

EFFECT OF CRAB FARMING ON THE LIVELIHOOD AS PERCEIVED BY COASTAL FARMERS

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**EFFECT OF CRAB FARMING ON THE LIVELIHOOD AS
PERCEIVED BY COASTAL FARMERS**

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*This is to certify that the thesis entitled, “EFFECT OF CRAB FARMING ON THE LIVELIHOOD AS PERCEIVED BY COASTAL FARMERS” submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science (MS) in Agricultural Extension**, embodies the result of a piece of bona fide research work carried out by **MD. SAZID AHSAN**, Registration No. **13-05584**, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that any help or sources of information, as has been availed of during the course of investigation have been duly acknowledged.

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DEDICATION

*Dedicated to my beloved parents and
respected teachers of
Sher-e-Bangla agricultural university*

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LIST OF ACCRONYMS AND ABBREVIATIONS

\$	=	United States Dollar
%	=	Percentage
BBS	=	Bangladesh Bureau of Statistics
BER	=	Bangladesh Economic Review
BFDC	=	Bangladesh Fisheries Development Corporation
CGIAR	=	Consultative Group on International Agricultural Research
CFI	=	Constraint Faced Index
DAE	=	Department of Agricultural Extension
DoF	=	Department of Fisheries
e.g.	=	exempli gratia (L), for example
EPB	=	Export Promotion Bureau
<i>et al.</i>	=	And others
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
FRSS	=	Fisheries Resources Survey System
FY	=	Financial year
GDP	=	Gross Domestic Product
gm	=	Gram (s)
GO	=	Government Organisation
ha	=	Hectare
i.e.	=	id est (L), that is
J.	=	Journal
Kg	=	Kilogram (s)
Kg/ha	=	Kg per hectare
MoYS	=	Ministry of Youth and Sports
MT	=	Metric ton
NGO	=	Non-Government Organization
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
SD	=	Standard Deviation
sq.	=	Square
SVRS	=	Sample vital registration systems
Tk.	=	Taka
UFO	=	Upazila Fisheries Office
USD	=	United States Dollar
YAS	=	Yearbook of agricultural Statistics

EFFECT OF CRAB FARMING ON THE LIVELIHOOD AS PERCEIVED BY COASTAL FARMERS

MD. SAZID AHSAN

ABSTRACT

Bangladesh has an excellent opportunity to earn a lot of foreign currency from the foreign market from crab export by utilizing the coastal belt. The agro-climatic conditions along the coast of Bangladesh can produce more crab farming than shrimp farming. As a result, more than 5,000 families living along the coastal rivers of Bangladesh have taken up crab farming. Considering above opportunities, this study was designed to investigate the effect of crab farming on the livelihood as perceived by coastal farmers. For this study, data were collected from 113 farmers of Rampal, Mongla, Sarankhola, and Morrelgonj upazilas of Bagerhat district during the period of February 10 to March 08, 2020. Descriptive statistics, stepwise multiple regression and constraints faced index (CFI) were used to analyze the data. Most of the coastal farmers (64.60 percent) achieved moderate livelihood improvement through crab farming, while 15.05 percent had a high effect of crab farming on the livelihood. Among the variables, annual income from crab farming alone contributed 37.8 percent of the variation while availability of marketing information, crab farm size, the experience of crab farming, and knowledge on crab farming contributed 5.7%, 2.6%, 2.7% and 1.9%, respectively to the effect of crab farming on the livelihood as perceived by coastal farmers. The majority (69.91 percent) of crab farmers faced moderate constraints on crab farming, while 7.97 percent faced high constraints. According to the Constraints Faced Index (CFI), natural disasters like flood, erosion etc. ranked first followed by presence of virus and other diseases, domination by middleman in case of price determination, non-availability of quality mud crab seed for commercial farming in farms, and grading system pricing of crab. It was concluded that the composite effect of crab farming on the livelihood of the farmers was moderate and needed further advancement. Based on the results, it was recommended that the concerned authorities should implement and popularize large-scale farmer-based projects for crab farming to improve the livelihood of the coastal farmers.

Keywords: Effect, crab farming, livelihood, crab farmers, Bangladesh coastal region

CHAPTER I

INTRODUCTION

1.1 General Background

With a population of 166.50 million and an area of 1,48,460 square kilometers, Bangladesh is one of the most densely populated countries in the world (BBS SVRS, 2019). The vast river network and enormous floodplains make the country's water resources potential and diverse. Fish products such as fish, crab, and prawns are the main water resources and play a very important role in the daily life of many communities in Bangladesh.

With over 4.76 million hectares of water resources, Bangladesh is one of the world's leading fish producing countries blessed with numerous rivers-canal, depression and oxbow lakes, ponds, and floodplains. In addition, the vast marine fisheries are expanding to 1,66,000 square kilometers in the Special Economic Zone (SEZ) (BBS, 2019). Since ancient times, these inland, coastal and marine waters have been the main sources of fish. As an agrarian nation, the contribution of the fisheries sector to the national economy has always been an important and major source of animal protein, employment opportunities, food and nutrition security, foreign income, conservation of aquatic biodiversity, and socio-economic development.

The fisheries sector contributes 3.57% to GDP and 25.30% to agriculture. Fish meet up 60% of animal protein intake at 18.1 kg consumed per person per year – and frequency of consumption. More than 11% of the population is directly or indirectly dependent on the fisheries sector for their livelihood. After 47 years of independence, Bangladesh has become a self-sufficient country in fish production with a per capita fish consumption of 62.58 g / day against the target of 60 grams per day. Bangladesh produced 4.277 million tons of fish in the 2017-18 fiscal years, where aquaculture production accounts for 56.25 percent of total fish production (DoF, 2019). Through this marvelous achievement, for the first time in history, Bangladesh has declared a self-sufficient country in fish production. The sector has grown at an average growth rate of 5.26 percent over the last 10 years. Aquaculture shows dynamic and sustainable growth, while the average growth rate over the same period is about 10 percent (DoF. 2018).

As it is on the edge of the Bay of Bengal, Bangladesh has a wide and diverse range of seafood options. From rock lobsters to mussels, from shrimp to pomfrets, the country

offers many options to cater to the local palette, while exporting a large portion of its production annually. But among many products, mud crab has emerged as the next largest fish export category, so much so that the Government of Bangladesh allocating the crab sub sector to the Special Development Division in its latest Export Policy Act 2018-21 (MoCom, 2018). Crab production and exports are growing rapidly in the country's marine resources. Mud crabs (*Scylla serrata*) are considered to have good potential in various parts of the world, including Bangladesh, a well-known region prone to climate change. Currently, the fisheries sector has become a growing venture in coastal Bangladesh, mainly due to the capacity of the export market and the availability of seeds locally (Rahman *et. al.*, 2020).

Crab belongs to the Portunidae family of the crustacea class, which also includes lobster and shrimp. Crabs are found abundantly along the coast of Bangladesh, especially in estuaries, Sundarbans mangrove swamps, and coastal gheras (Khan and Alam. 1992). The crab is commonly known as the "Green Crab" or "Mangrove Crab" and is locally known as "Habba Kankra", "Silla Kankra" or "Kankra" (Shafi and Quddas. 1982).

The crab farming growth rate in the last financial year was 9.58%, which is the second highest growth rate in the fisheries sector in Bangladesh. The productivity of crab farming is 534 kg per hectare, which is much higher than that of prawns (426 kg per hectare) and fish (478 kg per hectare) (DoF, 2017).

Over the years, mud crab farming in southwestern Bangladesh has grown significantly, as more and more farmers are benefiting from the rearing of crab. As of 2009, mud crab fishing has supported the livelihoods of more than 50,000 fishermen, traders, brokers, transporters, and exporters in Bangladesh (Molla *et. al.*, 2009), and has now increased to about 3,00,000 households (Islam *et. al.*, 2015). Crabs are more susceptible to disease compared to shrimp farming. In addition, mud crab farming is less vulnerable to the local effects of climate change and declining water quality (Shelton, 2014.). Therefore, the growth of mud crab farming can also be interpreted as a positive response to declining climatic and environmental conditions.

Crab has emerged as a potential earner of exports, thanks to high demand around the world and increased agriculture in the coastal areas of Bangladesh. From the southern belt, crabs are shipped to Dhaka for freezing and then exported to direct export or major export destinations. Traders grade the catch and sell them at high prices up to \$45 / kg

during the peak season. Crabs are exported in two forms: live or frozen. Live crabs are usually exported to Asian countries due to high demand and transport restrictions. Frozen soft shell crabs are popular in Western countries with Australia and the United Kingdom. In the 2018-2019 fiscal years, total revenue from crab export was \$42.8 million, of which \$33 million from frozen crab and \$9.8 million from the live crab (BER, 2019). According to Export Promotion Bureau (2018), the exported volume of crab in 2018 is 11435.33 metric tons, which is 97% of total crab market of Bangladesh.

In addition to the export market, the demand for crab locally in Bangladesh is growing in line with the growth of the middle and affluent class (MAC) population, which is projected to quadruple to 37 million in 2021 from 11.7 million benchmarks of 2015 (EPB, 2018). This has led to increased fish consumption in Bangladesh, including the demand for crab-based dishes. It is expected to be crucial to the demand for mud crabs in Bangladesh in the medium term. Currently, over 110 restaurants in Dhaka sell crab-based dishes to locals and expatriates (Ali, 2019).

Against this backdrop, crab farming is on the rise in Bangladesh, which has a great effect on the livelihood of farmers. This effect can be classified as positive and negative, necessary, and optional distant effect generated by direct or indirect, planned, or unintentional development intervention (Garbarino and Holland, 2009). According to the CGIAR, Effect Assessment is a form of assessment that is expected to determine the outcome of an intervention, in terms of interest outcomes (FAO, 2011).

However, it is encouraging to note that coastal farmers in Bangladesh are now increasingly involved in crab farming. And it provided more than 3,00,000 households (Islam *et. al.*, 2015), including those engaged in the crab supply chain with new livelihoods. Has enormous potential to grow very large, opening up new economic frontiers. Crab farming plays a very important role in farmers-livelihood development programs. Although crab farming has had a tremendous effect and potential on livelihood improvement, there has been little research on crab farming especially on the livelihood of coastal farmers in Bangladesh. Therefore, based on the above observations, research has been conducted under the title "Effect of crab farming on the livelihood as perceived by coastal farmers".

1.2 Statement of the problem

There is much demand for mud crabs in Malaysia, Singapore, China, Japan, Hong Kong and Korea. According to the Export Promotion Bureau of Bangladesh (EPB), Bangladesh exported crabs worth around Tk 1.73b in the fiscal 2017-18 and around Tk 4.29 billion in 2018-19. Global exports of crabs as frozen or live conditions were valued at \$ 7.65, 23.81, 18.27, 17.38, and \$ 42.93 million in 2014-15, 2015-16, 2016-17, 2017-18, and 2018-19, respectively (EPB, 2019). According to the Ministry of Fisheries, for every 100 crabs produced in Bangladesh, 97 of them are exported (DoF, 2019).

Crab farming is widely practiced along the coast, including Khulna, Shatkhira, Bagarhat, and Cox's Bazar, which has become a major crab production belt in Bangladesh. Crab farming gives 1.5-2.0 times higher returns than shrimp farming or other fisheries sources, as it is less prone to disease and climate change effect. Nowadays, more than 3,00,000 farmers in the country cultivate crab and about 500,000 people are directly or indirectly involved in the crab farming business as their sole livelihood (Islam *et. al.*, 2015). In order to formulate appropriate strategic measures for improving the livelihood of crab growers, this research will focus on the socio-economic characteristics of crab growers and their current conditions and examine the effect of crab farming on farmers-livelihoods. This is done by searching for answers to fellow questions:

- i. What are the characteristics of crab farmers?
- ii. How much effect did crab farming have on livelihood?
- iii. What is the contribution of the selected characteristics of the crab farmers on the effect of crab farming on their livelihood?

To get a clear idea of the above questions, the researcher conducted a study entitled the "Effect of crab farming on the livelihood as perceived by coastal farmers".

