not *M. rosenbergii,* but *Penaeus monodon* (marine shrimp), and therefore failed reach his expected production. Another farmer in Chitalmari zone (Ranjon Das, pers. comm.) noted that his prawn production had failed due to poor water quality as he had no knowledge of how to improve it. A key informant, the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.) claimed that very few farmers (5%) came to the office for their production problems, but considered that farmers would produce more prawns if they overcome their technical constraints.

5.2.6 Overview of social and economic conditions among prawn farmers

The results of the survey showed that farmers of different zones in the study area have different religious status, education level, age group, family size, income as well as other characteristics. The level of primary educated farmers was higher in Chitalmari zone (25%) than elsewhere, apparently due to higher numbers of Hindu farmers (60%), and it was found that religion was significantly and positively related to farmer's education, the value of coefficient correlation was 0.16, which was significant at the 0.01 level. It was also found that education was significantly and positively related to farmer's income, the correlation estimated at 0.17, statistically significant at 0.01 level.

There was a significant difference ($P < 0.05$) between farmer's income and zones. In Fakirhat-Mollahat, annual income (Tk 41,522 or US$ 865 farmer^{-1}) was higher than in others, apparently due to higher income from prawn farming and higher level of involvement in business and part time jobs as secondary occupations. The income from prawn farming was probably higher in Fakirhat-Mollahat due to the longer experience, and in Kachua, income was lower (Tk 29,821 or US$ 621 farmer^{-1} year^{-1}) probably due to less experience. In turn, the highest number of farmers claiming to have improved their social and economic conditions on prawn farming in Fakirhat-Mollahat (86%) and the lowest in Kachua (76%).

Farmers housing conditions were also higher in Fakirhat-Mollahat, due to higher income, the correlation between farmers income and housing structures were 0.81 which was significant at the 0.001 level. Farmer's income was also strongly and positively related with house size valued at 0.71, which was significant at the 0.001 level.

Overall, operators of smaller *ghers* (up to 0.61 ha) had lower annual income than others. The higher total income was found in the largest *gher* size (> 0.61 ha) category (Tk 51,233 or US$ 1,067 $farmer^{-1}$ $year^{-1}$) and the lower was found in the smallest *gher* size (< 0.21 ha) category (Tk 21,751 or US$ 453 $farmer^{-1}$ $year^{-1}$), with significant ($p < 0.05$) difference between *gher* size category. It was observed that wealthy farmers who had big *ghers* (> 0.61 ha) made a good profit from prawn cultivation and all (100%) improved their social and economic conditions, while poor farmers who had small *ghers* (< 0.21 ha) made a profit, but 30.7% did not improve their situation. Medium sized *gher* (0.21 – 0.61 ha) farmers made an adequate profit, but for 18.3%, socio-economic conditions were unchanged or diminished. It is evident that *gher* size plays a very important role in farmer's income. There was a strong positive association between *gher* size and farmers income, correlation being valued at 0.73, significant at 0.001 level. Farmer's income was also related to farmer's education. Larger farmers had more education than smaller farmers, and it was found that *gher* size was significantly and positively related to farmer's education, the value of coefficient correlation was 0.15, which was significant at 0.01 level.

Farmers socio-economic conditions were also related with *gher* size. In larger *gher* size categories, better housing structures and house sizes were found. The correlation between *gher* sizes and house sizes were 0.78, which was significant at 0.001 level. For larger farmers, better facilities such as health services, drinking water, sanitary, electricity, recreational items etc. were found. However such facilities were very poor for medium sized *gher* farmers and it was worst for the smallest farmers. None of the smallest *gher* (< 0.21 ha) farmers had *pucca* housing structure (made of brick - proper, good quality), good sanitary facilities, health service from MBBS doctor and recreational item of television.

It seems certain that the rich are getting richer as a result of prawn farming. Results showed that larger farmers who had built *ghers* on their own land with their own capital, requiring no loans, had benefited the most. Medium sized *gher* farmers also done well. However poor farmers with small *ghers* had benefited the least and 30.7% did not make any profits. In contrast, few local leaders stated that small farmers had benefited the most, because their situation had been so desperate before prawn farming, and now they are living a better existence (e.g. eating rice three times a day with better quality food).

5.3 Social and economic conditions of other associated groups

5.3.1 Women

For questionnaire interviews, 200 women were selected through simple random sampling, where the samples for each zone were distributed as equal number (50). Almost all interviewed women were farmer's wives, aged between 20 to 55, averaging 28.1 (median 30). According to the questionnaire responses, 65.5% of women involved in prawn farming were Muslims and the rest (34.5%) were Hindus. The highest percentage of Muslim women was found in Bagerhat Sadar (74%) followed by Kachua (70%), Fakirhat-Mollahat (62%) and Chitalmari (56%). During field visits, it was found that Hindu women were more active in *gher* farming (e.g. snail breaking, dike cropping, feed carrying from markets, prawn harvesting etc.) than Muslim women as the latter face religious constraints.

The education of women is an important factor, influencing socio-economic conditions within prawn farming areas. From the total interviewed, 156 (78%) women had no education, 37 (18.5%) had primary and 7 (3.5%) had secondary level of education. No one was found above secondary level of education, comparing that their education level was lower than that of men. The highest percentage of women had primary education in Fakirhat-Mollahat (20%), equally followed by Bagerhat Sadar, Chitalmari and Kachua (18%), while the highest percentage with secondary education was in Bagerhat Sadar (6%) followed by Fakirhat-Mollahat (4%), Chitalmari and Kachua (2%).

The role of women in the prawn related activities is potentially very important. The rapid development of prawn industry has provided employment opportunities for some women. Women are involved in various facets of prawn farming, including prawn feeding, gher construction, gher supervision and management, prawn harvesting, post-harvest handling etc. Almost all women noted that their social and economic conditions have improved due to involvement in prawn farming activities, and their prawn-related cash income had given them some economic independence, raising their status in the family and in society. However, a school teacher in Chitalmari (Subul Das, pers. comm.) stated that the position of women is still distinctly subordinate in the family and society despite their important contribution to various productive activities.

5.3.2 Primary producers

1) Fishermen (fry catchers)

Sixty fishermen were selected for questionnaire interviews through simple random sampling. Fishermen were interviewed on the Pasur river and/or river bank. A boat was hired for data collection. A large number of fishermen is known to be engaged in wild prawn fry catching in the coastal area during April to June. For fishermen, prawn post-larvae catching is a seasonal activity and the rest of the time they are involved in fishing and day labouring. According to the survey, almost all fishermen were engaged in fry catching for 6 to 10 years. It was considered that fishermen contribute substantially to the economy and to a part of the foreign exchange earnings, though they benefited little. The following paragraphs address fishermen's personal information, and socio-economic conditions:

Religion

From the total (60) interviewed, 41 (68.33%) of fishermen were Muslims and 19 (31.67%) were Hindus, with no Buddhists or Christians. Comparatively, the Hindu population is three times as high in coastal areas as nationally (10.5%; Chakraborty, 1998). Hannan (1994) also stated that in the coastal area of Bangladesh higher number of fishermen came from low caste of Hindu society.

Age and family member

From the questionnaire response, the average age of fishermen was 35.7 years (range 26 – 49, median 34). Specifically, 15 (25%) were less than 30 years old, between 31 and 40 years of 27 (45%), and the rest (30%) were more than 40. The families of fishermen were generally large, averaging 6.4 persons (range 3 - 11, median 6) in a single family. According to the interview responses and wider discussions during the survey, almost all males over 15 in these families are directly engaged in fishing, while women help in selling fry, repairing nets etc., and are also engaged in maintaining the house, collecting firewood and livestock rearing to supplement the household income.

Education

Of the surveyed group, 45 (75%) fishermen were illiterate, 8 (13.33%) were semi-literate (could only sign their name) and the rest (11.67%) were literate up to primary level of education. This showed that their literacy level was lower than that of prawn farmers (30.25%) or the national level (39%; CIHI, 1999). These findings concur with those of Rahman (1994a), who noted that in Bangladesh most of the fishermen were illiterate and few had primary level education. Bailey and Doulman (1994) also stated that coastal fishermen in Bangladesh had low levels of education.

The respondents stated that they did not appreciate the importance of educating their children. Rather, they try to send them to fish, or engage in other supplementary activities for additional income. A NGO worker (Md. Moniruzzaman, BRAC, pers. comm.) noted that the children of fishermen were interested in going to school, but their families were too poor to pay for educational expenses as well as family needs. He also described that the children's earnings were necessary for the poor families, a situation similar to that of other rural poor.

Housing structure

Most of the fishermen lived in very poor housing conditions, their houses typically made of mud and trees of *Nypa fruticans* (locally called '*gol pata*'), collected from the 'Sunderbans' mangrove forest. These houses do not prevent the entry of rainwater and are very susceptible to storm damage. Based on fishermen's descriptions, housing materials in coastal fishing communities often compare unfavourably with those found in agricultural or prawn farming communities, because fishermen are more likely to invest available cash resources in maintaining and improving boats and nets, which are constantly in need of repair.

Income and living standards

Increasing population pressures may aggravate the problem of meagre incomes of fishermen. According to the survey, the average daily income of a fisherman was calculated at Tk 64.4 (US$ 1.34) during the fry catching season (April to June). From those interviewed, 44 (73.33%) fishermen stated that their daily income was between Tk 50 and 70 (US$ 1.04 to 1.5), and the rest (26.67%) were less than Tk 50 (US$ 1.04). However, their income varies with fry catching rate, weather conditions and the market price of fry. According to the fishermen, a few years ago (1994-96) they earned more money than they earn now. The surveyed respondents claimed that their income had decreased over the last few years (since 1997), which they attributed to due to high fishing pressure. Based on fishermen's descriptions, the demand of fry has increased significantly, but the price of fry has not increased to a similar degree due to poor handling and high fry mortality that claimed by traders and *baperies* to keep prices down.

The average per capita income of the households of fishermen was estimated at Tk 3,750 (US$ 78), based on all income generating activities, which was greatly lower than prawn farmers households (per capita income Tk 6,458 or US$ 135). Living conditions of fishing families are extremely poor, although a few local NGOs have been working with them to improve their conditions by providing loans, support, training and technical assistance in fry catching (e.g. fry identification, better handling, improve survival rate during marketing etc.). Most fishermen noted that their families could not have three times meals a day (i.e. mainly twice). Hannan (1994) stated that fishermen lived from hand to mouth and were a highly neglected class in both Muslim and Hindu society in Bangladesh, and according to Hotta (1994), the rapid population increase in coastal communities and limited alternative employment opportunities have made the life of fishermen even more difficult. The results of the present survey appear to confirm this continuing level of disadvantage.

Health and sanitary conditions

The study suggests that coastal fishermen face severe health and sanitary problems; with no medical facilities in the fishing villages of coastal area, people often suffer from diarrhoea, cholera and lack of nutrition. A few fishermen (less than 5%) go to the unqualified village 'doctor' when they have serious health problems. Otherwise there are no means of access to health services. Fishing families also lack fresh drinking water, because of salinisation of coastal water, and almost all families use ponds for drinking water due to poor tube-well facilities, and use river water for bathing, washing dishes and clothes. Rahman (1994a) noted that fresh drinking water was a major problem for coastal fishermen in Bangladesh, and this situation does not appear to have substantially changed.

Infrastructure facilities

According to respondents, fishery related infrastructure in coastal areas, such as port, roads, markets, boat building, net making and repair facilities are very limited. Fishing nets in particular are of high price and are limited in availability, generally imported from India. The lack of such infrastructure facilities, adds to the difficulties faced by the respondents, influencing not only their role in the *gher* prawn sector, but their wider opportunities in fishing and in other activities.

Constraints of coastal fisheries

Constraints associated with over-population, low incomes, poor education, low economic status and lack of alternative employment opportunities are common amongst coastal communities. Fishing families specifically face problems of children's education, cooking fuel, animal feed and house building materials. These factors in turn may affect coastal resources in that there are few options available except to exploit these. Almost all respondents claimed lack of capital to be their biggest problem, others including piracy, bad weather, and risks to gear and lives due to the lack of weather forecasting or means to acquire weather information.