1.3 Objectives of the study

The focal point of the research work was to explore the effect of crab farming on farmers' livelihoods. The following objectives were designed to provide an appropriate track for research work:

- i. To assess and describe selected characteristics of the coastal crab farmers
- ii. To assess the extent of effect of crab farming on farmers' livelihood
- iii. To explore the contribution of the crab farmers' selected characteristics to the effect of crab farming on their livelihood
- iv. To evaluate the constraints faced by the farmers in crab farming

1.4 Rationale of the study

The current study is designed to understand the effect of crab farming on farmers-livelihoods and to explore its contribution to selected traits.

- i. The results of the study, in particular, apply to the study area located at the Upazilla of Morelganj, Sarankhola, Mongla, and Rampal of Bagerhat district. These results also apply to other regions of Bangladesh where socio-cultural, psychological, and economic conditions are not very different from the study areas.
- ii. The results of the study may be related to the field level of the extension service to enhance their operational strategies on the effect of crab farming on farmers-livelihoods.
- iii. The results of the study are favorable for agriculture, farmer-logistical support, information needs, and specially tuned outreach to key players in the community, as well as the effect of crab farming on farmers-accelerating livelihoods. These results also help planners and policymakers, extension workers, and beneficiaries of agriculture.
- iv. For academicians, it helps for further conceptualizing the design of the method to evaluate the effect of crab farming on livelihoods for farmers. In addition, the results of this study may contain other empirical evidence for all aspects of the effect of crab farming on farmers — subsistence, which may serve to formulate a theory of crab farming aspects.

1.5 Justification of the study

Providing a generous export market, crab farming has become a leading sector of fisheries and aquaculture in developing countries around the world. Apart from this, the recent rise in prices recommends us to expand our revenue to overcome this situation. Commercial crab farming is about ensuring food security for many developing countries like Bangladesh.

Bangladesh has a coastal belt for crab farming and meets the demand for export and local markets. The agro-climatic conditions along the coast of Bangladesh can produce more crab farming than shrimp farming. Bangladesh has an excellent opportunity to earn a lot of foreign currency from the foreign market if the production and marketing of crabs are well developed. The crab industry of Bangladesh offers a new way to diversify its export basket. In terms of production, crabs are easier to maintain with a lower mortality rate compared to shrimp. However, the industry is still in its infancy and the crab ecosystem has not yet been developed to complete its value chain. Although the Government of Bangladesh has taken steps to promote this sector, they should also focus on capacity building and create incentives to attract private investors, especially in crablet production, to prevent the decline of natural crabs.

Currently, about 3,00,000 farmers are engaged in crab farming on a commercial basis. Bangladesh does not have to spend any money to import crabs, as it is economically cheaper, most crabs are taken from the wild. However, sourcing from the forest leads to depletion of resources, and therefore hatchery-based crawl production should be established to achieve sustainability. That opens up the opportunity to develop another crab-based industry. It is hoped that if crab farming can be developed to the required extent, it will be able to achieve marketing potential in the short term: Besides, crab farming can make a potential contribution to our gross domestic product (GDP), can create employment opportunities, also increase the participation of rural women in income-generating activities, and subsequently have a great effect on promoting livelihoods.

This study may provide an idea of the effect of crab farming on the livelihoods of coastal farmers. To improve the socio-economic status of farmers, the government and some NGOs in Bangladesh have launched programs on crab farming, livestock, fisheries, housing, credit, and savings. The success of this program depends on the attitude and knowledge of crab farming. Hence, the researcher should inquire about the livelihood

effect on crab farmers. Consequently, it is logical that crab farming has an effect on the livelihood of farmers. Therefore, the results of the study are expected to be favorable to researchers, educators, and policymakers related to crab farming. In view of the above facts, a study entitled "Effect of crab farming on the livelihood as perceived by coastal farmers" was undertaken.

1.6 Assumptions of the study

An assumption is the supposition that an apparent fact or principle is true in the light of available evidence (Goode and Hatt, 1952). The researcher had considered the following assumptions while undertaking the study:

- i. The respondents were capable of furnishing proper answers to the questions contained in the interview schedule.
- ii. The data collected were free from any bias and normally distributed.
- iii. The responses answered were valid, acceptable and reliable.
- iv. Information sought by the researcher elicited the real situation was the representative of the whole population of the study area to gratify the objectives of the study.
- v. The researcher was well adjusted to himself with the social contiguous of the study area. Hence, the collected data were free from favoritism.
- vi. The selected characteristics and effect of crab farming on farmers' livelihood of the study were normally and independently allotted with respective means and standard deviation.

1.7 Limitations of the study

In order for the researcher to consider the time available, respondents, communication facilities, and other necessary resources and to make the study meaningful, it was necessary to impose certain restrictions within the specified limit.

- i. This study was limited to Morelongonj upazilla, Mongla upazilla, Rampal upazilla, and Sharancola upazilla of Bagarhhat district, which may fail to suggest a realistic picture of the overall situation of the Bangladesh Coastal Belt as people develop their strategies according to the concrete situation they face
- ii. It is difficult to get exact information on effect of crab farming on the livelihood as perceived by coastal farmers' on this indicator from the women, as many of them were illiterate.

- iii. The characteristics of crab farmers were very diverse, but only nine features were selected for the research study.
- iv. There were embarrassing situations during data collection. Therefore, the researcher had to maintain a proper relationship with the respondents to gather the maximum correct information.
- v. Many methods, criteria, and statistical tests were used in a very minimal way in this study.

1.8 Definition of important words

Age: Age refers to the terms of the actual years from their birth to the time of the interview, which was found based on the farmers' oral response.

Education: Mango growers measure education by assigning scores against successful school education.

Family size: Family size refers to the total number of family members, including his / her, children and other dependents.

Effective crab farm size: The effective crab farm size of a farmer refers to the total area on which agricultural activities are carried out, the area being in full benefit to the family.

Annual family income from crab farming: Annual family income from crab farming refers to the total financial income from crab production in a year.

Crab Farming Duration: The crab farming period of crab growers refers to the total number of years involved in crab farming.

Media Introduction: The introduction of media to different communication media related to agricultural activities is exposed to some extent.

Availability of marketing information: Availability of marketing information defines the degree of disclosure of available marketing information.

Crab Farming Knowledge: Crab farming knowledge refers to the knowledge of different parts of crab production.

Effect: Influence refers to a term that refers to continuous changes as a result of any intervention that has a lasting effect.

Change: This indicates any improvement or decline of the respondents in various aspects of their livelihood.

Effect Evaluation: An effective evaluation that refers to an outcome-based evaluation designed to answer the question of whether the observed results are the result of an intervention or whether any of the observed results have occurred.

Livelihood: Contains livelihood capabilities, assets (stores, resources, claims and accessibility) and activities necessary for livelihood. Livelihood is sustainable, can withstand and recover from stress and trauma, maintain or improve its capabilities and assets, and sustain livelihoods for the next generation ; And it provides net benefits to other livelihoods at the local and global level and without undermining the short and long term natural resource base.

CHAPTER II

REVIEW OF LITERATURE

The review of the literature gives the researcher a clear and concise direction to conduct the experiment. In this chapter, a review of the literature related to the objectives of this study was presented. This was mainly related to the effect of crab farming on the livelihood of farmers. There was a severe shortage of literature related to research studies on this topic. Therefore, no directly relevant literatures were available for this study. Some researchers have suggested the effect of crab farming on farmers - their effect on livelihoods and client groups and strategies for emancipation from socio-economic deprivation. A portion of these contemplates appropriate to this research were quickly discussed in this part underneath the accompanying four:

2.1 General review on crab farming perspective

According to the State of World Fisheries and Aquaculture 2019, Bangladesh positioned third in inland vast water catch production and fifth in world hydroponics production. At present Bangladesh positions fourth in tilapia production on the planet and third in Asia. On the off chance that this development of fish production proceeds, the fish production in the nation is relied upon to be 45.52 lakh MT. by FY2020-21 (BER, 2019).

Mud crab farming is assuming a significant function in the livelihoods of the waterfront areas in Bangladesh. As indicated by a study by Molla *et al.* (2009), mud crab fishery was supporting the livelihood of more than 50,000 fishers, dealers, specialists, carriers, and exporters in Bangladesh while the number has been expanded to 300,000 families at present.

Rahman (2020) has conducted a research through SWOT analysis and revealed that positive factors, both internal (strengths) and external (opportunities), predominate over negative factors (weaknesses and threats) and that the fishery can be an alternative livelihood option for vulnerable coastal communities in Bangladesh.

In 2018-2019 fiscal years about \$42.93 million earned by exporting crab to China, Japan, Taiwan, Korea, and Hong Kong. The commitments of crab among the items that are assuming a significant function in Bangladesh's fair pay are flooding. From the financial standpoint, among the sent out fish assets, crab stays in the second spot after shrimp (EPB, 2019).

As per the yearbook of agricultural statistics 2019, the all-out production of crab in the 2018-19 fiscal year is 12084 metric ton, and sent out 744.43 metric ton as solidified crab and acquire 278.05 crore taka (BBS, 2019).

Begum *et al.* (2009) directed a study to think about the endurance, production, and budgetary issues of mud crab stuffing in Bangladesh. Near advantage cost examination of their study created the impression that mud crab fattening using bamboo cage accomplished higher net advantage (Tk. 91,630) than in surrounded earthen zone (Tk. 9,345) from 12 harvests (12-16 days for every yield) fattening period. Higher absolute production of crab from confines was also recorded than the encompassed earthen region.

Salam *et al.* (2003) directed a study and looked at the advantages of shrimp and crab development inside the Khulna area dependent on net production, financial yield, and work potential. Examinations were made of brackish water shrimp and crab culture with unobtrusively saline-tolerant tilapia and prawn culture, freshwater carp culture, and traditional rice production frameworks. Notwithstanding, per hectare picking up was discovered a little higher for shrimp than for crab culture, they recognized shrimp as the premier capital intensive and hazardous production framework.

Chandra *et al.* (2012) directed a study to evaluate the production and overview of the promoting of mud crab inside the south-western Bangladesh and found a complete production of mud crab roughly 6,945 tons. The costs of mud crabs moved with grade and season. They additionally found that the mud crab marketing was significantly trade arranged and the significant fare markets were Taiwan, Singapore, Hong Kong, Malaysia, Thailand, and the USA.

Sumon *et.al.* (2012) led a study inside the mid waterfront area (Noakhali) of Bangladesh to perceive the chance of mud crab culture. Their study researched that the normal every year assortment of mud crabs from that zone was very nearly 890 tons. The presence of a potential marketing channel with 3-4 merchants was also observed.

Salam *et al.* (2012) assessed the crab culture potential in southwestern Bangladesh as a choice to shrimp culture for environmental change adaption. They found that farmers are trading to crab farming since it was less vulnerable against ailment, safe to unfavorable ecological conditions, and incorporates an extraordinary market cost. Their revelations besides uncover that a critical total of land fell underneath outstandingly suitable (28.33%) and modestly appropriate (62.22%) classification for crab culture.

Ferdoushi (2013) led a study to overview the financial state of the crab fatteners inside the southwest bit of Bangladesh and discovered around 52% farmers having inclusion of 5-10 years. She likewise found the Hindus inside the beachfront area having more captivated in crab farming. The result created the impression that practically 40% farmers have higher satisfaction by crab fattening whereas, scarcely any farmers detailed a couple of negative discernment.

Ferdoushi *et. al.* (2013) led a study in south-western Bangladesh and recognized twelve (12) fundamental impediments of mud crab fattening rehearses among which deficiently credit, absence of suitable data about crab developing, and cost influenced by marketing administrator were positioned first and second and third within the position.

Rahman (2016) directed a study in the Satkhira district of Bangladesh and found the normal yearly net profit by a tiny pond was Tk. 4,955. He found that the mud crabs fattening inside the little terrains were prospered as an option suggests of livelihoods that had imperative influence in wage generation of insignificant groups of seaside zones.

Haque *et al.* (2017) led a study to assess the effects of incorporation of tilapia into mud crab culture and found that the women and their family individuals advanced their livelihoods and usage of excellent protein. As a rule, the integration of tilapia is given a more affordable methodology for creating mud crab while improving the livelihoods of farmers.

Istiak (2018) conducted a study to survey the market chain and worth included things of mud crab in Bangladesh and found that it has been having an elective effect on shrimp culture. He also found that those crabs were gathered from nature, shrimp cultivate, seaside compose, and cage. His research also revealed the crab's worth chain as farms/nature-collectors-small depot, far-reaching distribution center, and exporters. The consequence of the study likewise revealed that crab trade has extended from 2009 to 2016.

Hungria *et. al.*, (2017) directed a study to assess that commercial investigation of swimming crab is rapidly extending the world over. In 2015, all-out production of crabs (fisheries moreover aquaculture) arrived at almost 1300 thousand tons. One of the premier significant marketing structures is designated "soft-shell crab". The web is one of the first basic promoting channels for soft shell crab, with costs starting at US\$3.5 a unit, yet going up to US\$8.00-10.00, contingent upon the size and presentation shape of

the thing (live, cooled, solidified, or took care of). In lavishness cafés, a dish containing one broad animal may cost well over US\$75.00. Logically, this market requires exchanging companies to introduce some sort of quality certification of the thing or get ready (primarily certifications related to food safety). Practically all-delicate shell crab production depends on crabs got within the wild, by either fishing or catching.

Dana *et. al.*, (2015) led aquaculture of the mud crab has been polished for as far back as 100 years in China and for as long as 30 years all through Asia. Practically all crab aquaculture production depends on wild-got stock, as larval raising has not yet arrived at a financially reasonable level for loading into aquaculture farms. Crabmeat is practically cent percent fat-free, wealthy in protein, and offers no starches. As per dieticians, crabmeat fits in impeccably with the new dietary rules, which recommend high-protein nourishments that are lean and either low fat or fat-free.

Globe Newswire (2020) has distributed a study report on crab farming and marketing procedures and expressed that the crab cost is exceptionally unpredictable in the worldwide supply chain, yet because of rising purchaser request, the eventual fate of the crab industry is splendid. The foodservice industry is the significant end-client of crabs; the ascent of the foodservice industry would straightforwardly flood the tendency of the worldwide crab market. As opposed to that, according to research investigation, The Worldwide Crab Market will arrive at 3.7 Million Metric Tons before the finish of the year 2026.

Rajasekaran *et. al.* (1993) analyzed the rice-crab production framework in south India to assess the piece of indigenous data in arranging food security approaches and found that crab contributed fundamentally to the protein affirmations of the advantage helpless families. In their article, they inspected the effect ing socio-economic factors just as the effect of crab utilization on food consumption.

Kovatcheva (2006) directed a study in which he portrayed that as of late, there has been a sharp decline in the supplies of red king crab in basically all the traditional fishing areas inside the Russian Far Eastern seas. As an outcome, the proposed volumes of the tolerable catch for the ongoing five years have been decreased to almost one 10th: from 30,000 tons in 1999 down to 3,583 tons in 2003 but in recent days, the catch for crab has been increased gradually to meet up the demand.

2.2 Literature concerning the contribution of the farmers' characteristics to the effect of crab farming on their livelihood

Exceptionally little or no observation was found about the contribution or relationship of crab farmers about the selected attributes (age, level of education, family size, crab farm size, the experience of crab farming, annual income from crab farming, media contact, planning introduction, availability of marketing information, and knowledge on crab farming) to the effect of crab farming on their livelihood.

The socio-demographic characteristics of the involved farmers in mud crab (*Scylla sp.*) fattening. Compare to other region the Hindu population is three times higher in coastal region of Bangladesh. Hannan (1994) also reported that the higher number of farmers in coastal area of Bangladesh came from low cast of Hindu society. However, Mud crab farming in Bangladesh is quite new. The Hindu people in the coastal region found to have more interest in crab farming (73%). On the other hand, about 27% Muslim were also found to involve in this farming. Comparatively higher involvements of Hindus farmers were found in Khulna region (80%) followed by Bagerhat (66%), (Ferdoushi, 2013).

Among different human capitals, family size or number of household in an important one. According to Gill and Motahar (1982), it could be a constraint factor for the farm productivity or efficiency. Larger family may make it difficult to invest in farming due to financial constraints.

Land holdings are important requirement playing significant role in the socio-economic status for rural as well as peri-urban people of Bangladesh (Khan, 2004). Total land size was measured by adding the total homesteads area, own cultivated area, pond and garden. Average land area was about 177.11 ± 241.19 decimal. The average land area in Bagerhat region was higher than adjacent districts. Farmers in Bagerhat region found to have higher average land holdings compared to Khulna (Ferdoushi, 2013).

Their average annual income in Bagerhat region (1366.26 ± 602.30 US\$ year⁻¹) was also found slightly higher than Khulna region (1360.70 ± 669.21 US\$ year⁻¹). The surveyed sites from Bagerhat region are situated in the port site and found to have more income generating activities compare to other two regions. In addition to this, surveyed sites in Khulna region are more vulnerable to the cyclones and other natural disaster. That might

be the cause for small land holding capacity and poor economic condition of the Khulna and Satkhira districts' farmers compare to Bagerhat district (Ferdoushi, 2013).

According to Ferdoushi (2013), 52% farmers found to have 5 to 10 years of experience. About 18% farmers in Bagerhat found to have more than 10 years' experience in crab fattening. However, the year of experience indicating that involvement in mud crab fattening is the recent development and innovation in those areas.

Ferdoushi (2013) conducted a study in where she stated that, among different social facilities, about 70% farmers in Bagerhat found to have electricity facility. Almost half of the interviewed farmers in the surveyed areas had no electricity facility. The sanitary condition in the rural area of Bangladesh is very poor especially the poor people in the coastal region are in worst condition. Farmers in Bagerhat region were found in better condition regarding having good sanitary facility. It was revealed from the survey that more than 63% farmers in the surveyed area did not get any training related to crab farming. According to their statements, neighbors and friends who received training are their main source of learning this farming. During the survey, it was reported that only half of the interviewed farmers had close contact with the extension workers.

In Bangladesh, the water supplies are based on collected rainwater, ponds pit walls, shallow and deep tube-well. In the present survey farmers mainly collecting their drinking water from pond or from tube-well. About 33 percent people of Bagerhat district drink water from open ponds (Ferdoushi, 2013).

During the survey, farmers were asked about their satisfaction towards the benefit from crab fattening. Farmers in Bagerhat region reported less satisfaction in crab fattening. Moreover, 40% of them said that they are not fully satisfied with the production and profit from mud crab fattening (Ferdoushi, 2013).

2.3 Research gap of the study

Exceptionally few researches had really assessed the effect of crab farming on farmers' livelihood. Moreover, among the limited investigations on the livelihood status of farmers yet just a few researchers followed the productive methodology of livelihood to assess the effect of crab farming on farmers' livelihood. This was one of the research gap of the study. Subsequently, the researcher did the current study to assess the effect of crab farming on farmers' livelihood in the coastal zone of Bangladesh (Bagerhat district) following the system which is indispensable to have the option to perceive and

comprehend the research approach appropriate for some random study since the assurance of a research approach effects the strategies picked, the statistical analysis utilized, the inference made and a definitive objective of the research (Creswell, 1994).

No research has endeavored beforehand following the methodology that was taken after by the current researcher. This was also a significant research gap in the study. The methodology of the current work was outstandingly unique in this regard. In this manner, the researcher executed the research program following the methodology as determined.

Again, no research was discovered which did taking the pointers of the “effect of crab farming on farmers’ livelihood”, this was done by the researcher within the current study. This is another research gap in current work. Along these lines, the researcher followed the ebb and flow research program using those markers to assess the effect of crab farming on farmers’ livelihood. At last, very few researches were led to overview of the effect of crab farming on farmers’ livelihood taking the components that were used within the current study. This is also a research gap in current research.

2.4 Conceptual framework of the study

In logical research, assurance and assessment of factors comprise an imperative assignment. Studies on individual, gathering, and society revealed that affirmation of innovative developments is contingent upon various factors. A couple of these are social, individual, affordable and situational factors and the behavior of crab farmers is affected by these attributes. The hypothesis of research while grew properly comprise in any event two significant parts i.e.: a dependent variable and an independent variable. A dependent variable is that factor which shows up, disappears, or shifts as the researcher presents evacuates or changes the independent variables (Townsend, 1953). An independent variable is a factor that is manipulated by the researcher in his undertaking to find its relationship to a watched phenomenon. Variables together are the causes, the phenomenon is effect, and thus, there is a cause-effect relationship everywhere on the universe for specific events or issues.

This study is concerned about the "Effect of Crab Farming on Cultivators' Livelihood in the coastal region of Bangladesh (Bagerhat District). In this way, the effect of crab farming on farmers' livelihood was the dependent variable and nine picked qualities of the crab farmers were considered as the independent variables underneath the study. The effect of crab farming on farmers' livelihood might be influenced through the joint effort

qualities of various independent variables. It is unimaginable to deal with all of the independent variables in a single study. It was subsequently, imperative to oblige the independent variables those are age, level of education, family size, crab farm size, annual income from crab farming, the experience of crab farming, media contact, availability of marketing information, and knowledge on crab farming for this study, constraints faced by the farmers in crab farming.

Considering the previously mentioned circumstance and conversation, a conceptual framework has been produced for this study, which is diagrammatically introduced in the accompanying-

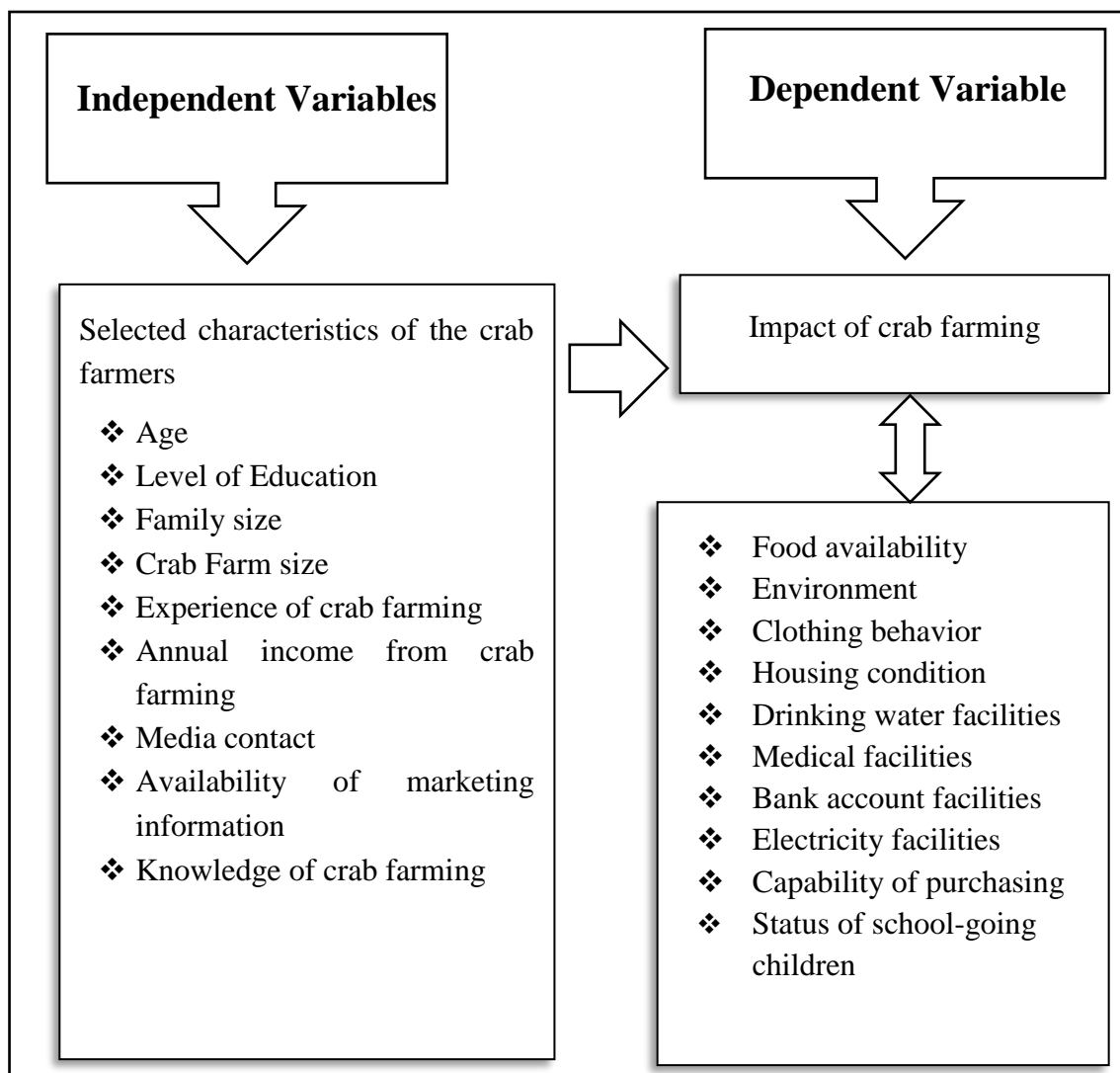


Figure 2.1 The conceptual framework of the study

CHAPTER III

RESEARCH METHODOLOGY

Methods play an important role in scientific research. In order to fulfill the objectives of the study, the researcher must be very careful when formulating methods and approaches in conducting research. According to Mingers (2001), a research method is a set of structured guidelines or activities to produce valid and reliable research results. This chapter describes the research methods and approaches used to answer research questions and to collect and analyze data to achieve benefits. The chronology of the methodology followed to carry out this research work has been presented in this chapter.