Almost all fishermen noted that their income had decreased due to involving more and more people in this job. In spite of rising demand and price of fry in prawn farming areas, fishermen did not get real price increase due to high fry mortality and poor handling. A key informant, the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.) suggested that the main reason for declining income was a decline in fry catches due to uncontrolled fishing of brood prawns which may threaten the natural populations.

2) *Snail collectors*

For snail collectors, data were collected in the Chanda *beel* of Gopalgonj district north of Bagerhat district, because snails have been over harvested in Bagerhat district and are effectively unavailable. PRA tools such as FGD were conducted with 75 snail collectors. A wide variety of rural poor are involved in snail collection. In the Chanda *beel*, snail collectors comprise a mix of Hindu (60%), Muslim (30.67%) and Christian (9.33%). The age of snail collectors ranged from 19 to 56, average 34.4 (median 35). The average family size was 6.3 (range 4 - 11, median 6), which was slightly lower than fishermen (6.4). The education level of snail collectors was very poor, and only 13 (17.33%) were literate up to primary level, however this level was higher than fishermen (11.67%).

According to the snail collectors, snail collection first started in 1992. Since then, this activity has generated new employment. It was estimated by the interviewees that more than 400 people are engaged in snail collection in the Chanda *beel* and collected an average 8,936 kg (22.34 kg collector^{-1}) day^{-1} during the season.

In the Chanda *beel*, people are engaged in snail collection only 4 months from June to October. Snail collectors are involved in agriculture, fishing, and day labouring during the rest of the year. From the survey, it is found that snail collectors earn an average Tk 40 (US$ 0.8) day^{-1} (range Tk 25 - 65, median Tk 38) during the season, which was lower than fishermen (Tk 64.4 or US$ 1.34 day^{-1}). Respondents noted that earnings have decreased, due to declining availability of snails in the *beel* area. In addition, every year more and more people are involved in this job, as the snail harvesting technique is very easy, and only requires a boat (common for monsoon transportation) and bamboo handled scoop net.

The living conditions of snail collectors was also very poor. According to the snail collectors, 65 (86.67%) lived in very poor housing condition with dwelling made of mud, palm leaves and jute straw, while the rest (10, 13.33%) lived in wood or/and tin made houses. The socio-economic conditions of snail collectors are extremely poor due to poor income, lower education level, and the lack of other employment opportunities. Almost all snail collectors noted that their families did not take food three times in a day and were struggling to survive, with health, nutrition, sanitation, children education, water supply, cooking fuel, animal feed, housing building materials etc.

5.3.3 Traders

1) Fry traders

From the total (40) number of fry traders interviewed in four different markets, 24 (60%) were Muslims and the remainder (40%) were Hindus. Muslim fry traders were predominant in Baroipara (80%), Babujong (60%) and Sinebord (70%) markets, but in Faltita, 70% were Hindu. Almost all fry traders were quite young, with average age estimated at 34.0 (range 24 - 49, median 33). Those in Baroipara were younger than elsewhere, averaging 31.1 compared to 33.5 in Babugonj, 34.9 in Sinebord and 36.6 in Faltita market.

It was reported that fry trading first started in Faltita in 1991, and therefore Faltita fry traders were more experienced and slightly older than others. According to the fry traders, almost all were engaged in this business for 5 to 8 years. Most of fry traders (72.5%) lived with their joint family, with an average family size of 5.1 persons (range 3 - 7, median 5). The highest average family members were in Faltita at 5.6 because they were older, had more children, and the lowest was found in Baroipara at 4.7. The average family member of Babugonj and Sinebord markets were found at 5.1 and 4.9 respectively.

From the survey it was found that all of the fry traders have education at some level, 13 (32.5%) had primary education, 16 (40%) had secondary, 5 (12.5%) had S. S. C, 4 (10%) had H. S. C and 2 (5%) had bachelor level of education. Education of fry traders varied with different markets, with the highest number secondary level educated traders in both Faltita and Sinebord markets (50%) followed by Baroipara and Babugonj markets (30%), with 10% at bachelor level education in Baroipara and Faltita markets, and none in Babugonj and Sinebord markets.

Fry trading is a profitable business and almost all fry traders reported that they had made significant profits. According to the survey, fry traders make an average net profit of Tk 27 (US$ 0.6) per 1000 fry in the buying from brokers and selling to farmers. The average net profit of fry traders is higher in Faltita than other markets, as quantities sold are higher. It may also be related to the higher education level, greater experience and the higher number of Hindu traders. The average net profit of a fry trader in Faltita market was estimated at Tk 1,130 (US$ 23.5) day^{-1}, while that of traders in Baroipara, Babugonj and Sinebord markets were Tk 285 (US$ 6.0), Tk 220 (US$ 4.6) and Tk 205 (US$ 4.3) respectively. According to the survey, a typical fry trader make an average net profit of Tk 41,400 (US$ 863) during the season (i.e. 3 months from April to June). According to the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.), fry traders belong largely to the middle class, as reflected in their access of capital, and most have been attracted by the particular opportunities to obtain high returns.

Fry traders typically operate with capital of around Tk 20,000 to 30,000 (US$ 417 to 625). Fry traders noted that the sources of the capital were both informal and institutional, such as loans from relatives, banks, savings or proceeds from sales of personal assets, especially gold jewellery and/or land. A small number of fry traders (15 to 20) are involved in each market and it was found that there was no competition to involvement in this job due to require higher capital. In addition, a strong network has developed with *baperies* and fry traders intervening between farmers at one end and the suppliers of wild caught post-larvae – the fishermen, at the other end. Fry traders maintained a good relationship with farmers and *baperies* for this business. The *baperies* often take advance money from fry traders to ensure the supply of fry. Prawn farmers are also often linked to fry traders who may advance them *dadon* credit against future supplies of marketable size prawns, when these traders act as prawn traders. Fry trading is a seasonal business and traders are involved in prawn trading, fish trading and prawn farming the rest of the time.

Almost all fry traders reported to have improved their social and economic conditions on this business and now they have better feed, clothing, housing conditions and children's education. However, they face problems of sanitary facilities, drinking water supplies, electricity facilities etc. Fry traders also noted that poor infrastructure facilities such as road, transport, electricity etc. also a problem for their business.

2) Snail traders

One important snail market was surveyed in each zone of the study area. About 15 to 20 snail traders were engaged in each market; among them 10 traders were randomly selected for questionnaire interviews. From those (40) interviewed in four different markets, 26 (65%) snail traders were Muslims and the remainder (35%) were Hindus. Muslim snail traders predominated in all markets except Faltita, where 70% of snail traders were Hindu. In Haderhat, Mativanga and Khaserhat markets Muslim traders were 70%, 80% and 80% respectively. Most snail traders were quite young, with an average age estimated at 32.7 (range 24 – 49, median 35) and there was very little difference between the markets. Most of snail traders (70%) lived within joint family, with an average family size of 5.3 persons (range 4 - 10, median 5), which was slightly higher than fry traders (5.1).

Amongst the surveyed group of snail traders, the literacy rate was found to be 100%. Respondents reported that 25 (62.5%) had primary education and 15 (37.5%) had secondary education. No one was found above secondary level of education, comparing that their education level was lower than that of fry traders. The highest numbers with secondary level education were in both Haderhat and Faltita markets (50%) followed by Mativanga (30%) and Khaserhat (20%).

According to the respondents, snail trading first started in 1993, and has generated new employment. Before snail trading 14 (35%) of traders had no job; of the rest 10 (25%), 12 (30%) and 4 (10%) were involved in agriculture, small business and *gher* farming respectively. A key informant, the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.) stated that around 150 traders were engaged in different markets, and large numbers of people were associated with the traders as day labourers (around 450; i.e. 3 labourers trader^{-1}).

During snail trading (July to October), traders make their primary living buying and selling snails, using operating capital in the range of Tk 2,000 to 10,500 (US$ 42 to 219). The rest of the time they are involved in *gher* farming or other small businesses. Snail traders noted that the sources of capital were informal (savings and/or loan from relatives), not institutional. The average net profit of snail traders is higher in Faltita than in the other markets, estimated at Tk 320 (US$ 6.7) day^{-1}, compared with Tk 173.50 (US$ 3.6), Tk 143 (US$ 3.0), and Tk 130 (US$ 2.7) in Haderhat, Mativanga and Khaserhat markets respectively. The average daily income of traders is higher in Faltita as quantities sold are higher. It may also be related to the higher education, the higher number of Hindu traders and greater experience. Snail traders noted that their income would be increased if more snail supply were available, because demand is high. According to the survey, a typical snail trader make an average net profit of Tk 14,500 (US$ 302) during the season (i.e. around 3 months), which was nearly one third of fry trader (Tk 41,400 or US$ 863).

The socio-economic condition of snail traders are lower than fry traders due to poor income, lower education level, and lower family size. Almost all snail traders reported to have improved their food and housing conditions, although they faced problems of children education, health and sanitary facilities, drinking water, electricity facilities, etc.

3) Prawn traders

One important prawn market was surveyed for each zone out of 7 markets in the study area. For questionnaire interviews, 10 prawn traders were selected in each market through simple random sampling. Of the total (40) interviewed, 25 (62.5%) prawn traders were Muslims and the rest 15 (37.5%) were Hindus. As with fry and snail traders, Muslim prawn traders predominated in all markets except Faltita, where 70% of prawn traders were Hindu. In Baroipara, Chitalmari and Sinebord markets Muslim prawn traders were 70%, 80% and 70% respectively. The average age of prawn traders was estimated at 33.8 (range 26 - 49, median 35), which was slightly lower than fry traders (34.0) and higher than snail traders (32.7). There was very little difference of prawn trader's average age between the markets, the highest average found in Baroipara (32.2) followed by Chitalmari (33.0), Sinebord (34.5) and Faltita (35.5). It was reported that prawn trading first started in Faltita in 1991, and therefore Faltita prawn traders were more experienced and slightly older than others. About 62.5% prawn traders lived with joint family, with an average family size of 4.8 persons (range 3 - 9, median 5), which was lower than both fry and snail traders.

Comparatively, prawn traders had more education than fry and snail traders. Of the total interviewed, 14 (35%) had secondary education, 11 (27.5%) had S. S. C, 9 (22.5%) had H. S. C and 6 (15%) had bachelor level of education. The highest number of prawn traders had secondary level education in Sinebord market (60%) followed by Chitalmari (50%), Faltita (20%) and Baroipara market (10%), while the highest number with bachelor level education was in Faltita (40%) followed by Baroipara market (20%). None of the traders had bachelor level of education in Chitalmari and Sinebord markets. This suggests that traders of Faltita and Baroipara markets were more educated with higher socio-economic status.

Prawn trading has generated new employment for traders. Before prawn trading 10 (25%) had no job; of the rest 12 (30%), 14 (35%) and 4 (10%) were involved in agriculture, small business and prawn farming respectively. According to the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.), around 150 traders were involved in different markets and large numbers of people were associated with the traders as day labourers (around 750, i.e. 5 labourers trader^{-1}). Prawn trading is seasonal (November to January) and traders are involved in fish trading, fry trading and other businesses during the rest of the year.

Prawn trading is a profitable business and almost all traders reported that they had made significant profit (average Tk 130,500 or US$ 2,719 in a season). According to the survey, prawn traders make an average net profit of Tk 8 (US$ 0.17) kg^{-1} of prawn in the buying from farmers and selling to processors. The average net profit of prawn traders was higher in Faltita than in the other three markets primarily, because prawn supply was higher. It may also be related to the higher education level, greater experience and the higher number of Hindu traders. The average net profit of a prawn trader in Faltita market was estimated at Tk 3,632 (US$ 75.7) day^{-1}, while those of traders in Baroipara, Chitalmari and Sinebord markets were Tk 1,496 (US$ 31.2), Tk 1,360 (US$ 28.3) and Tk 720 (US$ 15.0) respectively. According to the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.), prawn traders belong largely to the middle and upper class, as reflected in their access of capital. Prawn traders typically operate with capital of around Tk 25,000 to 100,000 (US$ 521 to 2,083). Prawn traders noted that the sources of the capital were both informal (savings and/or proceeds from sales of personal assets) and institutional (banks, processing companies etc.).