3.1 Research design

Research design is a blueprint of a detailed approach that tests the hypothesis and analysis of the data obtained. The research design followed in this study was *ex-post facto* due to uncontrolled and manipulating variables. It is the design of perfectly detailed and analytical research. A detailed research design is used for actual results with adequate explanation. Diagnostic research design, on the other hand, is concerned with testing the hypothesis to specify and explain the relationship of variables.

3.2 Locale of the study area

The study was conducted in the Rampal, Mongla, Sarankhola, and Morrelganj upazilla under Bagerhat district. The area of Rampal, Mongla, Sarankhola, and Morrelganj upazilla is 335.45 sq km, 1461.20 sq km, 756.60, and 460.91 sq km respectively. The three upazillas are selected purposively because of being adjacent to the Sundarbans, so that access to the crablet collection from the Sundarbans river and canal is easy to them. Crab farming, crab fattening, and crab collection from natural sources are an important part of the basic income of many farmers of the area. Map of study upazillas under Bagerhat district is shown in Figure 3.1.

Table 3.1 The features of the farmers and agriculture at Rampal, Mongla, Sarankhola, and Morrelganj upazila

Features		Rampal Upazilla (%)	Mongla Upazilla (%)	Sarankhola Upazilla (%)	Morrelganj Upazilla (%)
Main sources of income: agriculture		52.41	36.31	51.85	56.77
Non-agricultural laborer		7.71	17.02	9.59	5.81
Industry:		0.79	0.80	0.7	0.91
Commerce		20.71	18.85	16.24	15.32
Transport and communication		3.64	2.48	2.9	2.13
Service		5.26	10.65	6.56	8.10
Construction		1.33	1.36	1.68	1.22
Religious service		0.24	0.24	0.42	0.28
Rent and remittance		0.16	0.27	0.61	0.49
Others		7.75	12.02	9.45	8.97
Ownership of agricultural land	Landowner	55.59	41.12	48.74	57.45
	Landless	44.41	58.88	51.26	42.55
Agricultural landowner	Urban	64.13	31.55	44.35	39.78
	Rural	55.49	46.97	50.03	58.89
Main crops		Paddy, Sweet potato, Vegetables	Paddy	Paddy, Pulse	Paddy, potato, sugarcane, vegetables
Main exports		Shrimp, Crab	Shrimp, Crab	Shrimp, Crab	Shrimp, coconut, banana.

BBS, 2011

Rampal Upazilla has 10 Unions, Mongla Upazilla has 6 unions, Sarankhola Upazilla has 4 unions, and Morrelganj Upazilla has 16 unions. Hurka, Bashtala, and Sadar union of Rampal upazilla, Chilla union of Mongla upazilla, Dhansagar union of Sarankhola upazilla, and Jiudhora union of Morrelganj upazilla were selected purposively as the study area. The farmers of those unions are mostly engaged in crab culture like crab collection, crab fattening, crab farming, etc.

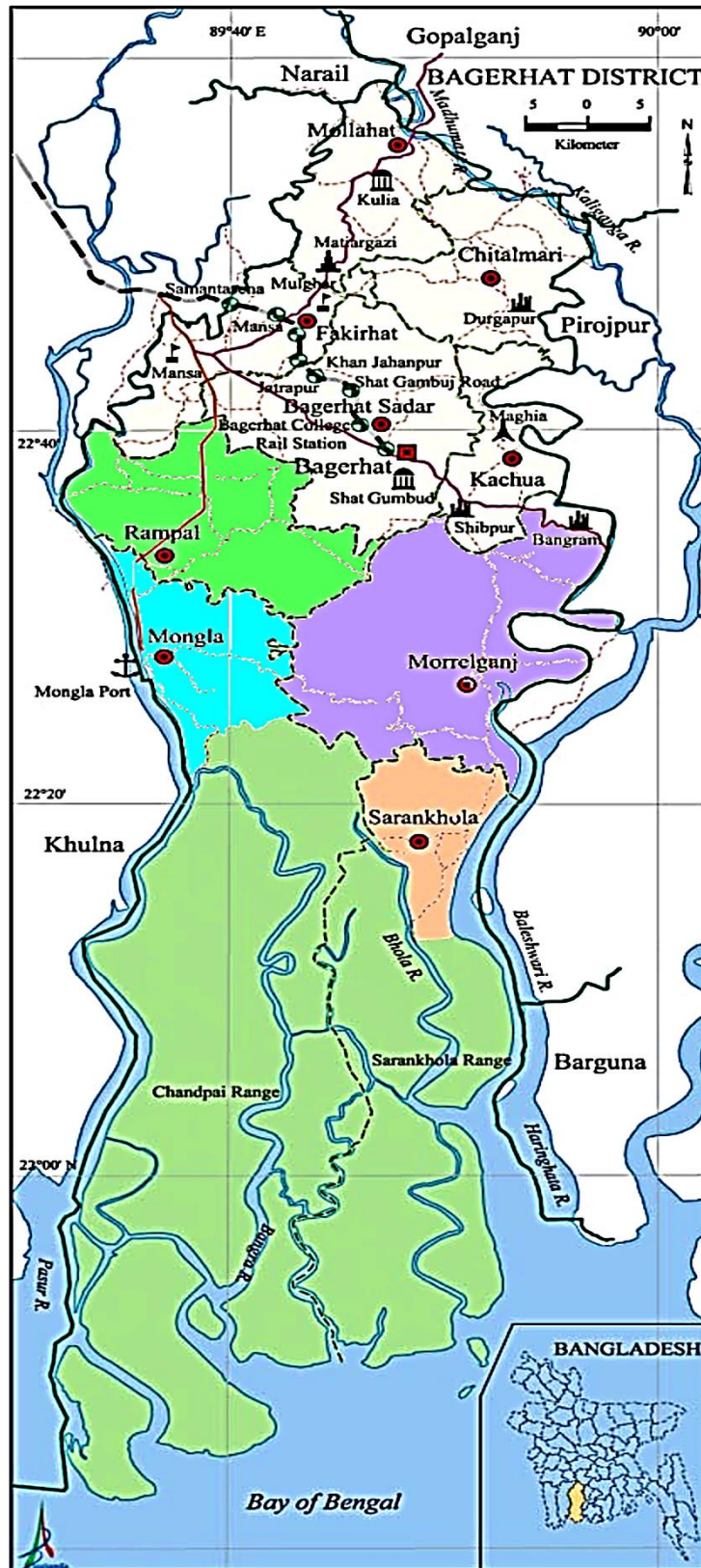


Figure 3.1 Map of Bagerhat district showing Rampal, Mongla, Sarankhola, and Morrelganj Upazilla upazila by using separate colors

3.3 Fundamental attributes of the study area

The population of the study areas consists of small, subsistence-dependent farmers, and almost everyone is directly or indirectly involved in the production or processing of agricultural commodities and related activities such as livestock, fisheries, and forestry. The economy of the study villages is mainly dependent on agricultural production, significantly rice, and some vegetables are in the crop sector and shrimp and crab are in the fisheries sector. In addition to agricultural products, some village households cultivate and sell shrimp and crabs further away to reach regional and national markets as well as for export. However, village households are usually facing a severe financial crisis and they are living below the poverty line. Most village households depend on income from urban areas for their livelihood. Typically, rural people build their homes in the form of a cluster called "Bari" and live together in "Bari" for several generations (2 to 3 generations). Rural homes are simple and functional but are generally not considered aesthetically pleasing. On average, there are 5-6 people in a household. Most of the village houses have a pond used for daily household needs, a nearby river that provides fish, trees (mainly mango and jackfruit), and a piece of garden that provides fruits and timber.

Feudal status mainly reflects the socio-economic class position in rural areas, although occupation and education also play a role. Large farm owners are at the top of the socio-economic level, small subsistence farmers are at the middle, and landless rural families are at the bottom of the socio-economic class. Another obvious sign of class status is clothing. The traditional cloth for men is the lungi and shirt and for women is saree. Gold jewelry represents a high social status among women as they have the ability to buy gold in very few households. Islam is the main religion in the study area.

Physical infrastructure is inadequate for public and health services. Roads are mostly dirt roads and rickshaws, auto-rickshaw "tempo", and tractors are the main means of transportation. Community clinic in these areas are inadequate and the main place where rural people were treated was pharmacies. In addition, sanitation and water facilities are inadequate. Residents use unclean pond water for washing, bathing and cooking. Open defecation is a common practice next to the pond and most toilets are close to the ponds. There are very limited electrification facilities in the study area. The study areas include a number of GOs, NGOs and civil society organizations that are developing and improving the livelihoods of the villagers.

3.4 Population of the Study

Four upazilas and six unions from four upazilas had been selected purposively whereas farmers mostly practiced crab farming. All the farmers who fattened mud crab at Chila union of Mongla Upazila, Hurka, Banshtoli, and Sadar union of Rampal Upazila, Dhansagar union of Sarankhola Upazila, and Jiudhora union of Morrelgonj Upazila constituted the population of the study. To attain the objectives of the study, the number of mud crab fatteners was determined approximately by consulting with Upazila Fisheries Office (UFO), field level assistant of the Department of Fisheries, Union Parishad Secretary, and local farmers. With their help, six rough lists for the six unions comprising the mud crab farmers were prepared. The total number of mud crab fatteners of the study area was 3320, which constituted the population of the study.

3.5 Sample, Sample Size and Sampling Procedure

The farm survey were carried out for mud crab fattening by applying the multistage stratified random sampling technique for selecting crab fatteners.

At the first stage, the Bagerhat district was selected based on higher contribution in the mud crab production of Bangladesh. At stage two, for selecting the 4 upazilas, the major crab farming upazilas were selected purposively through District Fisheries Office. Finally, the mud crab fatteners were selected randomly from the community level of six purposively selected unions from four upazilas based on number of crab farmers. Sample size of the study was determined by applying the following formula (Arkin, 1963):

$$n = \frac{Nz^2p(1-p)}{Nd^2 + z^2p(1-p)} \dots\dots\dots (1)$$

Where: n = Sample size

N = Total number of mud crab fatteners (approximately 3320)

z = Confidence level (at 95% level z = 1.96)

p = Estimated population proportion (8.26%)

d = Error limit of 5% (0.05)

Equation (1) suggest that a sample of above 113 respondents would be representative for the population. As a result, 113 respondents from six unions of four upazilas were randomly and proportionately selected from the population (Table 3.2).

The selected mud crab fattening households were surveyed with structured survey schedule to gather the required information for the study.

Table 3.2 Sample of the Study

Name of the District	Name of the Upazila	Population	Sample size
Bagerhat	Rampal	1120	38
	Mongla	806	27
	Sarankhola	890	31
	Morrelgonj	504	17
Total		3320	113

3.6 Data collection methods and tools

3.6.1 Data collection methods

This survey method was used to collect quantitative data that would allow to answer design questions and understand the effect of crab farming on farmers' livelihoods. Personal interviews were used in the survey and were conducted in the context of the researcher interview (Bryman, 2001). This method is useful for obtaining unanswered answers and for researchers to describe the world in a way that researchers do not see (Bryman, 2001).

3.6.2 Data collection tools

Structured interview schedules were prepared to meet the objectives of the study. The structured interview schedule consists of opened and closed formed questions. The questions in this schedule are designed to be simple and unambiguous and arranged in a logical order to be more engaging and comprehensive. These instruments were first developed in English and later translated into Bengali. Public questions allowed defendants to answer using their own language and categories (Casley and Kumar, 1998). Survey tools were initially built based on extensive literature reviews and pre-tested. The schedule was pre-tested with 15 randomly selected crab farmers at the study site. Preliminary examination helped in identifying incorrect questions and statements in the draft schedule. Therefore, necessary additions, deletions, changes and adjustments have been made in the schedule based on the experience gained from the pre-test. Supervisor and academic experts at Sher-e-Bangla Agricultural University (SAU) also checked the

questionnaires for validity. Finally, the interview schedule was finalized based on background information, expert evaluation and pre-examination. The data were collected individually by the researcher. During the data collection, necessary cooperation was obtained from the field staff and local leaders of various GOs and NGOs. Preliminary data were collected from February 28, 2019 to March 03, 2019 by recalling the respondents' memory for the pre-test. Appropriate criteria were also developed to operate on the causes of the questions. The last part of the data collection was launched from February 10, 2020 to March 08, 2020. The collected data were considered by the respondent's memory recall procedure should be appropriate.

3.7 Variables and their measurement methods

A variable is a feature that can hold different or different values in successive individual contexts. Research work usually consists of at least two important variables. Independent and dependent variables. The independent variable is manipulated in an attempt to confirm its relationship to the phenomenon observed by the researcher. The dependent variable is the factor that changes when the researcher introduces, deletes, or changes an independent variable (Townsend, 1953). In scientific research, the selection and measurement of variables is an important task. Following this concept, the researcher reviewed the literature to broaden this understanding of the nature and scope of variables relevant to this research. Finally, nine independent variables were selected, including age, education level, family size, crab farm size, annual income from crab farming, experience of crab farming, media introduction, availability of marketing information, and Knowledge on crab farming. The variable based on this study (dependent variable) is the effect of crab farming on the livelihood as perceived by coastal farmers. The methods and procedures of measuring the variables of this study are given below:

3.7.1 Measurement of independent variables

Nine characteristics of the crab farmers mentioned above were independent variables of this study. The following procedures were followed to measure the independent variables.

3.7.1.1 Age

Farmers' age was measured in terms of actual years from the time of their birth interview, which was found based on the farmers' verbal response. Each year a (1) score was assigned to one's age. This variable appears in item number 1 of the interview schedule in Appendix-I.

3.7.1.2 Level of education

Education was measured by assigning scores against a farmer school successful years. The score was given for passing each level in an educational institution (Rashid, 2014).

For example, if a farmer passes the final exam of the fifth class or equivalent examination, his/her education score is five (5). In case of cannot read and write, each farmer has given a score of zero (0). A person does not know how to read or write but can only get a score of 0.5 if he can sign. Even if a farmer does not go to school and takes formal education, his educational status will be determined as the equivalent to a formal school student. This variable item appears in number 2 as shown in the interview schedule in Appendix-I.

3.7.1.3 Family size

Family size of a farmer was determined by the total number of member's in his/her family including him/her, children and other dependents. The scoring was made by the actual number of family members expressed by the farmers. For example, if a farmer had five members in his/her family, his/her score was given as five (5). This variable appears in item number 3 in the interview schedule as presented in Appendix-I.

3.7.1.4 Crab Farm Size

The size of a farmer's farm refers to the total area on which his/her family conducts agricultural activities, the area being the full benefit to the family. The data were first recorded in terms of local measurement unit, i.e. kani or decimal and then converted to hectares. The total area thus obtained is considered to be his crab farm size score (assigning a score of one per hectare of land). This variable appears in item number four (4) of the interview schedule as shown in Appendix-I.

3.7.1.5 Experience of Crab farming

The experience of crab growers in crab farming was determined by the total number of years involved in crab farming. Each year a score of one (1) was assigned to the crab-growing season. This variable appears in the fifth number in the interview schedule as shown in Appendix-1.

3.7.1.6 Annual income from crab farming

Annual family income from crab farming refers to the total financial income from crab production in a year. It will be expressed in taka. 1 score was assigned for Tk. 1000. In

total, less than Tk.1000, a fraction score was calculated and added to the main score. This variable appears in the fifth number in the interview schedule as shown in Appendix-I.

3.7.1.7 Media Contact

It was defined as one's range of different communication media related to agricultural activities. The media contact exposure of a farmer was measured by calculating the media contact scores based on the nature of their contact with the eight media. Each farmer was asked to indicate his or her contact nature with five alternative responses, regularly, often, infrequently, and not on each basis for eight media, and a score of four, three, two, one, and zero was assigned for those alternative responses, respectively. These five options for each medium were defined for each medium taking into account the condition, rationality, and outcome of the pre-test. Logical frequencies were assigned to the five-alternative nature of the contact.

The following scores were assigned against each of the extent of media contact:

Extent of Contact	Score
Regularly	4
Frequently	3
Sometimes	2
Rarely	1
Not at all	0

Farmer's media contact was measured by adding the scores of eight selected resource sources. Therefore, a farmer's media contact score ranges from zero (0) to thirty-two (32), with zero (0) indicating no media contact and the highest level of thirty-two (32) media contacts. This variable appears in the fifth number in the interview schedule as shown in Appendix-1.

3.7.1.8 Availability of marketing information

It is defined as one's scope for available marketing information related to crab marketing. The availability of marketing information is measured by calculating the scores based on the five extent of the marketing information. Each farmer was asked to indicate his nature of marketing information with five alternative responses, like regularly, frequently,

sometimes, rarely, and not at all basis to each of the six information. The following scores were assigned against each of the extent of marketing information:

Extent of Marketing information	Score
Regularly	4
Frequently	3
Sometimes	2
Rarely	1
Not at all	0

These five options for each medium are defined for each medium taking into account the condition, rationality and outcome of the pre-test. Logical frequencies are assigned to the five-alternative nature of contact. The availability of marketing information cited by farmers is measured by adding the scores of five selected resource sources. Therefore, a farmer marketing information score availability ranges from zero (0) to twenty (20), where zero (0) indicates that marketing information is not available and twenty (20) indicates the highest level of availability of marketing information. This variable appears in item number 08 of the interview schedule Appendix-I.

3.7.1.9 Knowledge on Crab Farming

A farmer's crab farming knowledge was measured by asking 10 questions related to different parts of crab production. It was measured by assigning score four (4) to each question. Therefore, the total scores assigned to all the questions became forty. The score was given according to the response during the interview. Correctly, answering a question gives a person a full score, but he who did wrong answer or does not answer get a score of zero (0). A partial score was assigned for a partially correct answer. Therefore, a farmer's agricultural knowledge score ranges from zero (0) to forty (40), where zero indicates very poor knowledge and forty indicates sound knowledge. This variable appears in item number 09 in the interview schedule as shown in Appendix-I.

3.7.2 Measurement of dependent variable

The dependent variable of this study was "Effect of crab farming on the livelihood as perceived by coastal farmers". The dependent variable i.e. effect of crab farming on

farmers' livelihood was measured by asking 10 items having four alternative responses. The following scores were assigned against each of the items:

Extent of Problems	Score
High Effect	3
Medium Effect	2
Low effect	1
No Effect	0

The effect of the crab farming of a farmers' livelihood were measured by adding the scores of 10 items. Thus, effect of crab farming score of a respondent could range from zero (0) to thirty (30) where zero (0) indicated no effect and thirty (30) indicated highest effect of crab farming on the livelihood of farmers. This variable appears in item number 10 in the interview schedule as shown in Appendix-I.

3.8 Constraints faced by farmers during crab farming

Constraints in crab farming faced by the farmers were measured based on extent of constraints faced by the crab farmers. It was measured by asking the extent of problems on 10 items. The following scores were assigned against each of the problem items:

Extent of Problems	Score
Very high problem	4
High problem	3
Moderate problem	2
Low problem	1
No problem	0

Thus, constraints in crab farming score of a respondent could range from zero (0) to forty (40) where zero (0) indicated no constraints and forty (40) indicated very

high constraints faced in crab farming. This variable appears in item number 11 in the interview schedule as shown in Appendix-I.

3.8.1 Rank order of constraints in crab farming

To ascertain the best problem conflict strategies Constraint Faced Index (CFI) was computed for each of the selected items of crab farming.

A Constraint Faced Index (CFI) was computed for each constraints strategy by using the formula:

$$\text{Constraint Faced Index (CFI)} = f_{\text{vhc}} \times 4 + f_{\text{hc}} \times 3 + f_{\text{mc}} \times 2 + f_{\text{lc}} \times 1 + f_{\text{nc}} \times 0$$

Where, CFI = Constraint Faced Index

f_{vhc} = No. of respondents faced very high constraint

f_{hc} = No. of respondents faced high constraint

f_{mc} = No. of respondents faced moderate high constraint

f_{lc} = No. of respondents faced low high constraint

f_{nc} = No. of respondents faced no high constraint

Constraint Faced Index (CFI) for each constraint strategies could range from 0 to 452, where 0 indicating no constraint and 452 indicating highest extent of constraint.

3.9 Hypothesis of the study

According to Kerlinger (1973), a hypothesis is a conjectural statement of the relation between two or more variables. Hypothesis are always in declarative sentence form and they are related, either generally or specifically from variables to variables. In broad sense hypothesis is divided into two categories: (a) Research hypothesis and (b) Null hypothesis.

3.9.1 Research hypothesis

Based on review of literature and development of conceptual framework, the following research hypothesis was formulated:

“Each of the nine selected characteristics (age, education level, family size, crab farm size, crab farming experience, annual income from crab farming, media contact, availability of marketing information, knowledge on crab farming) of the farmers has significant contribution to the effect of crab farming at their livelihood.”

3.9.2 Null hypothesis

A null hypothesis states that there is no contribution between the concerned variables. The following null hypothesis was formulated to explore the contribution of the selected characteristics on effect of crab farming on farmers' livelihood. Hence, in order to conduct tests, the earlier research hypothesis was converted into null form as follows:

“There is no contribution of the selected characteristics (age, education level, family size, crab farm size, crab farming experience, annual income from crab farming, media contact, availability of marketing information, knowledge on crab farming) of farmers to the effect of crab farming at their livelihood.”

3.10 Data processing and analysis

Bogdan and Biklen (2006) emphasize that data analysis is an ongoing component of data collection. Initially, all data collected were carefully recorded in the Microsoft Excel. Exported data was randomly checked against the original completed interview schedule. Errors have been identified and necessary corrections have been made after export. Further consultation with research assistants and in some cases community members was required. Finally, data were exported from the Microsoft Excel program to IBM SPSS version 26.0, which provided statistical tools applicable to the social sciences. If necessary, the qualitative data was converted into quantitative numbers, followed by processing, scaling, and indexing of the required and relevant variables, to make inferences and further statistical analysis. As mentioned earlier, a wide variety of forms and methods can be used to analyse both quantitative and qualitative data in line with the objectives of the study. Both descriptive and analytical methods were used to analyse the data. Detailed methods were used to describe the current situation, to describe the different variables separately, and to generate tables presented in the results. These included frequency distribution, percentage, range, mean and standard deviation. Analytical methods have been used to investigate the contribution of selected traits of crab farmers on the effect of crab farming on the livelihood of crab farmers. Statistical testing such as regression was used in this study. Each statistical technique is used in specific situations.

3.11 Statistical analysis

Stepwise multiple regression was used to determine the contribution of the selected characteristics of the farmers to the effect of crab farming on their livelihood. Throughout the study, five (0.05) percent level of significance were used to reject any null hypothesis.

If the computed value of b was equal to or greater than the designated level of significance (p), the null hypothesis was rejected and it was concluded that there was a significant contribution of the independent variable to the dependent variable. The null hypothesis cannot be rejected whenever the computed value of (B) was small at designated significance (p). The model used for this analysis can be explained as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + e$$

Where,

Y = effect of crab farming on farmers' livelihood

a = constant value of the equation

X_1 = crab farmers' age

X_2 = level of education

X_3 = family size

X_4 = crab farm size

X_5 = experience of crab farming

X_6 = annual income from crab farming

X_7 = media contact

X_8 = availability of marketing information

X_9 = knowledge on crab farming

e = random error, which is normally and independently distributed with zero mean and constant variance

$b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8,$ and b_9 are regression coefficients of the corresponding independent variables

CHAPTER IV

RESULTS AND DISCUSSIONS

Recorded observations were presented in line with the objective of the study and what was found was discussed with justifiable and relevant comments under this chapter. The results of the study and their interpretation have been presented in this chapter. These are presented in four sections according to the objective of the study. The first section deals with the selected characteristics of farmers, while the second section describes the effect of crab farming on farmers' livelihoods. The third section describes the contribution of farmer-selected traits to the effect of crab farming on farmer-livelihoods, while the fourth section describes the constraints faced by farmers associated with crab farming.