The socio-economic condition of prawn traders are better than any other associated groups due to higher income, higher education, lower family size, easy access to capital (processing companies, banks) and other advantages (profitable business, few competitors). Most prawn traders noted that they have improved their conditions as a result of prawn trading, and have been able to spend more money on improving their children's education, medication, transport facilities (e.g. motor cycle), family functions, and recreational items including television, cassette player etc. However, prawn traders noted that poor infrastructure facilities, especially transport, road, ice supplies etc. were major constraints for this business.

5.3.4 Others

1) Day labourers

Large numbers of people are involved as day labourers in prawn farming activities. According to the day labourers, most did not have any property, i.e. they were landless. From the total (25) interviewed, 17 (68%) were Muslims and the rest 8 (32%) were Hindus. Most of the day labourers were much younger than other associated groups (except women), averaging 31.6, as below 50 years of age, and 10 (40%) were below 25. All of the day labourers were illiterate. Since prawn farming, they reported to have benefited due to greater paid employment opportunities and higher wages, and opportunities for finding work have increased significantly, especially during the months of peak labour demand for constructing, repairing and preparing *ghers*, from February to

April.

Wage labour is also needed for breaking snails, work being available from about July to October, the peak months for prawn feeding and snail availability. Not only casual day labouring opportunities, but also more secure contractual employment opportunities have increased, in particular for work as guards of *ghers* for a monthly wage (Tk 800 with food or Tk 2,000 without food).

Although wage rates fluctuate during the year with seasonal labour demand, wages in prawn farming areas appear to be two to three times higher than agricultural wage rates in nearby rice producing areas (e.g. Gopalgonj, Faridpur etc.; source: Md. Faridul Islam, Bagerhat Sadar *Thana* Fisheries Officer, pers. comm.). According to the day labourers, the normal wage rates of a labourer are from Tk 80 to 120 (US$ 1.7 to 2.5) day^{-1} during the peak labour demand, and the wage rate drops to Tk 40 to 50 (US$ 0.8 to 1) day^{-1} during the early monsoon. A key informant school teacher (Kobir Ali, Bagerhat Sadar, pers. comm.) commented about the increased wage rates, "*before one could buy one kg of rice with a day's wage, now it buys five to six kg*". According to key informants (Bagerhat *Thana* Fisheries Officers, NGO workers, and CARE GOLDA Project staff), the average annual income of a day labourer was estimated at Tk 18,500 (US$ 385), which was nearly half of prawn farmers (Tk 35,519 or US$ 740).

Most of day labourers reported experiencing real benefits from the higher wages and increased wage-earning opportunities brought about by *gher* expansion suggesting active involvement around 300 days in a year. Almost all day labourers (96%) noted that they were better off now than they were before prawn farming became widespread. Day labourers socio-economic conditions are comparatively better than fisherman and snail collectors due to higher income and higher employment opportunities. However, day labourers probably have less opportunity in prawn farming areas than others because of less access to capital, no education, and other disadvantages (e.g. no cultural land, no income if unexpected events such as illness).

2) Moneylenders

Of the 5 moneylenders interviewed, all were Muslims and aged between 42 to 55 years. All moneylenders were educated, 3 had S.S.C, 1 had H.S.C and 1 had a bachelor's degree. In general local businessmen acted as moneylenders, although they were reluctant to discuss much about their actions as moneylenders, and offered only limited interview responses. By their own account, almost all were engaged in this business for 4 to 6 years, and as they described their role, were simply helping poor people to participate in prawn farming. They help farmers by letting them have money at the rate of 20 to 25% per month (some farmers quoted a higher rate, 30%), usually for 8 to 9 months, repaid after the harvest. As they described the situation, they typically lent money to an average 20 to 30 farmers, with loan sizes ranging from Tk 1,000 to 10,000 (US$ 20.8 to 208). However they did not state the total amount of money lend in a prawn farming season.

A school teacher in Fakirhat (Abul Kashem, pers. comm.) noted that moneylenders capable of providing loans from Tk 50,000 to 100,000 (US$ 1,042 to 2,083) to 20 farmers for a prawn farming season. According to the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.), these moneylenders had clearly played a critical role in *gher* development – without them there would have been far fewer *ghers* – and they appeared to be extracting much of the profit (around 70 to 80%) from them in the process. The present study also found that moneylenders received an average 80% profit from prawn farming when the loan is repaid nine months later.

Moneylenders noted that they were happy about their role in prawn farming, and one noted that from this business he had bought a bus (worth Tk 200,000 or US$ 4,167) for use in commercial transport from Bagerhat to Khulna. However, others did not reveal their views or their benefits from involvement. A local leader in Fakirhat (Abul Kalam, pers. comm.) noted that the moneylenders are probably reaping the biggest benefits from prawn farming. According to key informants (Bagerhat *Thana* Fisheries Officers, NGO workers, and CARE GOLDA Project staff), a typical moneylender make an average net profit of Tk 175,000 (US$ 3,646) year^{-1} from money lending.

3) Baperies

In fry trading, most of the 10 *baperies* interviewed were young, below 40 years of age, average 32.7. Seven (70%) were Muslims and 3 (30%) were Hindus. The *baperies* appeared to be better educated than fry catchers, 7 (70%) had primary education but 3 (30%) were semi-literate. The role of *baperies* is to buy prawn post-larvae from catchers in coastal markets and carry them to fry traders in prawn farming areas. After the fry is bought, it has to be kept alive till it is taken to traders as well as *gher* farmers. This involves labour, besides some transport cost. Money is also needed to buy equipment to keep the fry alive. Based on the *baperies'* description, the fry are kept in a aluminium container of saline water; this water has to be changed 2 to 3 times before the container is taken to a trader. The risk of fry mortality is borne by the *baperies*.

According to the *baperies*, they started their business with Tk 5,000 to 15,000 (US$ 104 to 312.5) capital. The sources of capital were informal, not institutional. Almost all *baperies* noted that they were engaged in this business for 3 to 6 years. They made just enough to maintain their families and repay their loans. A few *baperies* had no operating capital. They had to take a loan from fry traders before each season and repay at the end of season, the profit being used for family expenses. However a few *baperies* (30%) who started out with big capital (Tk 12,000 to 15,000) have made profit from this business – buying and selling more fry from coastal markets to fry traders.

Almost all *beparies* lived in the coastal areas. The *baperies* maintained a good relationship with the catchers and traders for this business. Almost all *baperies* noted that they did not get the price of fry from traders at once, they have to make several trips to release their money. Conversely, they have to pay the catchers immediately, and can not buy on credit, because the catchers sell only for cash. According to respondents, the average net profit of a *baperi* was estimated at Tk 125 (US$ 2.6) day^{-1} (range Tk 80 – 175, median Tk 120) during the season, which was nearly double of fishermen (Tk 64.4 day^{-1}). Almost all *baperies* noted that they were involved in marine shrimp fry trading, day labouring and other small businesses during the rest of the year. The average annual income of *baperies* was estimated at Tk 30,550 (US$ 636.5) *baperi*$^{-1}$, based on all income generating activities, which was lower than prawn farmers (Tk 35,519 or US$ 740 farmer^{-1}). The *baperies* noted that the fry business has improved their social and economic conditions, although they faced problems of lower fry supply, high fry mortality and transport difficulties.

5.4 Overall social and economic impact of prawn farming

5.4.1 Overview

The freshwater prawn farming sector plays an important role in the economy of southwestern Bangladesh, creating jobs, earning foreign currency and supplying protein. A total of 2,167 t prawn (head-on) production with a total area of 5,008 ha (total number of *gher* 21,773, average size 0.23 ha) was estimated in 1998 (average yield 432.6 kg ha^{-1}). The livelihoods of a large number of people are associated with prawn farming. It was estimated together with published sources and the results of primary data collected in Bagerhat district that around 45,000 people are directly involved in prawn sector. Potential incomes for this sector are great and it was estimated around Tk 606 million (US$ 12.6 million) in a season from whole parts of prawn farming system, an average value of Tk 13,467 (US$ 281) person^{-1}. Amongst major income generated from 79% prawn farmers, 9% processing companies, 3.7% prawn traders, and the rest (8.3%) of other associated groups.

5.4.2 Positive impacts

The introduction of freshwater prawn production infused unprecedented amounts of cash into the local economy. This can simply be demonstrated by the differences between revenue ha^{-1} prawns, compared with fish or rice. Clearly there have been visible qualitative and quantitative changes in standard of living, food consumption, and level of economic activity in the prawn farming areas. According to the farmers, the main benefits from prawn farming were an increase in economic solvency and improved social status in the community. A key informant, the Bagerhat Sadar *Thana* Fisheries Officer (Md. Faridul Islam, pers. comm.) noted that before prawn farming a large number of farmers lived below the poverty line and after converting their land to *gher* most of these households are now at least eating rice. Farmers also mentioned that the new *gher*-based production systems can substantially improve their livelihoods. A few farmers noted that their families had benefited from selling and eating vegetable, which is grown in *gher* dike.

Some small farmers (6%) have experienced dramatic improvement in their living standards because the land that they have converted into *ghers* was previously not utilised; lying so low in the *beel* that no crops could be grown. For these farmers prawn production has obviously brought positive impact. A few small farmers have managed to avoid high-interest loans, and increased cash income had provided the opportunity for more investment in productive resources. With a few exceptions they have hopes and expectations of achieving a significantly better life after a few more years of prawn production.

It was found that all (100%) of the larger farmers (> 0.61 ha *gher*) have gained positive experience on prawn farming. Most of the medium sized (0.21 – 0.61 ha *gher*) farmers (91%) have also benefited and improved their socio-economic conditions, even, 69% small farmers (< 0.21 ha) have also benefited. However larger and wealthy farmers have benefited the most, and poor farmers with small *ghers* have benefited the least.

A range of associated groups have also benefited from prawn sector. Improvements in the standard of living which have occurred for prawn traders, fry traders, snail traders, snail collectors, women, middlemen, moneylenders, and even day labourers. The position of women in their families and communities has improved due to involving *gher* activities. A net work for fry trading - the fishermen, middlemen, fry traders, field workers (*forias*) all are gained from this network. A similar network for snail trading - the collectors, middlemen, boat operators, traders, day labourers (including women) all derive benefits from this system. After use of snail meat, a huge amount of snail shells are discarded, which are used poultry feed, fishmeal and fertiliser and generated new employment opportunities. The opportunities for day labourers to find work has increased significantly for *gher* farming. Additional employment opportunities are also generated in the ice plants, commercial prawn feed industries and transport sector, from *rickshaw* pullers to large trucks which carry prawn from local markets to prawn processing plants.

5.4.3 Negative impacts

Food security may be an issue for small and marginal farmers who have converted to *ghers*, especially those who have turned good rice field. Farmers who converted rice fields reported that they felt greater insecurity due to lower rice production in their *gher*. Agricultural sharecropping[9] opportunities have been reduced dramatically as a result of prawn farming. According to key informants (Bagerhat *Thana* Fisheries Officers, NGO workers, and CARE GOLDA project staff), rich farmers who would previously have given their surplus land out for sharecropping now prefer to lease it out for *gher* construction. As a result of reduced sharecropping opportunities, some households faced reduced food security.

Due to the increased amounts of cash transactions, and the more from traditional market exchanges, and increasing number of small farmers can be described as cash croppers, a significant change. As a result, some negative impacts could be found. For example gambling, the consumption of alcohol, tobacco, and drugs by farmers has increased according to key informants. A school teacher in Bagerhat Sadar (Md. Feroz Ali, pers. comm.) noted that some women lived alone with their young children because their husbands had married again and abandoned them. Dowry payment have also increased as a result of prawn farming and increased pressure on women for exploitation of their families. As noted earlier, the incidence of theft has also increased in prawn farming areas. A local leader in Fakirhat (Abul Kalam, pers. comm.) noted that sometimes thieves that have been caught were punished by the community people, beatings were meted out as punishment, and some have been handed over to the police.

[9] Under a typical sharecropping system in Bangladesh, the share cropper is given the right to cultivate the land at his own initiative and cost in return of 50% of the total crop production. In the event of crop production a landowner gets 50% of output, while in the event of crop failure the landowner does not bear any costs.