4.1 Characteristics of the farmers

A person's behavior is largely determined by one's personal characteristics. There are various traits that can have consequences for the livelihood of farmers. But in this study, nine of them were selected as independent variables, including their age, education level, family size, crab farm size, annual income from crab farming, experience in crab farming, availability of marketing information, knowledge on crab farming that might be greatly influenced by the effect of crab farming on their livelihood are presented-

4.1.1 Age Distribution of the Crab Farmers

The average and standard deviation for farmers aged 18 to 75 years is 41.96 and 9.58, respectively. Considering the recorded age, farmers are classified into three age groups: "young", "middle" and "old" (MoYS, 2012). Their distribution according to the age of the farmers is shown in Table 4.1

Table 4.1 Age Distribution of the Crab Farmers

Category	Basis of categorization (age)	Observed range (age)	Crab fatteners		Mean	SD
			Number	Percent		
Young aged	< 32.38 <(Mean-SD)	2-10	33	29.20	41.96	9.58
Middle aged	32.38-51.54 (Mean ± SD)		61	53.98		
Old aged	> 51.54 >(Mean+SD)		19	16.81		
Total			113	100		

Distribution of the crab farmers based on their age reveals that the middle-aged farmers comprised the highest proportion (53.98%) followed by young (29.20%) and old (16.81%) aged category. Results also indicate that the young and middle-aged category constitute 83.18% of the total farmers. The result seems that, the young and middle-aged farmers were generally more involved in crab fattening activities after the realization of the extra profit generating capacity of several practices.

4.1.2 Level of education

The average and standard deviation of farmers' education scores was 5.94 and 3.86, respectively ranging from 0 to 17. Farmers are classified into five categories based on their educational scores. The distributions according to the level of education of the farmers are shown in Table 4.2

Table 4.2 Distribution of the farmers according to their level of education

Category	Basis of categorization (Score)	Observed Range (Score)	Farmers		Mean	SD
			Number	Percent		
Can't read and sign	0	0-17	1	0.89	5.94	3.86
Can sign only	0.5		21	18.58		
Primary education	1-5		32	28.31		
Secondary education	6-10		48	42.48		
Above secondary	>10		11	9.74		
Total			113	100		

Table 4.2 shows that farmers in the secondary education category have the highest proportion (42.48 percent), followed by primary education (28.31 percent) and above the secondary education category (9.74 percent). On the other hand, can sign only (18.58 percent) and 0.89 percent of respondents can't read and sign. Thus the data revealed that 80.53% of crab farmers are literate which is better than the average literacy rate of Bangladesh (Islam, 2016).

4.1.3 Family size

The mean and standard deviation of the family size of crab farmers' was 4.11 and 1.55, respectively ranging from 2 to 10 members. Sujan (2018) found more or less the same

result. According to family size, crab farmers are classified into three categories by adding and subtracting the standard deviation from the average family size into the ‘small’, ‘medium’ and ‘large’ family. The distribution of farmers according to their family size is shown in Table 4.3.

Table 4.3 Distribution of the crab fatteners according to their family size

Category	Basis of categorization (members)	Observed range (members)	Crab fatteners		Mean	SD
			Number	Percent		
Small Family	< 2.57 < (Mean-SD)	2-10	40	35.40	4.12	1.55
Medium Family	2.57-5.67 (Mean ± SD)		66	58.41		
Large Family	> 5.67 > (Mean+SD)		7	6.19		
Total			113	100		

The result represents a medium-sized family with the highest proportion (58.41%), followed by the small(35.40%) sized family. Only 6.19% of the respondents had a large family. Such a finding is very common in Bangladesh. The study results indicated that the mean family size (4.11) of the study was almost equal to the national average of 4.06 (BBS, 2016). The tendency of the nuclear family is increasing in the study area and subsequently the size of the family becomes smaller over the time.

4.1.4 Crab Farm size

The farm size of the farmers ranged from 0.012 ha to 2.67 ha with a mean and standard deviation of 0.17 and 0.29, respectively. Based on their crab farm size, farmers are classified into five categories after classification according to the DAE (1999). The distribution of farmers according to their crab farm size is shown in Table 4.4.

Table 4.4 Distribution of the farmers according to their crab farm size

Category	Basis of categorization (ha)	Observed Range (ha)	Farmers		Mean	SD
			Number	Percent		
Landless	≤ 0.02	0.012-2.76	6	5.31	0.17	0.29
Marginal	0.021-0.20		81	71.68		
Small	0.21-1.00		25	22.12		
Medium	1.01-3.0		1	0.89		
Large	>3		0			
Total			113	100		

The result indicates that the marginal farm holder has the highest ratio (71.68 percent), followed by the small farm holder (22.12 percent). The results of the study reveal that the majority of farmers are less likely to be marginal scale farmers. The average agricultural area of farmers in the study area (0.17 ha) is lower than the national average (0.60 ha) in Bangladesh (BBS, 2016).

4.1.5 Experience of crab farming

The experience score of crab farmers for crab farming ranges from 2 to 35 with an average and standard deviation of 12.11 and 6.62 respectively. Based on the experience of crab farming scores, crab farmers are classified into three categories namely "low", "medium" and "high" experience. The distribution of crab farmers according to crab farming experience is given in Table 4.5.

Table 4.5 Distribution of the farmers according to their experience of crab farming

Category	Basis of categorization (years)	Observed range (years)	Crab farmers		Mean	SD
			Number	Percent		
Low experience	< 5.49 $< (\text{Mean}-\text{SD})$	2-35	22	19.47	12.11	6.62
Medium experience	5.49-18.73 (Mean \pm SD)		73	64.60		
High experience	> 18.73 $> (\text{Mean}+\text{SD})$		18	15.93		
Total			113	100		

The results show that the majority (64.60%) of the farmers fell in the medium experience category, 19.47% in the low experience category and only 15.93% in the high experience category. The vast majority (84.07%) of respondents from lower to medium-term crab farming experiences.

4.1.6 Annual income from crab farming

The score of the annual income of the crab farmers ranged from 20 to 1500 with an average income of 176.46 thousand taka. The closest result was also found by Rahman(2016), Ferdoushi (2013), Molla *et. al.* (2009), and Sujan (2018). On the basis of annual income from crab farming, the crab farmers were classified into three categories namely “low”, “medium” and “high” annual income from crab farming. The distribution of the crab farmers according to their income from crab farming is presented in Table 4.6.

Table 4.6 Distribution of the farmers according to their annual income from crab farming

Category	Basis of categorization ('000' Tk)	Observed range ('000' Tk)	Crab farmers		Mean
			Number	Percent	
Low income	<100	20-1500	28	24.78	176.46
Medium income	100-250		75	66.37	
High income	>250		10	8.85	
Total			113	100	

Although 24.78% of crab farmers have low income from their farming, 66.37% and 8.85% of them have medium and high income from that practice respectively. Therefore, a high percentage (75.22%) of crab farmers have medium to high annual income from that practice.

4.1.7 Media contact

The observed score of media contact of the farmers ranged from 8 to 18 against a possible range of 0 to 32. The average score of the farmers was 8.57 with a standard deviation of 1.51. The farmers were categorized into three categories based on their exposure to farming information through ‘communication exposure scores’ and distribution of the three categories namely “low”, “medium” and “high” extension media contact of the farmers. The distribution of the crab farmers according to their media contact is presented in Table 4.7.

Table 4.7 Distribution of the farmers according to their media contact

Category	Basis of categorization (score)	Observed range (score)	Crab farmers		Mean	SD
			Number	Percent		
Low contact	< 7.06 < (Mean-SD)	8-18	85	75.22	8.57	1.51
Medium contact	7.06 -10.08 (Mean \pm SD)		23	20.35		
High contact	> 10.08 > (Mean+SD)		5	4.43		
Total			113	100		

From Table 4.7, it can be concluded that most of the crab farmers (75.22%) has low to medium correlation with media. The results of the study revealed that 20.35% of farmers are interrelated, which demands to strengthen and improve the communication strategy.

4.1.8 Availability of marketing information

Marketing information availability scores on the study area ranged from 10 to 18 with an average and standard deviation of 15.20 and 1.53, respectively. Based on the availability of marketing information score, crab farmers are classified into three categories namely low, medium, and high availability of marketing information. The distribution of crab farmers according to the availability of marketing information is shown in Table 4.8.

Table 4.8 Distribution of the crab farmers according to availability of marketing information

Category	Basis of categorization (score)	Observed range (score)	Crab farmers		Mean	SD
			Number	Percent		
Less Information	< 13.67 < (Mean-SD)	10-18	30	26.55	15.20	1.53
Medium Information	13.67 -16.73 (Mean \pm SD)		79	69.91		
High Information	> 16.73 > (Mean+SD)		4	3.54		
Total			113	100		

The data revealed that a high proportion (69.91 percent) of crab farmers had moderate availability of marketing information, 3.54 percent had high availability of marketing information and the lowest 26.55 percent had low availability of marketing information.

4.1.9 Knowledge on Crab farming

Farmers crab farming knowledge scores ranged from 23 to 33 against a score of 0 to 40. The average score and standard deviation were 26.93 and 2.04, respectively. Based on the crab farming knowledge scores, the farmers were classified into three categories namely poor knowledge, moderate knowledge and sound knowledge are shown on the Table 4.9.

Table 4.9 Distribution of the farmers according to their knowledge on crab farming

Category	Basis of categorization (score)	Observed range (score)	Crab farmers		Mean	SD
			Number	Percent		
Poor knowledge	< 24.89 < (Mean-SD)	23-33	15	13.28	26.93	2.04
Moderate knowledge	24.89 -28.97 (Mean \pm SD)		75	66.37		
Sound knowledge	> 28.97 >(Mean+SD)		23	20.35		
Total			113	100		

Table 4.9 revealed that 66.37 percent of the farmers had moderate crab farming knowledge, 16.81 percent had little knowledge and 7.97 percent had good knowledge on crab farming. Therefore, a large number (83.19%) of the farmers are knowledgeable on crab farming.

4.2 Effect of crab farming on farmers' livelihood

Effect of crab farming on the livelihood of farmers ranged from 4 to 30. The average and standard deviation were 15.27 and 6.25 respectively. Based on effect of crab farming on the livelihood of farmers, the respondents were categorized into three categories namely "low", "medium" and "high" effect as shown in Table 4.10.

Table 4.10 Distribution of the respondents according to effect of crab

Category	Basis of categorization (score)	Observed range (score)	Crab farmers		Mean	SD
			Number	Percent		
Low Effect	< 9.02 < (Mean-SD)	4-30	23	20.35	15.27	6.25
Medium Effect	9.02 -21.52 (Mean \pm SD)		73	64.60		
High Effect	> 21.52 > (Mean+SD)		17	15.05		
Total			113	100		

Table 4.10 reveals that 64.60 percent of the farmers perceived medium effect, 20.35 percent perceived low effect and 15.05 percent perceived high effect of crab farming. Thus, an overwhelming majority (79.65 %) of the farmers perceived medium to high effect of crab farming on farmers livelihood.

4.3 Contribution of selected characteristics on the farmers' livelihood

For this study, nine traits of the respondent were selected and each trait was considered as an independent variable. Among the independent variables, X_1 was the crab farmers' age, X_2 was the level of education, X_3 was the family size, X_4 was the crab farm size, X_5 was the experience of crab farming, X_6 was the annual income from crab farming, X_7 was the media contact, X_8 was availability of marketing information, and X_9 was the knowledge on crab farming. Y was the effect of crab farming on livelihoods of farmers as a dependent variable of this study.

To find out the contribution of the selected traits to the effect of crab farming to the livelihood of the farmers, the method of stepwise multiple regression was used and nine independent variables were arranged together in a stepwise multiple regression analysis. Table 4.10 shows the summary results of a multi-regression analysis with nine independent variables to the effect of crab farming on the livelihood of farmers. Of the nine variables, only five independent variables namely annual income from crab farming (X_6), availability of marketing information (X_8), the crab farm size (X_4), the experience of crab farming (X_5), and the knowledge on crab farming (X_9) were entered into the regression equation. The other four variables were not entered into regression equation. The regression equation so obtained is presented below:

$$Y = -12.163 + 0.365X_6 + 0.180X_8 + 0.226X_4 + 0.197X_5 + 0.163X_9 + e$$

Multiple R	0.733	R-square	0.538
Adjusted R-square	0.498	F-ratio	13.322
Standard error of estimate	4.428	Constant	-12.163

The multiple R and R^2 values were found to be 0.733 and 0.538, respectively, and the corresponding F-ratio was 13.322. To determine the specific contribution of each of the five variables, the R^2 value increase on livelihood was determined. These five variables explain the effect of crab farming on the livelihoods of 50.7 percent of the total variation.

The annual income from crab farming contributed to 37.8 percent variation, where the availability of marketing information contributed 5.7 percent, crab farm size 2.6 percent, experience in crab farming 2.7 percent and knowledge on crab farming 1.9 percent effect on farmers' livelihood.

Table 4.11 Summary of step wise multiple regression analysis showing the contribution of selected characteristics of the respondents to the effect of crab farming on their livelihood

Variables entered	Standardized Partial 'b' Coefficients	Value of 't'	Adjusted R ²	Increase in R ²	Variation explained in percent
Annual income from crab farming(X ₆)	0.365	3.459***	0.378	0.378	37.8
Availability of marketing information (X ₈)	0.180	2.393**	0.435	0.057	5.7
Crab farm size (X ₄)	0.226	2.527**	0.461	0.026	2.6
Experience of crab farming (X ₅)	0.197	2.631**	0.488	0.027	2.7
Knowledge on crab farming (X ₉)	0.163	2.227*	0.507	0.019	1.9
Total				0.507	50.7
*** Indicates significant at 1% level					
** Indicates significant at 5% level					
* Indicates significant at 10% level					

4.3.1 Contribution of annual income from crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers

The contribution of annual income from crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers was measured by testing the following null hypothesis: "There is no contribution of annual income from crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers".

The following observations were made based on the value of the concerned variable of the study under consideration.

- i. The contribution of the annual income from crab farming was 37.8 percent.
- ii. It had the highest contribution to the effect of crab farming on the livelihood as perceived by coastal farmers.

Based on the above finding, it was concluded that a respondents' annual income from crab farming has increased the capabilities of shifting crab farming. An annual income from crab farming enhances the abilities of the respondents at a short time than others, which transformed to the effect of crab farming on the livelihood as perceived by coastal farmers. Thus, the null hypothesis was rejected.

4.3.2 Contribution of availability of marketing information to the effect of crab farming on the livelihood as perceived by coastal farmers

The contribution of availability of marketing information to the effect of crab farming on the livelihood as perceived by coastal farmers was measured by testing the following null hypothesis: "There is no contribution of availability of marketing information to the effect of crab farming on the livelihood as perceived by coastal farmers".

The following observations were made based on the value of the concerned variable of the study under consideration.

- i. The contribution of the availability of marketing information was 5.7 percent.
- ii. It was an important contributor to the effect of crab farming on the livelihood as perceived by coastal farmers.

Based on the above finding, it was concluded that a respondents' availability of marketing information increased the capabilities of shifting crab farming. An availability of marketing information enhances the abilities of the respondents at a short time, which transformed to the effect of crab farming on the livelihood as perceived by coastal farmers. Thus, the null hypothesis was rejected.

4.3.3 Contribution of crab farm size to the effect of crab farming on the livelihood as perceived by coastal farmers

The contribution of crab farm size to the effect of crab farming on the livelihood as perceived by coastal farmers was measured by testing the following null hypothesis: "There is no contribution of crab farm size to the effect of crab farming on the livelihood as perceived by coastal farmers".

The following observations were made based on the value of the concerned variable of the study under consideration.

- i. The contribution of the crab farm size was 2.6 percent.
- ii. It was an important contributor to the effect of crab farming on the livelihood as perceived by coastal farmers.

Based on the above finding, it was concluded that a respondents' crab farm size increased the capabilities of shifting crab farming. A farm size enhances the abilities of the respondents at a short time, which transformed to the effect of crab farming on the livelihood as perceived by coastal farmers. Thus, the null hypothesis was rejected.

4.3.4 Contribution of experience of crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers

The contribution of experience of crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers was measured by testing the following null hypothesis: "There is no contribution of experience of crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers".

The following observations were made based on the value of the concerned variable of the study under consideration.

- i. The contribution of the experience of crab farming was 2.7 percent.
- ii. It was an important contributor to the effect of crab farming on the livelihood as perceived by coastal farmers.

Based on the above finding, it was concluded that a respondent's experience of crab farming increased the capabilities of shifting crab farming. An experience of crab farming enhances the abilities of the respondents at a short time, which transformed to the effect of crab farming on the livelihood as perceived by coastal farmers. Thus, the null hypothesis was rejected.

4.3.5 Contribution of knowledge on crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers

The contribution of knowledge on crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers was measured by testing the following null hypothesis: "There is no contribution of knowledge on crab farming to the effect of crab farming on the livelihood as perceived by coastal farmers".

The following observations were made based on the value of the concerned variable of the study under consideration.

- i. The contribution of the knowledge on crab farming was 1.9 percent.
- ii. It was an important contributor to the effect of crab farming on the livelihood as perceived by coastal farmers.

Based on the above finding, it was concluded that a respondent's knowledge on crab farming increased the capabilities of shifting crab farming. A knowledge on crab farming enhances the abilities of the respondents at a short time, which transformed to the effect of crab farming on the livelihood as perceived by coastal farmers. Thus, the null hypothesis was rejected.

4.4 Constraints faced by the farmers in crab farming

Constraints faced by farmers in crab farming scores ranged from 19 to 34 against 0 to 40. The average score and standard deviation were 26.94 and 2.876, respectively. Based on the constraints in the crab farming scores, the respondents were classified into three categories namely low, medium and high restrictions in crab farming.

Table 4.12 Distribution of the respondent according to their constraints in crab farming

Category	Basis of categorization (score)	Observed range (score)	Crab farmers		Mean	SD
			Number	Percent		
Low Constraints	< 24.064 < (Mean-SD)	19-34	25	22.12	26.94	2.876
Medium Constraints	24.064-29.816 (Mean ± SD)		79	69.91		
High Constraints	> 29.816 > (Mean+SD)		9	7.97		
Total			113	100		

Table 4.12 revealed that 69.91 percent of the respondents had medium constraints on crab farming, 22.12 percent had low constraints to crab farming and 7.97 percent had high constraints to crab farming. Therefore, a large number (77.88 percent) of the respondents had medium constraints on crab farming in the study area.

4.4.1 Rank order of constraints in crab farming

The purpose of this section was to understand the comparative constraints faced by crab farmers in crab farming. To compare the constraints, a rank order was made based on Constraints Faced Index (CFI). Constraint faced index (CFI) of the farmers of the 10 constraint items in crab farming ranged from 153 to 430 against a possible range of 0 to 452. According to the descending order of the CFI, a rank order was made as shown in the Table 4.12.

Table 4.13 Rank order of constraints faced by respondents in crab farming

Sl. No.	Nature of Constraints	CFI Score	Rank
1.	Natural disasters like flood, erosion etc.	430	1 st
2.	Presence of virus and other diseases	411	2 nd
3.	Domination by middleman in case of price determination	390	3 rd
4.	Non-availability of quality mud crab seed for commercial farming in farms	349	4 th
5.	Grading system pricing of crab	325	5 th
6.	Lack of financial and non-financial government supports	309	6 th
7.	Occasional fluctuation of price of mud crab	258	7 th
8.	Over dependency on natural wild seed	229	8 th
9.	Exploitation and deprivation by the middlemen	191	9 th
10.	The rate of increasing the cost of production	153	10 th

According to the Constraints Facing Index (CFI), 'natural disasters such as floods, cyclones, etc.' rank first and 'increasing the cost of production' rises last in respect of crab farming.

Constraints faced by farmers in crab farming as per descending order by CFI from respondents including natural disasters like- flood, erosion etc. that ranked first, presence of virus and other diseases that ranked second, domination by middleman in case of price determination that ranked third, Non-availability of quality mud crab seed for commercial farming in farms that ranked fourth, grading system pricing of crab that ranked fifth, lack of financial and non-financial government supports that ranked sixth, occasional fluctuation of price of mud crab that ranked seventh, over dependency on natural wild seed that ranked eighth, exploitation and deprivation by the middlemen that ranked ninth, and the rate of increasing cost of production that ranked last, respectively.

The results show that natural disasters like flood, erosion etc. are the biggest constraints facing farmers in crab farming. Coastal farmers are more prone to natural calamities and disaster rate is very high in the study area. The least obstacle in crab farming is to increase the cost of production. This can happen because the production cost of crab farming is lower than the cost of shrimp or other fisheries-related production.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Major Findings

5.1.1 Selected characteristics of the crab farmers

Age: The middle-aged crab farmers comprised the highest proportion (53.98 percent) and the lowest proportion by old aged category (16.81 percent).

Level of education: Secondary education has the highest proportion (42.48 percent) and 0.89 percent in the illiterate and unsigned category.

Family Size: Medium size family has the highest proportion (58.41 percent) and the lowest 6.19 percent farmers have large family size.

Crab Farm Size: The highest proportion of marginal farm holder (71.68 percent), no large farm holder was found. In fact, this marginal proportion of crab farm size has had significant effect on the livelihood of coastal farmers.

Experience of Crab Farming: The highest percentage (64.60 percent) in crab farming was in the medium experience of the crab farming category, while the low experience of the crab farming category was 19.47 percent, and the high experience in the crab farming category was only 15.93 percent.

Annual income from crab farming: The crab farmers having medium income from crab farming constituted the highest proportion (66.37 percent), followed by a low income of 24.78 percent and a high income of 8.85 percent.

Media contact: The highest percentage (75.2%) of farmers had low media contact, of whom 20.35 percent had medium contact of media and 4.43 percent fell in high contact of media.

Availability of marketing information: The highest proportion (69.91 percent) of crab farmers have moderate availability of marketing information and the lowest 3.54 percent have the highest access to the marketing information category.

Knowledge on crab farming: 66.37 percent of farmers have medium knowledge on crab farming, 13.28 percent have low knowledge and 20.35 percent have sound knowledge on crab farming.

5.1.2 Effect of crab farming on farmers' livelihood

The study reveals that 64.60 percent of the farmers had a medium effect of crab farming on their livelihood. Whereas, 20.35 percent had a low effect and 15.05 percent had a high effect of livelihood through crab farming. Thus, an overwhelming majority (79.65 %) of the farmers had a medium to the high effect of crab farming on the livelihood as perceived by coastal farmers.

5.1.3 Contribution of selected characteristics of the respondents' livelihood conditions

The multiple R and R^2 values were found to be 0.733 and 0.538, respectively, and the corresponding F-ratio was 13.322, which was significant at the 1% level of significance. To determine the specific contribution of each of the five variables, the R^2 value increase on livelihood was determined. These five variables altogether explain the effect of crab farming on the livelihood of 50.7 percent of the total farmers. The annual income from crab farming contributes to 37.8 percent variation, where the availability of marketing information (5.7 percent), crab farm size (2.6 percent), experience in crab farming (2.7 percent) and knowledge on crab farming (1.9 percent) have an effect on farmers' livelihood.

5.1.4 Constraints faced by farmers in crab farming

The study revealed that 69.91 percent of the respondents had medium constraints on crab farming, 22.12 percent had low constraints to crab farming and 7.97 percent had high constraints to crab farming. Therefore, a large number (77.88 percent) of the respondents had medium to high constraints on crab farming in the study area.

5.1.5 Rank order of constraint faced by farmers in crab farming

The rank order of the ten strategies of constraint confrontation was measured. According to the Constraints Facing Index (CFI), 'natural disasters such as floods, cyclones, etc.' rank 1st and 'increasing the cost of production' rises last in respect of crab farming.

5.2 Conclusions

The results of the research work and the relevant facts prompted the researcher to draw the following conclusions.