CHAPTER 6

DISCUSSION

6.1 Introduction

The study has explored the practice of freshwater prawn farming in *gher* systems, and carried out an economic analysis of *gher* production and its socio-economic effect on prawn farming community. The research focused on production systems in terms of productivity and profitability, socially and economically, all being important parameters of sustainability. The purpose of this chapter is to assess the evidence developed in the previous chapters, to describe how prawn farming brings social and economic benefits to the associated groups, and to consider the sustainability of *gher* farming in the broad sense. In doing so, it also returns to the original hypothesis of the study, that is 'the introduction of freshwater prawn production into *gher* systems in the southwestern Bangladesh is able to bring about widespread and sustainable social and economic benefits', and examines the extent to which these can be supported. Finally in response to the increasing trend towards diversity natural-resource based development in terms of livelihood objectives, and in particular, sustainable livelihoods (SL) (Ashley and Carney, 1999), an outline SL prospective is developed.

6.2 Success of *gher* farming

The evidence of the study, together with other secondary information confirms that the introduction of freshwater prawn production into *gher* systems in the southwestern Bangladesh has brought about widespread social and economic benefits. The positive changes brought about by the cultivation of freshwater prawns and the income generated from the development of a completely new cash crop, was reported to have occurred, by most farmers and associated groups. An estimated about 45,000 people are directly involved and generated Tk 606 million (US$ 12.6 million) of income in a prawn farming season. Most of the farmers have improved their income through prawn farming. However, there are several primary factors, which are increasing vulnerability amongst *gher* farmers, including increasing operating costs, the high level of debt, low supplies of wild fry, high price of snail meat, lack of alternative feeds, and the virtual absence of technical assistance. The following paragraphs discuss the three components of the research hypothesis, based on prawn production in *gher* systems, economic analysis and social analysis.

6.2.1 Production technology

The potential for freshwater prawn production in *gher* systems to continue, depends on inputs, production systems, markets and technology development, as has been described in Chapter 3. The concept of *gher* farming makes it possible to incorporate a wide variety of crops together with prawn and fish culture. Almost all (86%) farmers are mainly dependent on integrated prawn farming and only a few did not so due to low production. According to Mires (1991), integrated prawn and fish culture is suitable where prawn and fish do not compete for feed. Durairaj and Umamaheswari (1991) noted that in India the growth and yields of prawn in integrated farming systems did not appear to be influenced by fish, and therefore prawn-cum-fish culture was technically and economically viable. Hulata *et al.*, (1990) obtained good results when prawn and carp were cultured in an integrated system. In Bangladesh, Hoq *et al.*, (1996) also noted that the integrated culture of freshwater prawns with Indian and Chinese carps was more profitable and gave better results.

Productivity of prawn in *gher* systems is closely related to seed and feed inputs. However, farmers noted that the shortage of wild fry and their high price to be one of the biggest constraints. A decade ago, Shafi (1990) recommended the construction of a large hatchery in Bangladesh to compensate for the possible shortage of prawn fry. Although hatchery production is technically feasible, and has been introduced into Bangladesh, it has not effectively been established. Regardless of the source of fry, the growth, survival and yield of *M. rosenbergii* depends on stocking density, environmental quality and feed availability (Siddiqui *et al.,* 1997). Better survival of stocks has been reported when nursing of post-larvae is done in net cages (Singh and Vijiarungam, 1992). In the study area the average stocking density of post-larvae was 20,680 ha^{-1} and nursing of post-larvae has increased in recent years to improve survival rate. Hulata *et al.*, (1990) got significant results when prawns were stocked at 20,000 ha^{-1} with carp. However, New (1995) noted that higher densities appear to result in a greater size variation at harvest, and recommended stocking rates of 12,500 prawns ha^{-1}, which gave better yields.

The other main constraint is feed. Currently farmers feed a diet based primarily on freshwater snails (*P. globosa*), noting that production of prawn is higher and costs lower, when snails are used rather than other feed. This was carborated by Bombeo-Tuburan *et al.*, (1995) who got significant results when they use snail as feed for the tiger shrimp, *Penaeus monodon*, in ponds; stating that the snail, with an essential amino acid index (EAAI) of 0.84, is a useful alternative source of protein. According to Muley (1975) freshwater snail contains about 37.5 to 68.2% protein, 6.3 to 10.8% fat and 3 to 6.2% glycogen, which is a suitable composition for feeding prawns. Sing (1991) reported that *P. globosa* contains about 4.745 to 5.594 Kcal g^{-1} energy in dry weight basis.

However, as described earlier the snail population has declined in the Bagerhat area due to excessive harvesting and snails are now procured from neighbouring districts. Supplies of snail are also increasingly irregular. Thus almost all farmers now using cooked rice and other home made feed, besides snail meat. Boonyaratpalin and New (1993) noted that many farmers make their own feed for *Macrobrachium* in other countries, and in Thailand soybean meal, corn meal, broken rice and sometimes shrimp shell meal are commonly used. The use of organic fertiliser has also been proposed a partial replacement for formulated feeds in *M. rosenbergii* culture (MacLean *et al.*, 1989). In *gher* farming systems, development of a feed based on low-cost locally produced ingredients would help increase prawn production.

The *gher* design potentially provides good opportunities for diversified production. Most farmers (87.25%) produced rice in their *gher* for additional income and food consumption, but 12.75% not doing so due to low production. Overall, rice production has decreased in the prawn-raising areas, and more households are now dependent on purchased rice rather than on the product of their own fields. It was found that almost farmers avoided cultivation of a monsoon season rice crop (*aman* rice) when the prawns are in the *gher*, because of negative effects of prawn growth. However, Roy *et al.*, (1991) noted that in integrated prawn culture in deep water rice fields, rice production was increased by the presence of fish and prawn. Nguyen (1993) stated that integrating prawn culture with rice farming is ecologically sound, and a good method of diversification in Vietnam, where prawns predate on insects and improve soil fertility and are a high value cash crop. These reports suggest that the culture of monsoon season rice crop in *gher* systems is technically possible.

Markets have become a major issue for many aquaculture sectors, where consumer demands, international competitiveness, health and quality product attributes have assumed far greater importance than in early stages where production levels were lower (Muir *et al.*, 1996). According to Shang (1981), the return of farm depends on production level and market prices, the price usually fluctuating seasonally due to variations in the supply and demand. Countries starting freshwater prawn production without basic information, have experienced considerable marketing problems; as New (1995) noted, economic evaluations of prawn grow-out systems are few and far between. The consumer acceptance and price levels in the market place are two of the major factors that determine economic viability in many situations (Sadanandan *et al.*, 1992). As marketing respects, prawn production is economically profitable and earning considerable amounts of foreign exchange, and it is anticipated that the potential of Bangladeshis as a low cost producer may generate even greater future economic benefits.

There are several risks involved in prawn production, in terms of return on investment and technological aspects. In the study area the production of prawn (head-on) is quite variable because of the simple culture method, averaging 432 kg ha^{-1} (range 220 – 650 and median 425 kg ha^{-1}). *Gher* farmers are not achieving the higher level of productivity compared to other countries due to a variety of technical constraints. It might be necessary to promote low-cost technologies for higher production (Laureti, 1991; Nash, 1992; Dillon and Hardaker, 1993; Pillay, 1994). It may be necessary to provide financial and technical assistance, training and extension services, and scientific co-operation for aquaculture development (FAO, 1997b). Garforth and Lawrence (1997) noted that extension programmes should encourage the adaptation of new technologies. Many developing countries (such as Nepal) have increased farm productivity by encouraging the adoption of new technology (Rauniyar, 1998). Thus it is necessary to provide low-cost technologies to increase *gher* productivity as well as provide institutional and policy support.

6.2.2 Economic returns

In *gher* farming systems, prawn production has been shown to have created additional income for farmers. When comparing the returns on freshwater prawn farming and rice cultivation, there are striking differences, the net return of prawn production averaged Tk 57,812 (US$ 1,204) ha^{-1}, while that of rice production averaged Tk 9,398 (US$ 196) ha^{-1}. Most of the farmers including those who would normally be classified as small and marginal have improved their income through increased profitability in prawn farming and diversified cropping systems. The study has shown that prawn farming communities present a picture of rapid economic development due to prawn cultivation (total income Tk 606 million or US$ 12.6 million in a season). One of the most significant differences is simply the increased flow of cash in the local economy.

As described in chapter 4, the delivery of economic benefits of *gher* farming depend on market chains and on resource ownership. Despite the highest production costs per ha *gher*, the highest net return is found (Tk 79,586 or US$ 1,658 ha^{-1}; average net return Tk 76,856 or US$ 1,602 ha^{-1}) amongst larger farmers (> 0.61 ha) mainly due to the higher yield of prawn, fish and rice. It is evident that seed, feed and labour play a very important role in prawn production and its net return, and this has led to the higher productivity of larger *ghers*. Medium sized (0.21-0.61 ha) farmers obtained considerable amounts of profit (Tk 76,832 or US$ 1,601 ha^{-1}). However, smaller (< 0.21 ha) farmers had lower profit (Tk 74,163 or US$ 1,545 ha^{-1}, 3% less than average) due to lower inputs of seed and feed as well as lower production costs.

There may be potential to increase productivity, particularly for small and marginal farmers. The profitability of different *gher* size categories was closely related to 1) increased production, 2) decreased input costs, mainly seed and feed, and 3) increased market price. Almost all farmers noted that in recent years their profit had decreased as costs of *gher* farming had increased significantly while the price of prawns had not increased to a similar degree. For profitability given relatively static market prices, the main constraints are costs of production associated with input costs and/or output efficiency. The costs of production depend on availability and quality of inputs and *gher* management.

A range of associated groups have gained from prawn marketing. A network for prawn trading - traders, *forias*, day labourers, agents, processing companies all have benefited from this system. It was estimated that from Tk 100,000 to Tk 1 million (US$ 2,083 to 20,833) in cash transactions are conducted daily in each market during the peak marketing season (November to January).

6.2.3 Social benefits

As noted in Chapter 5, the introduction of freshwater prawn production into *gher* systems has been accompanied by a great deal of social benefit and the extent to which these benefits are sufficiently distributed depends on relative power relationships within the community. A range of associated groups such as prawn farmers, prawn traders, fry traders, snail traders, snail collectors, women, middlemen, moneylenders, and even day labourers - all have benefited. A range of social transformations can be seen to have been brought about by the rapid and widespread adoption of *gher* farming.

Socio-economic conditions have altered, and most of the farmers (81%) have made significant profits while only a few are unable to repay debts. Significant positive impacts have been observed for 69% of smaller farmers (< 0.21 ha) who were able to convert their land for prawn production (average profit Tk 17,466 or US$ 364 farmer^{-1} year^{-1}). Amongst medium sized farmers (0.21 - 0.61 ha) 91% also benefited as they have invested their own money in their own land, without taking loan (average profit Tk

28,128 or US$ 586 farmer^{-1} year^{-1}). For big farmers (> 0.61 ha *gher*) who were already moderately prosperous, constructed *ghers* with their own money, and 100% obtained benefits, and many have become wealthy in local terms (average profit Tk 42,101 or US$ 877 farmer^{-1} year^{-1}) (Table 6.1). Certain categories of prawn farmers (6%), who had land but were unable to cultivate it due to lying so low in *beel*, have seen significant improvements in their level of living as a result of converting their land into *ghers*.

Table 6.1 Income of farmers from prawn sector.

Farmers category	Total No. of farmers	% of farmers improved socio-economic conditions	Average annual income farmer^{-1}		Total earnings		% of total earnings
			Tk	US$	Tk million	US$ million	
Small farmers	8,724 (45%)	69	17,466	364	152.37	3.17	31.75
Medium farmers	9,017 (46%)	91	28,128	586	253.63	5.28	52.85
Large farmers	1,755 (9%)	100	42,101	877	73.89	1.54	15.40

Source: survey data, 1999.

However, 19% farmers have not obtained any specific benefits from their involvement in prawn farming. Most of these less successful farmers failed their prawn harvest, due to flood, drought, disease outbreak, water quality deterioration, poor feed or seed inputs, or lack of technical knowledge; which was the single most important reason for their disadvantaged situation.