- i. The demographic profile of crab farmers indicates that most of the young to middle-aged (83.18%) crab farmers are involved in crab farming and most of them (58.41%) are from medium (4-6 members) family. The majority (42.48%) of those with secondary education status was marginal holder (71.68%) farmers. However, a high percentage (75.22%) of them earned medium to high annual income from crab farming. Although, most of them (64.60%) have moderate crab farming experience, a large number (83.19%) of farmers have gained knowledge on crab farming.
- ii. The findings revealed that an overwhelming majority (79.65 %) of the farmers had medium to high effect of crab farming on farmers' livelihood category. However, in order to meet the growing demand of economic conditions, crab farming needs to be continued. It can be concluded that the mixed effect of crab farming on the livelihood of farmers requires maintenance and improvement.
- iii. Maximum (66.37 %) crab farmers had medium annual income from crab farming category and regression analysis revealed that annual income from crab farming of the crab farmers was a contributing factor to the effect of farmers' livelihood. Therefore, it can be concluded that high family income from crab farming encourages the farmers to practice crab farming.
- iv. Crab farming knowledge has made a significant contribution to the livelihood effect of farmers. Through crab farming knowledge, an individual gained information on various aspects of crab production methods selected by the farmer. Consequently, they were motivated to practice crab farming. The above facts confirm that necessary arrangements should be made to increase the knowledge of the farmers who are finally farming crab with the intention of increasing the effect on the livelihood of the farmers.
- v. It was found that the size of the crab farm contributed significantly to the livelihood effect of farmers. The larger the size of the crab farm, the greater the chances of raising the farmer's perspective, which leads to the practice of crab farming with the aim of maximizing the effect on farmers' livelihoods. It can be concluded that

more areas for crab farming need to be considered to have a significant effect on the livelihood of coastal farmers.

- vi. The availability of marketing information has had a significant effect on the livelihoods of coastal farmers. The crab dealer regularly provides information about the daily market price and market demand. This helps the farmer to determine the market condition and the amount to be caught from the farm or pond. However, the availability of regular marketing information can reduce the loss percentage by avoiding catching large amounts of crab.

5.3 Recommendations

5.3.1 Recommendations for policy implications

The following recommendations are made from the results of the study based on the observations and conclusions:

- i. The increased rate and range of crab farming are very important to increase the livelihood of coastal farmers. It is evident from the effect of crab farming on the livelihood as perceived by coastal farmers that a significant proportion (79.65%) of farmers have had moderate to the high effect of crab farming on their livelihood. Therefore, it is recommended that the Department of Fisheries (DoF) and Non-governmental organizations (NGOs) take effective action to strengthen the qualities of farmers in favor of crab farming to improve their livelihood.
- ii. Relevant authorities such as the Department of Fisheries (DoF) and Non-governmental organizations (NGOs) can often arrange field days, demonstrations, and training programs to provide farmers with crab farming knowledge. The concerned authority should provide further extension services.
- iii. Major cost of the farming practices constituted by crablets. However, smallholder farmers often face disease attacks on their farms. To prevent these attacks, disease-free improved crablets are essential. The government may take the initiative to supply disease-free improved crablets at a subsidized rate. In addition, it is imperative to establish a Crablet Hatchery to ensure an uninterrupted supply of disease-free crablets.
- iv. Farmers with moderate and good knowledge about crab farming have a great effect on their livelihood. It should be selected on a priority basis for any incentive training conducted by the Department of Fisheries (DoF) and non-governmental organizations (NGOs) to achieve sustainable crab production.

- v. The annual income from crab farming by crab farmer was an important factor in the effect of crab farming on farmers' livelihood. Therefore, it is recommended that extension workers work with farmers and encourage them to increase their annual income through crab farming, which can help improve their livelihoods.
- vi. Farmers' crab farming experience has made a significant contribution to the effect of crab farming on farmers' livelihoods. This indicates the importance of experience for crab farmers. Relevant authorities may recommend that arrangements be made to increase training facilities and conduct demonstrative farming on farmers' fields to enhance the experience level of crab farmers.

5.3.2 Recommendations for further study

Based on the scope and limitations of the current study and observation made by the researcher, the following recommendations will be made for future study.

- i. The present study was conducted in Rampal, Mongla, Sarankhola, and Morelgonj upazillas of Bagerhat district. It is recommended that similar studies be conducted in other parts of Bangladesh.
- ii. This study explored the contribution of nine traits of farmers on the effect of crab farming as independent variables on the livelihoods of coastal farmers. Therefore, it is recommended to further study the effect of crab farming on farmers' livelihood along with other characteristics of farmers.
- iii. Studies need to be undertaken to ascertain the principles and procedures for installation and patronization of nursing organization in the rural areas of Bangladesh.
- iv. This study was conducted on the effect of crab farming on the livelihood of farmers. Further studies can be conducted on other emerging fisheries sectors such as Kuchia to determine the effect on farmers' livelihoods.

5.4 Limitations of the Study

Considering the time, respondents, communication facilities and other necessary resources available to the researcher and to make the study meaningful, it became necessary to impose certain limitations as mentioned bellow-

- i. The study was limited to Rampal, Mongla, Sarankhola, and Morelgonj upazillas in the Bagerhat district, which may fail to represent the real scenario of the whole situation of the coastal belt of Bangladesh, as people are developing their strategies to adapt to the concrete situation they are facing.
- ii. Only nine important characteristics of farmers to determine the effect of crab farming have been studied, which may not reveal the actual conditions of their livelihood.
- iii. A control group and a treatment group are needed to evaluate the effect of crab farming, which cannot be maintained due to the time limit of the research.
- iv. Data were required for at least two periods to evaluate the effect of crab farming, but it was not possible to collect data at both intervals due to short research time.

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APPENDICES

APPENDIX I

ENGLISH VERSION OF THE INTERVIEW SCHEDULE
Department of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University
Dhaka-1207

An Interview Schedule for the Study Entitled
**EFFECT OF CRAB FARMING ON THE LIVELIHOOD
OF COASTAL FARMERS**

Serial No:

Name of the respondent:

Union:

Upazilla:

(Please provide the following information. Your information will be kept confidential
and will be used for research purpose only)

1. Age

How old are you? Years.

2. Level of education

Please mention your level of education.

a) I can't read and write

b) I can sign only

c) I have passed.....class.

3. Family size

How many members do you have in your family?

4. Crab farm size

(Please mention the area of your land according to use)

Sl. No.	Land use	Area of land	
		Local unit	Hectare
1.	Crab Farming		
Total			

5. Experience in crab farming

How many years do you involve with crab farming? Years

6. Annual income from crab farming

Please mention your annual income from crab farming:

Sl. No.	Name of the sources	Source of income		Amount of income
		Crab Growth	Crab Fattening	
1.	Crab			
Total				

7. Media contact

Please state the extent of your contact with the following ones:

Sl. No.	Name of information sources	Extent of Contact				
		Regularly (4)	Frequently (3)	Sometimes (2)	Rarely (1)	Not at all (0)
1.	Crab Collectors	>9 times/year	7-9 times/year	4-6 times/year	1-3 times/year	0 time/year
2.	Crab Fatteners	>9 times/year	7-9 times/year	4-6 times/year	1-3 times/year	0 time/year
3.	Upazilla Fisheries Officer	>6 times/year	5-6 times/year	3-4 times/year	1-2 times/year	0 time/year
4.	Assistant Fisheries Officer	>6 times/year	5-6 times/year	3-4 times/year	1-2 times/year	0 time/year
5.	Group Discussion	Once in a month	Once/2 months	Once / 3 months	Once/4 months	0 time / 6 months
6.	Watching Fisheries related program on TV	Daily	Weekly	Fortnightly	Once /Month	0 time /month
7.	Listening Fisheries related program on Radio	Daily	Weekly	Fortnightly	Once /Month	0 time /month
8.	Reading Fisheries related leaflets	Daily	Weekly	Fortnightly	Once /Month	0 time /month
Total						

8. Availability of marketing information

Please mention about availability of marketing information on crab business.

Sl. No.	Item	Extent of marketing information				
		Regularly (4)	Frequently (3)	Sometimes (2)	Rarely (1)	Not at all (0)
1.	Receiving information against market price					
2.	Receiving information against packaging house					
3.	Receiving information against quality product					
4.	Receiving information against production					
5.	Receiving information against product demand					

9. Knowledge on crab farming

Please answer the following questions about crab farming:

Sl. No.	Questions	Full Marks	Marks Obtained
1.	In commercial production, how many crabs can be fed per square meter area?	4	
2.	How do you distinguish between green mud crab and red claw species?	4	
3.	Which depth of pond is suitable for crab farming?	4	
4.	Which size of the crabs has higher demand and value in the market?	4	
5.	For commercial production, which process of fattening is profitable in ponds or in cages?	4	
6.	At which time of a day major part of the total feeds should be supplied in farms?	4	
7.	What is the benefit of applying quicklime in the pond during pond preparation?	4	
8.	What happened if crabs are kept under direct sunlight?	4	
9.	Name two disease of crab	4	
10.	Which Crab is more valuable between hard shelled and soft-shelled crab?	4	

10. Effect of crab farming

Sl. No.	Item	Extent of Effect			
		HE (3)	ME (2)	LE (1)	NE (0)
1.	Effect on increasing food availability due to crab farming				
2.	Effect on changing environment due to crab farming				
3.	Effect on changing clothing behavior due to crab farming				
4.	Effect on changing housing condition due to crab farming				
5.	Effect on availability of drinking water and sanitary facilities due to crab farming				
6.	Effect on medical facilities and cost of health management due to crab farming				
7.	Effect on bank account facilities due to crab farming				
8.	Effect on improving electricity facilities due to crab farming				
9.	Effect on capability of purchasing entertainment equipment due to crab farming				
10.	Effect on the status of school going children due to crab farming				
<p>HI= High Effect. MI= Medium Effect , LI= Low Effect , NI= No Effect ,</p>					

11. Constraints faced by the farmers in crab farming

Please mention the extent of constraints you facing in achieving food security

Sl. No.	Item	Extent of Constraints				
		VHC (4)	HC (3)	MC (2)	LC (1)	SA (0)
1.	Natural disasters like flood, erosion etc.					
2.	Over dependency on natural wild seed					
3.	Presence of virus and other diseases					
4.	Non-availability of quality mud crab seed for commercial farming in farms					
5.	Lack of Financial and non-financial government supports					
6.	Exploitation and deprivation by the middlemen					
7.	Occasional fluctuation of price of mud crab					
8.	Domination by middleman in case of price determination					
9.	The rate of increasing cost of production					
10.	Grading system pricing of crab					
		VHC = Very High Constraints, HC =High Constraints, MC = Moderate Constraints, LC = Low Constraints, NC = No Constraints				

Thanks for your participation.

Dated:

(Signature of the interviewer)

APPENDIX II

STATISTICAL ANALYSIS

ANOVA Table of the statistical analysis

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2350.950	9	261.217	13.322	.000 ^b
	Residual	2019.546	103	19.607		
	Total	4370.496	112			
<p>a. Dependent Variable: Effect of Crab farming</p> <p>b. Predictors: (Constant), Knowledge on Crab Farming, Family Size, Media Contact, Age, Availability of Marketing Information, Experience of Crab Farming, Crab Farm Size, Level of Education, Annual Income from Crab Farming</p>						

Table showing co-efficient interception

Coefficient					
Model		Unstandardized Coefficients		Standardized Coefficients	t
		B	Std. Error	Beta	
1	(Constant)	-12.163	7.546		-1.612
	Age	-.033	.051	-.050	-.643
	Level of Education	-.080	.126	-.050	-.634
	Family Size	.292	.292	.073	1.001
	Farm Size	4.851	1.919	.226	2.527
	Experience of Crab Farming	.186	.071	.197	2.631
	Annual Income from Crab Farming	.012	.004	.365	3.459
	Media Contact	-.215	.363	-.052	-.592
	Availability of Marketing Information	.737	.308	.180	2.393
	Knowledge on Crab Farming	.499	.224	.163	2.227

APPENDIX III



A



B



C



D

Plate 1 Photograph showing (A. Data Collection at Rampal Upazilla, B. Data Collection at Mongla Upazilla, C. Data Collection at Morrelgonj Upazilla, D. Data Collection at Sarankhola Upazilla) experimental site.