Since prawn farming, the poor and landless labourers have also benefited due to greater paid employment opportunities and higher wages (average annual income Tk 18,500 or US$ 385 person^{-1}). Wage labour is needed for snail breaking, *gher* construction, fry trading, carrying ice from the ice factories, break it up, mix ice with prawns, load prawns on to the vehicles, etc. Day labourers situation's had been so desperate before prawn farming, and now they are able to eat meals three times a day.

Prawn production has meant increased workloads for almost all women (who have *gher*) along with a change in the type of productive economic activities in which women become involved. The increased role of women in *gher* farming has increased *gher* production and improved their position in the family and society. They now tend to play a stronger role in economic decisions for the management of their households, including children education, attending social and religious functions, inviting guests, accepting family planning methods, etc.

Other associated groups such as fry traders, snail traders, prawn traders - all appeared to have gained from their activities and improved their social status. Amongst prawn traders have benefited the most (average net profit Tk 130,500 or US$ 2,719 trader^{-1} in a season; 3 months) and snail traders the least (average net profit Tk 14,500 or US$ 302 trader^{-1} in a season). Fry traders have also obtained considerable amounts of profit (average Tk 41,400 or US$ 863 trader^{-1} in a season) from their business.

However, sharecroppers have been the group most negatively effected by the shift of prawn cultivation as sharecropping opportunities have dramatically decreased. Food security is probably the most significant concern for those farmers who have converted to *ghers*, especially those who have used good rice land.

6.3 Sustainability of *gher* farming

According to Stewart (1995), the concept of sustainability in the context of human activities has its roots the growth of the environmental movement of the 1960s and 70s in the west, and, in less developed countries (LDCs), the perceived shortfalls in the capacity of technology transfer and economic growth to overcome increasing problems of poverty. Sustainable development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable (FAO, 1988). Tisdell (1999) noted that aquaculture development is giving rise to concerns about its environmental consequences and the sustainability of aquaculture. The environment is defined as being external to the aquaculture system and includes the natural resources used for aquaculture development such as land, water, nutrients and biological diversity; the internal environment of the culture system is considered as part of the husbandry of production technology (Edwards, 1998). To be sustainable, it is therefore of vital importance that aquaculture is environmentally friendly (Asche *et al.*, 1999). Sustainability may be expressed in terms of three interrelated aspects which are shown in Figure 6.1: production technology, social and economic aspects, and environmental aspects (AIT, 1994; cited in Edwards, 1998). An aquaculture farming system needs to be sufficiently productive to make it an attractive option versus alternative or competing uses of resources.

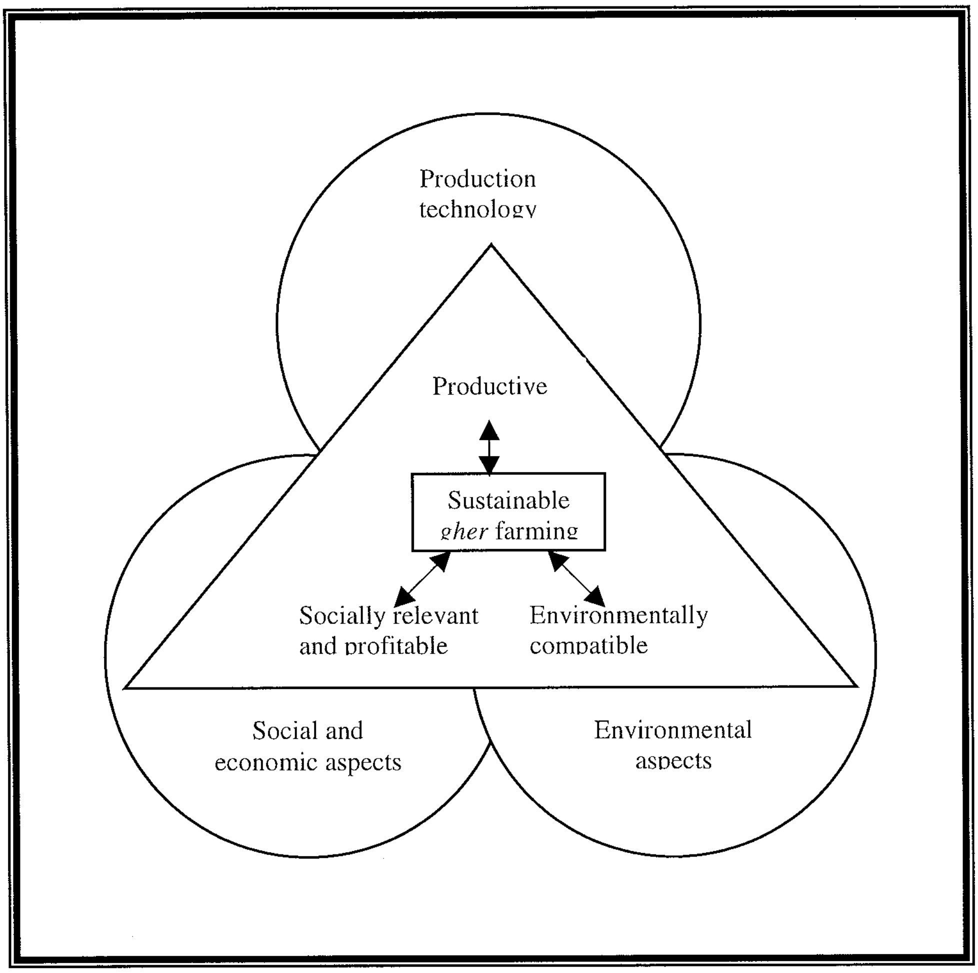

Figure 6.1 The three inter-related aspects of the sustainability of prawn farming in *gher* systems (adapted from AIT, 1994; Edwards, 1998).

Prawn farming in *gher* systems appears initially to have broad potential in terms of sustainability, based on the local level concept of production continuing at present levels in present location without time limit (Asche *et al.*, 1999). However, there are concerns about the long-term sustainability due to social stability, economic viability, and technological and environmental aspects, which are described as follows –

6.3.1 Social and economic aspects

Social and economic aspects of aquaculture still have received relatively little attention compared to production aspects and are major constraints to development through aquaculture (Edwards, 1998). In Bagerhat district, freshwater prawn farming into *gher* systems has been widely practised and socially accepted by the farmers; however, differences in farming practices were found between regions, *gher* sizes, educational levels, age groups, family status and social traditions, all of which may have an impact on *gher* development.

Prawn farming has been a simple practice for the rural poor in southwestern Bangladesh, and proven to contribute to enhance and diversified food supply, and income generation. However, the rural economy is characterised by inadequate social services and infrastructural development. Access of the rural population to vital social services such as education and health is poor. Infrastructures such as roads, transportation are inadequate and rural electrification is slow. Despite planned rural development attempts for more than two decades in Bangladesh, various indices of rural standards and quality of life do not show significant improvement.

Prawn production has implications for the economic sustainability of the farming systems. Economic factors influencing *gher* development may be considered at the macro-level and the micro-level. Macro-level issues include world trade, national development goals, government policy and social characteristics such as cultural attitudes and input supply and marketing. Micro-level issues are mainly alternative uses of resources. The efficiency of resources allocation and micro-economic analysis of existing *gher* farming may help in the successful establishment and development of future prawn industry enterprises.

Bangladesh currently has an advantage in relatively low labour and production cost, and its production has up to now supply been supportable from local natural resources. However, it may face competition, notably from Vietnam, India and Myanmar (DOF, 1999). The global conditions of intensification, population growth, economic growth and technical development might be expected to appear in Bangladesh, these factors may also influence positively on prawn sector.

6.3.2 Technological aspects

Production technology may be subdivided into three main aspects: cultural species, culture facility and husbandry (Edwards, 1998). From these aspects freshwater prawn production in *gher* systems has a great potential. However, due to the lack of technological capacity *gher* farmers are not achieving high levels of productivity. Prawn farmers face low supplies of wild fry, snail meat and lack of alternative prawn feed. Almost all farmers noted that the supply of wild post-larvae was about 50% of demand in 1998, and demand has increased due to expansion of *ghers* in 1999. Most of the prawns are cultivated using more extensive methods and therefore production is low compared to other countries (Table 6.2). Prawn farming systems in Vietnam reported higher yields and lower input costs than those in Bangladesh (DFID, 1997).

Table 6.2 Comparative prawn production (kg ha^{-1}) in Bangladesh and other producing countries.

Countries	Prawn production (kg ha^{-1})	References
Bangladesh	432	Survey data
Egypt	360 to 460	Sadek and Moreau, 1996
India	525 to 1,288	Harikrishnan and Kurup, 1995
Israel	1,500 to 2,000	Mires, 1991
Malaysia	979	Ang, 1990
Puerto Rico	2,346	Perez, 1999
Taiwan	1,500	New, 1995
Vietnam	500	New, 1995

It may be necessary to increase technology and improve the management skills, developing and applying methods that can cope with restrictions of reduced resources and increased quality control. Improve management skills and lower inputs (feed and seed), reduce stress and increase productivity might be expected to increase production.

6.3.3 Environmental aspects

In Asian countries, the rapid expansion of marine shrimp (i.e. penaeid crustacean) farming has led to a range of environmental problems during the 1980s and 1990s (Csavas, 1993; Phillips *et al.*, 1993; cited in Be *et al.*, 1999). According to Kamp and Brand (1994), however freshwater prawn farming in Bangladesh had not been associated with any of the negative environmental consequences for which marine shrimp production has received so much criticism. However, in recent years there are some concerns about the long-term environmental sustainability. Unplanned construction of *ghers* in *beel* and low-lying areas is likely to have the negative impacts on reduced fish production, reduced wildlife, loss of local varieties of rice, loss of aquatic plants etc. There are also some problems which *gher* operators face, most are of a technical nature. Packing *ghers* back-to back and side-to-side raises worries about water quality control and about disease.

Negative environmental effects appears to be extensive over-harvesting of snails for use as prawn feed, not only in the prawn raising areas but in many surrounding districts as well. Over-harvesting snails has also created problems of disposal of large quantities snail shells, which has resulted in pollution and blockage of canals and other open water bodies where they are often dumped.

Wild stock of prawns has decreased due to high fishing pressure and uncontrolled fishing of brood prawns which may threat to their natural population. This has also affected the livelihoods of fishermen, whose catches have fallen. In spite of these environmental problems, the practice of prawn farming has offered an opportunity for increasing farmers incomes.

6.4 Sustainable livelihoods

A further extension of the concept of sustainability is that of sustainable livelihoods, in which specific focus is given to the conditions of target populations, most particularly those with poorer quality of livelihood. According to Ashley and Carney (1999), a sustainable livelihood (SL) approach is a way of thinking about the objectives, scope and priorities for development, in order to enhance progress in poverty elimination. As described by Chambers and Conway (1992) '*a livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the long and short term*'.

Scoones (1998) noted that five key indicators are important for assessing the achievement of sustainable livelihoods: 1) poverty reduction, 2) well-being and capabilities, 3) livelihood adaptation, 4) vulnerability and resilience, and 5) natural resource base sustainability. According to Ashley and Carney (1999), livelihoods are sustainable when people:

- are resilient in the face of external shocks and stress;
- are not dependent upon external support (or if they are, this support should itself be economically and institutionally sustainable);
- maintain the long-term productivity of natural resources; and
- do not undermine the livelihoods of, or compromise the livelihood options open to, others.

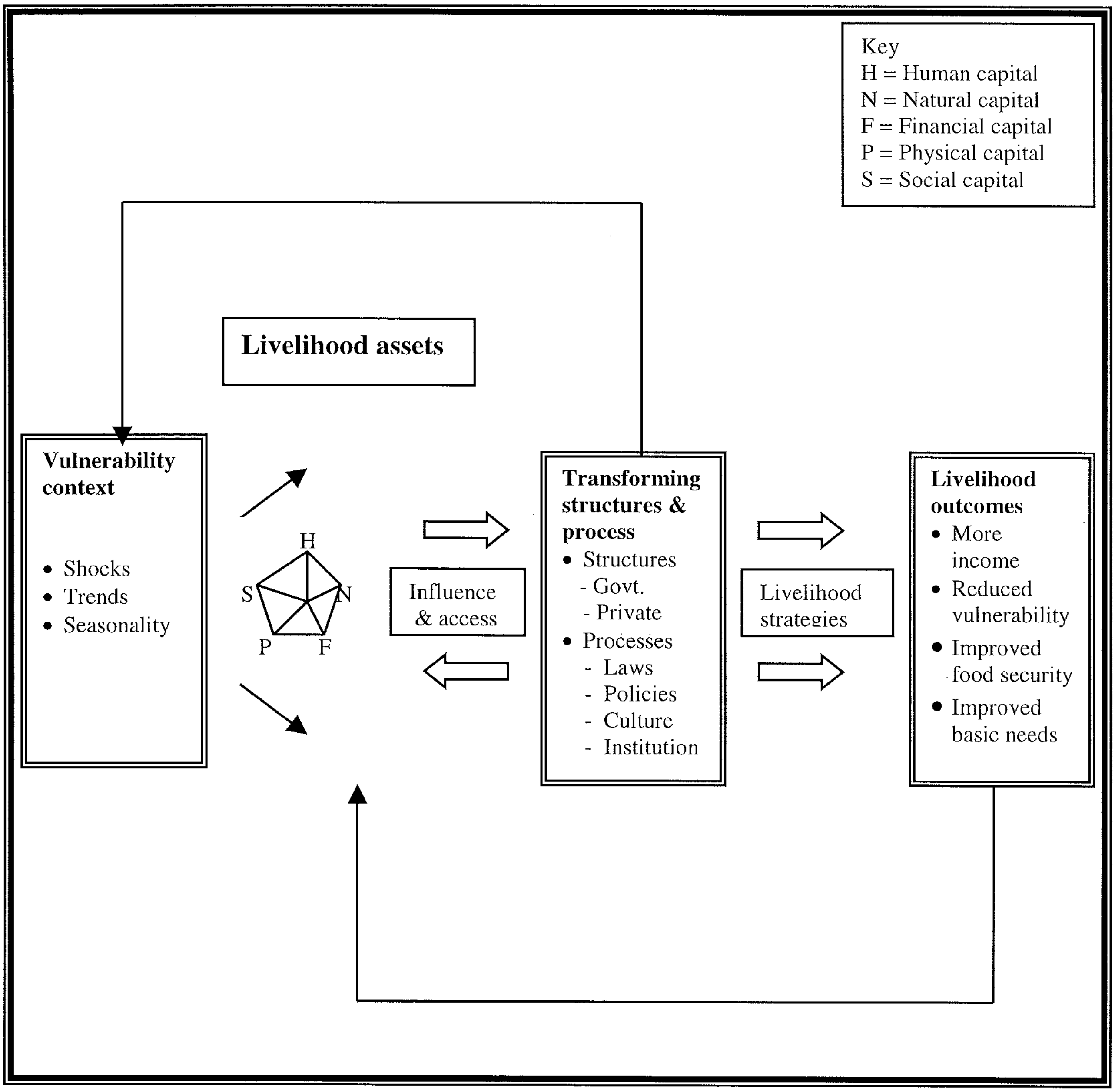

Figure 6.2 Sustainable livelihoods framework (from Ashley and Carney, 1999).

Figure 6.2 shows the sustainable livelihoods framework and its various factors, that constrain or enhance livelihood opportunities and show how they relate to each other. The framework provides a way of thinking through the different influences (constraints and opportunities) on livelihoods, and ensuring that important factors are not neglected (Ashley and Carney, 1999). The sustainable livelihoods framework helps in thinking holistically about the things that poor might be very vulnerable to, the assets and resources that help them thrive and survive, and the policies and institutions that impact on their livelihoods (DFID, 2000). The framework shows how, in differing contexts, sustainable livelihoods are achieved through access to a range of livelihood assets which are combined in the pursuit of different livelihood strategies. Central to the framework is the analysis of the range of formal and informal organisational and institutional factors that influence sustainable livelihoods outcomes.

The prawn sector in Bangladesh has an important and significant role in providing food and offering income earning opportunities to some of the poorest people. The basis of sustainable livelihoods is income generation and food supply. If prawn farmers, fry traders, snail traders, prawn traders and other associated people have access to a secure source of income they will escape poverty. Income helps poor farmers to buy food and gain access to social benefits, and allows farmers to withstand shocks and prevent them falling into poverty. A household is food secure when it has the capacity to procure a stable and sustainable basket of adequate food.

The livelihood security of the farmers is assumed to increase with the increase in income of the farmers. A farming families can be said to be 'livelihood secure' when members have adequate and sustainable access through farming activities, to income and resources to meet basic needs. Basic needs would include food, drinking water, housing, health facilities and economic security. However, social, economic and political relations of associations and inequality may influence livelihood security and patterns. The following sections consider the findings of the study with respect to the livelihoods framework, in taking further the concepts of the necessary conditions in which the sector can contribute to livelihoods, and its activities and environment to underpinned where appropriate with development inputs. The key sections of the livelihood framework are considered in turn:

Livelihood assets

The natural resources as well as 'livelihood assets' of prawn farming are:

- Human capital – human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue their livelihood strategies. As well as being of intrinsic value, human capital is required in order to make use of any of the four other types of assets. It is therefore necessary, though not on its own sufficient, for the achievement of positive livelihood outcomes. In prawn farming sector, people are moderately healthy and they have built up skills (e.g. fry catching, snail collection, prawn farming, integrated *gher* management etc.) through their own knowledge, but there is potential to improve their health to more work ability for their sustainable livelihoods.

- Natural capital – natural capital of prawn farming represents the natural resources - land, water, wild fry, snail, and wider environmental goods that are critical for farmers and associated groups, to support production. Large areas of land, water and natural resources have been used for prawn production. However, rapid population growth in prawn farming communities have led to accelerated natural capital depletion that has affected prawn production as well as income.

- Financial capital – financial capital denotes the financial resources that people use to achieve their livelihood objectives. Financial capital of prawn farming represents the savings, credit etc. The prawn culture industry has the potential to generate considerable amounts of financial capital relative to the resources of associated groups. However the study shows that small farmers, fishermen, snail collectors etc. are often disadvantaged due to differentially distributed financial capital.

- Physical capital – transport, shelter, road, market etc. are the physical capital of prawn farming that enable people to pursue their livelihood strategies. However, different groups of people such as small farmers, fishermen, snail collectors etc. are often disadvantaged due to the limited physical capital.

- Social capital – almost all community people are disadvantaged in social capital such as the networks, groups, trust, access to institutions etc. The lack of social capital has affected livelihoods of poor people in prawn farming communities.

Vulnerability context

The livelihoods of individuals or groups as previously defined in terms of capital assets are further affected by the vulnerability context. Here, the vulnerability context refers to the seasonality, trends, and shocks that have affected livelihoods of people in prawn farming communities. The external environment of prawn farming in which people exist:

- Shocks – illness, natural disasters (flood, drought), conflicts, diseases etc. are the shocks of prawn farming and make prawn cultivation hazardous.

- Trends – it is important to recognise the difference between local and national or global trends. Many trends such as increasing population may aggravate the problem of meagre incomes of poor people (e.g. small farmers, fishermen, snail collectors, day labourers etc.).

- Seasons – seasonal employment opportunities such as fry catching, fry trading, snail collection, snail trading, prawn trading all have affected livelihoods of poor people.

The key attribute of these factors is that they are not susceptible to control by local people themselves, at least in the short term. It is therefore important to identify indirect means by which the negative effects of the vulnerability context can be minimised – including building greater resilience and improving overall livelihood security. The wider availability of assets in prawn farming are fundamentally affected by critical trends as well as by shocks and seasonality – over which they have limited or no control. Shocks by flood or drought in prawn farming areas have destroyed assets directly. Due to long-term trends livelihoods can be made more or less vulnerable. Seasonal shifts in employment opportunities and food availability are one of the greatest and most enduring sources of hardship for poor people in prawn farming areas.

Transforming structures and process

The institutions and policies of the transforming structures and processes have a profound influence on access to assets. Transforming structures and processes are the institutions, organisations, policies and legislation that shape livelihoods. Understanding institutional processes allows for the identification of barriers and opportunities to sustainable livelihoods. An absence of appropriate structures and process is a major constraint to the development prawn production in Bangladesh. Many organisations - both private and public sector do not reach in prawn farming areas. NGOs have not played much of role in the development of the industry in general. Thus lack of institutional and administrative help, poor infrastructures and extension services – all have affected livelihoods of poor people.

Livelihood strategies

Livelihood strategies tend to focus on income sources. Income is an important objective for poor people, higher incomes allow members to satisfy their needs and also to invest in other productive activities. In prawn farming communities, livelihood strategies fully depend on poor natural resources. However, the *gher* design provides an ideal opportunity for a diversified production strategy to increase farmers income.

Livelihood outcomes

Transforming structures and process directly influence livelihood outcomes. Policy, institutions and processes (PIP) are key determinants of livelihood outcomes (DFID, 2000). Livelihood outcomes can be thought of as the inverse of poverty. Contributing to the eradication of poverty and food insecurity depends on equitable access to resources, access of disadvantaged groups to sufficient, safe and nutritionally adequate food. In spite of poor resources, livelihood outcomes of prawn farming are positive and most of people have increased their income, food security, and basic needs, although many of them have not improved their income as such level to resilient vulnerability. It is essential to need institutional and organisational support, government support, more research and knowledge of prawn farming, and extension services for sustainable livelihoods.

6.5 An overview of the potential of the sector

The original hypothesis of the study was that 'the introduction of freshwater prawn production into *gher* systems in the southwestern Bangladesh is able to bring about widespread and sustainable social and economic benefits'. From the above discussion and evidence of the study confirms that prawn farming into *gher* systems has brought about such benefits, but concerns exist concerning its as long-term sustainability. Poor resources, weak transforming structures and process, vulnerability context, poor institutional support, lack of extension services – can all be identified as constraints for long-term sustainability as well as for sustainable livelihoods to the farmers and associated groups.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

The freshwater prawn (*M. rosenbergii*) farming sector plays an important role in the economy of SW Bangladesh, earning valuable foreign exchange and contributing to increased food production, diversifying the economy, increased employment opportunities, and maintaining rural communities.

Prawn farming is now a good business and farmers and their families have a good basis of skills upon which to draw in the management of their *gher*. There has been a steady increase in the production of prawn by small and marginal farmers, and prawn farming promises to remain a growth sector for the economy. However, it is questionable whether its benefits are completely evident within rural communities, particularly amongst its poorer members, and the study has identified a number of key issues:

- the displacement of traditional food production systems and the potential for increased risk to food security
- the greater dependence on cash transactions for rural livelihoods
- the technical risks faced by smaller *gher* producers and their vulnerability to debt and the reduction of their physical and financial livelihood capital
- the shift in opportunities for landless groups, some of which may have been positive, but reducing greater dependence on specific labouring roles, as appeared to participation, e.g. in share-cropping

- the dependence of a network of supplies of goods and services to the prawn sector – fry catchers, snail harvesters, and their vulnerability, associated with increased pressure on the resources they exploit
- the potential environmental change brought about by major changes in land use, interference with drainage systems, and changing habitats
- the evidence of significant financial gain by some sectors of the communities concerned and their increased potential for dominating the asset systems, and the social influence structures of these areas.

There are also concerns about the long-term sustainability of prawn farming. For farmers, the lack of technical knowledge in *gher* management may have an effect on productivity, and on the ability to award natural resource depletion. A range of technical issues may be important for the development of *gher* farming including:

1) Improved management skills: farmers need to extend their basic knowledge and develop better skills in integrated prawn cultivation methods in *gher* environments. Training and extension services would help to improve profitability and reduce risks. Better ideas of suitable input levels for best returns in specific conditions, ideally reducing heavy cash requirements during the prawn cycle. Although a few NGOs and the DFID-funded CARE GOLDA Project have been providing training of farmers and their families, the government's Fisheries Department is ill equipped to provide training and extension. A critical issue is to get farmers to view *ghers* more as integrated

farming systems than as intensive units for prawn production. Farmers need a sufficient knowledge of rice and crop cultivation techniques compatible with prawn and fish cultivation, to maintain or increase rice and other crop production. If farmers are persuaded to cultivate *aman* and *aus* rice crops in their *ghers*, their income and local food supply will increase and the overall risks will decline. In addition, agricultural labour demand will increase especially during the *aman* season when other labour opportunities are scarce.

2) Widening options for credit: *dadon* and other systems will not disappear, but if farmers and their families have a wider range of income sources and less absolute dependence on prawns, they may be able to increase their choices – these in turn could be improved, e.g. by NGO and other groups advancing credit on more reasonable terms. The high level of risk that most small and marginal farmers face is the high-interest loans that they must take from local moneylenders and others in order to finance *gher* construction and operation. Many farmers find that when they harvest their prawns they owe their maximum profit to the moneylenders. The provision of low-interest credit to help ease the debt burden and reduce the risks for small and marginal farmers, as well as to improve access to enter prawn farming for poor people. Good management may also reduce farmers input costs that reduce risks and their need for borrowing.

3) Prawn stock: access to low-cost and high quality post-larvae from hatcheries to reduce the current, almost total reliance on wild post-larvae. Wild post-larvae and juvenile for stocking *ghers* are in scarce supply, a problem which is causing prawn farmers grave concern. The distribution system of prawn stock appears to function relatively well, but hatchery-raised prawn seed are going to be needed very soon to avert a crisis in the supply of stocking materials to existing and new *gher* farmers. Hatcheries may reduce the pressure of fry exploitation and increase wild production.

4) Prawn feed: the need for the development of low-cost prawn feed to reduce the current, heavy dependence on natural, decreasing supplies of snails which have been the standard feed since the inception of prawn cultivation in *gher* systems. Farmers are at a turning point in their prawn feeding strategies due to the scarcity and high price of snail meat and are experimenting with other feeding regimens out of necessity. However, lack of knowledge and information make them feel insecure about these experiments. Many feel that the best alternative is commercial prawn feed, also expensive and in short supply. Development of a feed based on low-cost locally produced ingredients would help improve farmer's declining profit margins and reduce the negative environmental consequences of over-harvesting of snails.

5) Better approaches to promoting the role of women: *gher* farming has already introduced new ways of thinking about women's work, as evidenced by

changes in the types of work that women perform. The increased participation of women in *gher* farming could bring women's economic power along with their increased work loads. Due to women's involvement, dike cropping has increased and increased food supplies in local markets. However technical assistance both with actual production and dike cropping strategies, and more importantly with marketing of vegetables, is urgently needed.

In addition, several broader conditions may facilitate successful implementation of *gher* farming including:

1) a favourable market and a positive attitude regarding *gher* products
2) a positive policy at government level to support sustainable *gher* farming
3) research into improved seed and feed production

Specific suggestions for sustainable *gher* farming and to maintain sustainable livelihoods of associated groups would be as follows:

i) A basic technical knowledge of integrated prawn farming should be provided to farmers with the help of Department of Fisheries and NGOs. Prawn farmers themselves could be utilised as trainers in farmer-to-farmer training programmes.

ii) Farmers should make strong efforts to promote at least two rice crops including *aman* rice production within the *ghers*.

iii) Farmers and families should consider to cultivate more dike crops to increase their income and household consumption.

iv) A number of prawn hatcheries should be established in this area. Nursery rearing of post-larvae could be an ideal activity to be taken up by a small NGO, while technical assistance to the hatchery sector would be the responsibility of larger NGOs and agencies in co-operation with the private sector.

v) A number of low-cost locally produced ingredients feed industries should be established that would help to improve farmer's declining profit margins, reduce the negative environmental impacts of snail harvesting and increase job opportunities.

vi) Assisting farmers to obtain cheaper credit for *gher* financing, and especially for annual operating costs, would be the single most important recommendation for reducing the risks of *gher* cultivation. Adequate bank credits without interest or very low interest is to be ensured by the government as well as national banks to the farmers. Low-cost credit should provide by the national banks and NGOs to the poor and landless people and women to develop new business.

vii) Training, extension programmes, institutional and organisation support and government support should be provided to the associated groups for their sustainable livelihoods.

Further research

Applied research in areas such as dike cropping, seed and feed production, extension services and the training of farmers and associated groups may need to be given particular attention, considering existing technology, the transfer, adaptation and development of new technology. Considering the lack of information services among producers, distributors and marketing agencies, as well as development institution, the establishment of an information network needs to be given attention.

The issues of environmental sustainability of prawn cultivation, while clearly not as negative as those of marine shrimp culture in Bangladesh, are nevertheless poorly understood, especially when *ghers* are created at the density levels they have achieved in Bagerhat area. Therefore further research would be required as quantitative and qualitative environmental impacts for sustainable *gher* farming.

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APPENDICES

Appendix 1

Table 1.1 Export of fish and fishery products (tonne) over the years 1985-1998.

Year	Commodity							Percentage of national export earnings
	Frozen shrimp/ prawn	Frozen fish	Dry fish	Salted/ dehyd. fish	Turtle/ Crab/ Tortoise	Shark fin/Fish maws	Total	
1985-86	13631 (2693.1)	5017 (365.0)	786 (100.6)	422 (49.5)	3142 (346.8)	50 (12.5)	23048 (3562.5)	14.65
1986-87	16275 (3417.5)	4046 (354.1)	402 (49.0)	295 (38.4)	2629 (346.6)	114 (34.9)	23761 (4240.5)	12.99
1987-88	15023 (3611.7)	4191 (283.5)	475 (66.9)	372 (48.1)	3232 (484.8)	130 (46.2)	23423 (4541.2)	11.93
1988-89	15386 (3820.5)	2427 (225.9)	567 (138.9)	293 (41.2)	2978 (464.7)	68 (27.7)	21719 (4718.9)	11.51
1989-90	17505 (4143.1)	3484 (255.8)	1278 (234.)	161 (14.4)	876 (112.4)	35 (28.)	23339 (4787.7)	9.62
1990-91	22985 (4512.2)	5720 (414.0)	427 (57.5)	1194 (139.5)	723 (105.8)	78 (37.2)	26109 (5266.2)	8.64
1991-92	26730 (4557.3)	2604 (301.0)	892 (141.1)	80 (13.9)	1709 (176.1)	65 (54.1)	22080 (5243.5)	6.91
1992-93	29224 (6040.3)	2704 (383.1)	1042 (122.6)	599 (98.4)	2800 (216.0)	239 (142.5)	26608 (7002.9)	7.57
1993-94	32054 (7877.3)	3125 (511.8)	2473 (418.3)	50 (10.6)	4088 (363.7)	45 (27.9)	31835 (9209.6)	9.12
1994-95	35277 (10456.7)	9267 (1802.6)	521 (83.9)	649 (153.5)	4760 (406.7)	212 (166.0)	41686 (13069.0)	9.38
1995-96	35225 (11063.9)	8827 (1766.2)	182 (30.5)	436 (114.7)	4203 (392.)	56 (42.1)	38929 (13409.0)	8.44
1996-97	36742 (11889.1)	8754 (1767.4)	427 (79.2)	561 (138.1)	5952 (614.8)	113 (85.5)	41549 (14574.0)	7.75
1997-98	38630 (11814.8)	8836 (1516.6)	233 (31.1)	1106 (264.3)	1198 (143.4)	155 (107.9)	30158 (13878.1)	5.93

Year ending 30 June
Value in parenthesis in million Tk
Source: DOF, 1999.

Table 1.2 Prawn and shrimp farming areas (ha) of Bangladesh.

Division	District	Prawn		Shrimp	
		No. of farms	Area (ha)	No. of farms	Area (ha)
Khulna	Khulna	1100	706.00	1597	27913.00
	Satkhira	58	65.44	3573	29478.72
	Bagerhat	10442	3308.04	2934	42526.98
	Jessore	49	343.60	----	----
	Narail	471	272.08	----	----
	Magura	2	4.25	----	----
	Jhenidah	3	6.40	----	----
Subtotal		12125	4705.81	10291	99918.70
Barisal	Barisal	47	64.39	----	----
	Barguna	87	618.00	30	----
	Bhola	21	84.00	1	----
	Pirojpur	687	2277.56	----	----
	Jhalakati	46	51.43	----	----
	Potuakhali	9	245.92	28	----
Sub-total		897	3341.30	59	65.18
Chittagong	Noakhali	----	----	8	----
	Laxmipur	5	5.30	----	----
	Feni	2	4.86	----	----
	Cox's Bazar	----	----	2039	28908.75
	Chittagong	11	9.99	81	797.07
Sub-total		18	20.15	2128	29071.00
Dhaka	Gopalgonj	172	138.63	----	----
	Faridpur	3	0.59	----	----
	Madaripur	55	39.46	----	----
	Dhaka	1	4.00	----	----
	Sariatpur	2	1.42	----	----
	Kishoregonj	3	52.25	----	----
	Rajbari	1	1.70	----	----
Subtotal		237	288.33	----	----
Country total		13277	8306.73	10291	129689.7

Source: DOF, 1995.

Appendix 2

Time frame of fieldwork

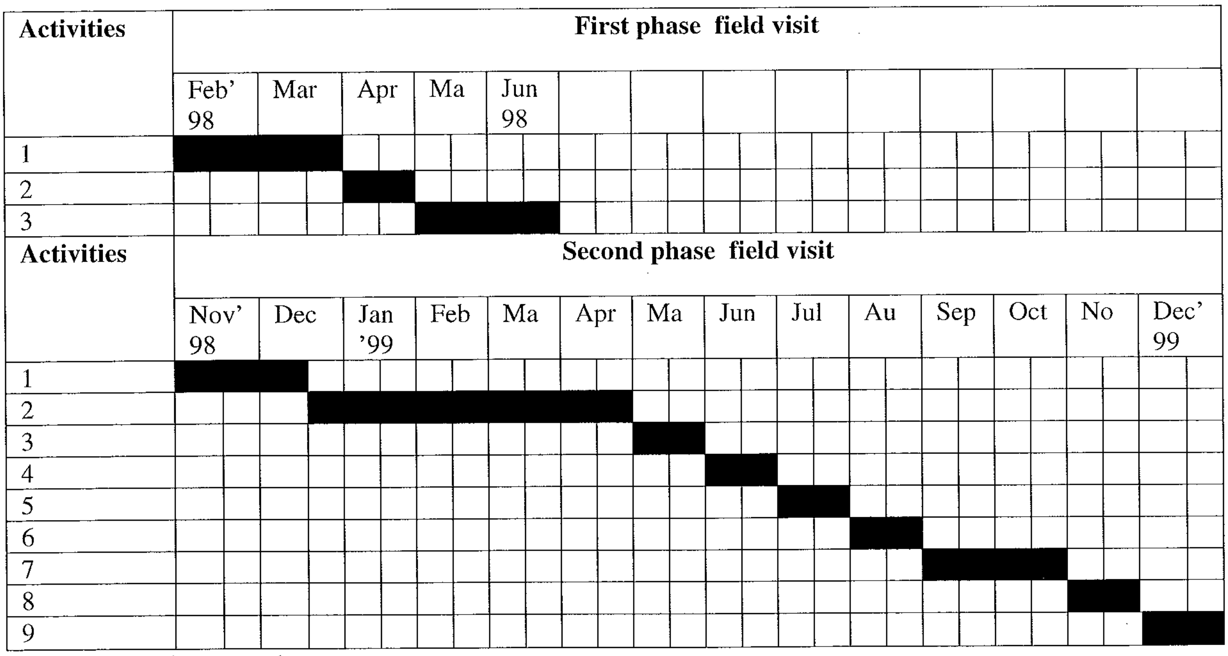
First phase field visit (February 98 to June 98)

1. Identify and select appropriate study area after series of field visits and discussion with community people as well as key informants; and collect data for an overview of prawn production systems.
2. Secondary data collection.
3. Questionnaire test as a part of pilot survey.

Second phase field work (November 98 to December 99)

1. Data collection from prawn traders in 4 different markets, visit prawn processing and export companies in Khulna and also visit Mongla port in coastal area of Bagerhat district.
2. Data collection from prawn farmers in 4 different zones of Bagerhat district.
3. Data collection from fry catchers on the Pasur river in Mongla, Bagerhat district.
4. Data collection from fry traders in 4 different markets of Bagerhat district.
5. Data collection from snail collectors in the Chanda beel of Gopalgonj district.
6. Data collection from snail traders in 4 different markets of Bagerhat district.
7. Data collection from women in 4 different zones of Bagerhat district.
8. Data collection from day labourers, moneylenders and brokers.
9. Data collection from community people in Bagerhat district for environmental and other issues.

Table 2.1 Time frame of fieldwork



Every small unit = 2 weeks

Questionnaire for prawn (*gher*) farmer

(Please write down and circle the appropriate answer)

Section A: Personal information

1. Farmer's name: ....

2. Address: Union:....................................., Thana (Zone):...

3. Religion: [ ]

Muslim	1
Hindu	2
Christen	3
Buddhist	4

4. Age:...

5. Education - [ ]

No education	0
Primary (up to 5 class)	1
Secondary (6 to 10 class)	2
S.S.C (10 class pass)	3
H.S.C (12 class pass)	4
Bachelor	5

6.1. Family type: [ ]

Joint family	1
Nuclear family	2

Other (please specify)...

6.2. Total family member:...

Section B: Socio-economic information

7.1. Farmers annual income: ....Tk

7.2. Farmers annual expenditure:...Tk

8.1. Farmers size of house area:.. decimals / m^2

8.2. Housing condition: ☐

Katcha	1
Semi *pucca* (tin/wood made)	2
Pucca	3

9. Do you have electricity facilities? ☐

Yes	1
No	2

10. Where do you usually go for health facilities? ☐

Village doctor	1
Thana health complex	2
Hospital	3
MBBS doctor	4

11.1. Source of drinking water: ☐

Pond	1
Tube-well	2
Tap	3

Other :..

11.2. Do you have tube-well?

Yes	1
No	2

11.3. Using washing cloth, dish and bathing water:

Pond	1
Tube-well	2
Tap	3

Other (please specify)..

11.4. Do you have good sanitary facilities?

Yes	1
No	2

12. Using fuel (mainly) for cooking:

Cow-dung	1
Paddy straw	2
Wood	3

13. Do you have the following recreational items:

Recreational items	Yes -1; No - 2
Radio	
Cassette player	
Television	

Section C: Prawn/*gher* farming information

14. When did you first start *gher* farming:..year

15.1. How *gher* farming experience acquired:

Self study	1
Friend & neighbours	2
NGO	3

Other (please specify)...

15.2. Do you get any training for prawn farming:

Yes	1
No	2

If yes, where ....

16.1. Percent of annual income from prawn farming:...%

16.2. Other source of income:

Agriculture	1
Business	2
Job	3

Other (please specify)...

17.1. Category of prawn farmer:

Owner	1
Lease	2
Both	3

If leased, how much for lease:...Tk /*Bigha* /year

How many year for lease:...Year

17.2. Total *gher* area:...decimals

17.3. How did you get your *gher*: ....

....

17.4. How much money did you spend for *gher* construction at the beginning of prawn

farming :..Tk/ 52 decimal *gher*

18.1. Which cultural method do you follow for prawn farming? [ ]

Prawn + fish	1
Prawn + paddy	2
Prawn + fish + paddy	3
Prawn	4

18.2. What is the rate of stocking density -

.... PL/52 decimal or ....juvenile / 52 decimal

18.3. What is the source of PL/juvenile [ ]

Natural/wild	1
Hatchery	2

18.4. Which feed do you prefer for prawn farming? [ ]

Snail meat	1
Fish meal	2
Rice barn	3
Cooked rice	4

Other (please specify)..

What is the feeding rate: .... kg/day

19.1. Total production of prawn:...kg/52 decimals/year

19.2. Total production of fish:...kg/52 decimal/year

19.3. Total production of paddy:...*Maund*/52 decimal/year

20.1. Do you satisfied prawn production in your *gher*:

Yes 1

No 2

If no, why (please specify only one reason):...

....

20.2. What percent of prawn do you sell:...%

20.3. Where do you sell your prawn

Prawn traders 1

Foria 2

Company 3

Agent 4

20.4. What is your selling price of prawn per kg ....

....

21.1. Do you think that prawn farming is more profitable than agriculture?

Yes 1

No 2

21.2. Do you think prawn farming is more relax than agriculture?

Yes 1

No 2

21.3. If you have more land, do you like to convert into *gher*?

Yes 1

No 2

22. Cost-return analysis of *gher* farming:

Cost analysis:

Items	**Sub-items**	**Unit**	**Tk/unit**	**Amount (Tk)**
Seed/fry	Prawn fry Fish fry			
Feed	Snail-meat Fishmeal Rice-bran Wheat flour Home made feed Others			
Fertiliser				
Labours				
Harvesting and marketing				
Rice cultivation				
Others				
Salary of management staff				
Interest				
Depreciation				

Total

Revenue:

Items	**Unit**	**Tk/unit**	**Amount (Tk)**
Prawn			
Fish			
Paddy			

Gross revenue

Net Return = Gross revenue...............Tk - Total costs...............Tk. = ...Tk

23.1. Do you get loan for prawn farming?

Yes 1

No 2

If yes, please fill-up the following table:

SL NO	Source of loan	Loan amount	Interest rate (%) per month	Comments
1	Moneylender			
2	Bank			
3	NGO			
4	*Depot owner (dadon)*			

23.2. If you took loan from other sources except bank, why do not go to banks (please select one)

Lack of education 1

Too much official work 2

Interest rate high 3

Loan amount low 4

24. What is the single most important problem for prawn farming?

....

....

25. Have you improved your socio-economic conditions on prawn farming?

Yes 1

No 2

If no why: ....

....

Questionnaire for woman (who have *gher*)

(Please write down and circle the appropriate answer)

1. Name:..

2. Address (zone):..

3. Religion :

Muslim	1
Hindu	2
Christen	3
Buddhist	4

4. Age:..

5. Marital status:

Married	1
Unmarried	2

6. Education:

No education	0
Primary	1
Secondary	2
S.S.C	3
H.S.C	4
Graduate	5

7. Do you involve in *gher* farming?

Yes	1

No 2

If no, why :..

If yes, go to the following questions.

8. Do you involve making of feed and feeding of prawn?

Yes 1

No 2

If yes, how:..

9. Do you involve *gher* supervision and management?

Yes 1

No 2

If yes, how:..

10. Do you help about harvesting, grading and marketing of prawn?

Yes 1

No 2

If yes, how:..

11. Do you involve dike cropping?

Yes 1
No 2

If yes, how:..

12. How many hours per day do you involve in *gher* as well as prawn farming ?

....hours/day.

Questionnaire for fisherman (post-larvae catcher)

(Please write down and circle the appropriate answer)

1. Name: ....

2. Address: ....

3. Religion:

Muslims	1
Hindu	2
Christen	3
Buddhist	4

4. Age:..

5. Educational qualification:

Illiterate	0
Semi-literate	1
Literate	2

6. Family member: ....

7. Housing condition:..

8. Health facilities:..

9. Fry catching season: ....

10. Fry catching time:..

11. Type of net for fry catching: ....

12. Fry catching rate:.../ Day

13. Where do you sell your fry?..

14. Selling price of fry: ....Tk / 1000 fry

15. Your daily income from fry catching...Tk/day

16. What is your comment about fry catching rate in this year?...............................

....

Questionnaire for fry trader

(Please write down and circle the appropriate answer)

1. Name:..

2. Address (market name and zone):...

3. Religion:

Muslim	1
Hindu	2
Christen	3
Buddhist	4

4. Age:..

5. Education qualification:

No education	0
Primary	1
Secondary	2
S.S.C	3
H.S.C	4
Bachelor	5

6.1. Family type:

Nuclear	1
Joint	2

6.2. Total family member:..

7. When did you first start fry trading? ....

8. What did you do before fry trading?..

9.1. Season of fry trading: ....

9.2. Selling time in day:...

10. What do you do another season?..

11.1. What is the source of fry?

Natural	1
Hatchery	2

11.2. Where does fry come from:...

12. Who supply fry to you?

Fry catcher	1
Bapari (broker)	2
Own-self	3

13. What type of transport are used for fry carrying?..

14. How many fry do you sell per day?..

15. How much your daily income?.. Tk./day

16. What is the selling price of fry?..Tk./ 1000 fry

17. Who buy fry from you?

Gher farmer	1
Foria	2

18. What is your comment of fry supply and demand in this season?..................................

....

19. Have you improved your socio-economic conditions on fry trading?

Yes	1
No	2

Questionnaire for snail trader

(Please write down and circle the appropriate answer)

1. Name: ....

2. Address (market name and zone):...

3. Religion

Muslim	1
Hindu	2
Christen	3
Buddhist	4

4. Age:...

5. Educational qualification:

No education	0
Primary	1
Secondary	2
S.S.C	3
H.S.C	4
Bachelor	5

6.1. Family type:

Nuclear	1
Joint	2

6.2. Total family member:..

7. When did you first start snail trading?..

8. What did you do before snail trading?..

9.1. What is the season of snail trading:..

9.2. Selling time in day:...

10. What do you do rest of the season?...

11. Where does snail come from?...

12. Who supply snail to you?

Snail collectors	1
Bapari (middleman)	2
Own-self	3

13. What type of transport are used for snail carrying?..

14. What is the average selling price of snail meat?...Tk/kg

15. How many snail meat do you sell per day?...kg /day

16. How much your average daily income?...Tk/day

17. Who break the snail?

Labour	1
Own-self	2
Farmer	3

18. Who buy snail from you?

Gher farmer	1
Foria (middleman)	2

20. What is your comment of snail supply and demand in this season: ....

....

21. Have you improved your socio-economic condition on snail trading?

Yes	1
No	2

Questionnaire for prawn trader (*depot malik*)

(Please write down and circle the appropriate answer)

1. Name:..

2. Address (market name and zone):...

3. Religion:

Muslim	1
Hindu	2
Christen	3
Buddhist	4

4. Age: ....

5. Educational qualification:

No education	0
Primary	1
Secondary	2
S.S.C	3
H.S.C	4
Bachelor	5

6.1. Family type:

Nuclear	1
Joint	2

6.2. Total family member:...

7. When did you first start prawn trading?...

8. What did you do before prawn trading?..

9.1. Season of prawn trading:..

9.2. Selling time in day:..

10. What do you do another season?..

11.1. Who supply prawn to you? ☐

Prawn farmer	1
Foria (field worker)	2
Own-self	3

11.2. Who do the prawn headless and grading? ☐

Prawn farmer	1
Company	2
Labours	3
Own-self	4

12. What is the price of prawn for buying?.. Tk / G.....

13. Where do you supply your prawn / who collect prawn from you? ☐

Agent	1
Company	2

Other (please specify):..

14. What is the selling price of prawn?..Tk/ G....

!5. How many kg of prawns do you sell per day?....................................kg/day

16. What type of transport are used for prawn carrying?..

17. Wow much your daily income from prawn trading?.............................. Tk/day

18. How many labour are worked in your depot?...

19. What is your comment of prawn production and marketing in this season?...

....

20. Have you improved your socio-economic conditions on prawn trading?

Yes	1	☐
No	2	

Sample determination for each stratum

The following formula for allocation of the sample to strata was used:

ni = Yi n / Y (Arens and Loebbecke, 1981)

Where,

ni = Sample size for a stratum in each zone where the total sample size is known

Yi = Total population of a stratum in each zone

n = Total sample size in each zone (100)

Y = Total population in each zone

Table 2.2 shows the distributions of samples were allocated proportionately according to *gher* size in each stratum by zone wise.

Table 2.2 Allocation of sample size of prawn farmers in each stratum by zone.

Name of zones	**< 0.21 ha**	**0.21-0.4 ha**	**0.41-0.61 ha**	**> 0.61 ha**	**Total**
	n = 179	n = 136	n = 49	n = 36	n = 400
Bagerhat Sadar	44	30	16	10	100
Fakirhat-Mollahat	34	39	16	11	100
Chitalmari	53	30	9	8	100
Kachua	48	37	8	7	100

n: Sample size