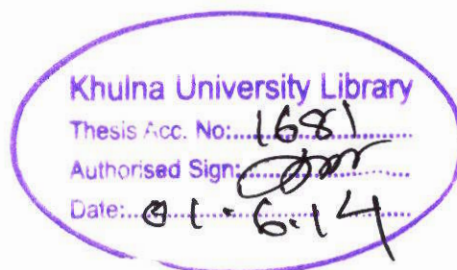


Mud Crab (*Scylla serrata*) Marketing and Transportation from the South-Western Region of Bangladesh



A thesis

By

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**Mud Crab (*Scylla serrata*) Marketing and Transportation
from the South-Western Region of Bangladesh**

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Fishery

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Dedicated

My Father and Mother

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Abstract

Various aspects of mud crab (*Scylla serrata*) marketing and transportation in the South-Western region of Bangladesh were evaluated through a regular field survey in upazilla of Khulna, Satkhira and Bagerhat district at monthly interval for one year in 2001.

A total of 6947.627 MT mud crab was produced from Khulna-Satkhira-Bagerhat districts of the South-Western region of Bangladesh in 2001. The maximum (2655.917 MT) mud crab was produced in Bagherhat district and the minimum (1779.150 MT) in Satkhira district. Among 15 upazillas, the maximum (2311.110 MT) and minimum (5.650 MT) production were recorded from Rampal and Morelgonj upazilla of Bagherhat district respectively. The production of mud crab was found to be maximum (3567.860 MT) in the monsoon and the lowest production (1306.957 MT) was found in the winter season.

The total number of mud crab depots and manpower involved in crab business were estimated to be 292 and 702 respectively in the region. The maximum and minimum numbers of crab depots were recorded in Khulna (122) and Satkhira (76) respectively. While the maximum (305) and the minimum (193) number of manpower involved in crab business at local mud crab depots were recorded in Khulna and Bagerhat district respectively. Most of the crab depots were located on the bank of rivers and connected with the highways. Three types of physical condition of the crab depots were recorded *Katcha* (137 nos.), *Semi-pacca* (120) and *Pacca* (35) in the SW region.

The prices of mud crabs were found to vary by grade (size, sex and physical condition) and season as well as by the demand in export market. However the average higher prices were accounted for F1 (female) and XL (male) grade mud crabs throughout the year. The mud crab marketing was found to be fully exported oriented and the major export markets of mud crab in the last decade were Taiwan, Singapore, Hong Kong, Malaysia, Thailand and USA. The highest amount (5792 thousand US \$) of mud crab was exported in 1995-96 fiscal year.

The Sundarbans mangroves, tidal rivers and estuaries, canal, shrimp farm, fattening ponds are the sources of the mud crabs from where marketable size male and female crab are harvested. Although mud crabs catching occur round the year, the peak-harvesting season was June to August from shrimp ghers, November to January from the mangrove areas and tidal rivers.

Although a rudimentary domestic market of mud crab exist in the region based on rejected crabs at depots. Small non mechanized country boat, pick up, van and mini truck were found as the means of mud crab transportation from harvesting point to exporting point. The use of bus as

transportation media was stopped from the early months of 2001. During transportation from harvesting point to the exporter point about 5-25% harvested crabs were found to be died. The mortality rate during transportation was varied with season. The maximum mortality occurred during summer season (9.9%) and the minimum during winter season (6.8%). Another 5-10% of harvested crabs were rejected at depot during handling due to soft-shell, broken leg and/or lean (poor fat) condition.

The overall cost-benefit ratio in mud crab business at depot level was (cost: benefit) s found 1: 2.06, 1: 3.19 and 1: 7.91 in Khulna, Satkhira and Bagherhat district respectively. However the ratio was varied from 1: 2.06 to 1: 7.91.

The marketing channel for the mud crab, in general was found to be similar at all Upazillas in Khulna, Satkhira and Bagherhat districts of the South- Western region. The catchers harvest crabs from the various wild sources and sold to the small depots or to brokers or directly to the suppliers. The marketable crabs from the small depot owner were sold to the suppliers. The exporter purchased mud crab directly from the supplier located at the Upazilla level. A big chunk of the profit goes to middlemen or brokers. Broker act as a middleman between the catchers and the suppliers. Sometimes, the exporters directly purchase crabs in cash from the local depots by employing agents. The rejected crabs (under grade and broken claws or legs) are transferred to the local market for domestic consumption at low price. The lean or poor health crabs are sold to the local fattener for fattening.

The crab business is still remained as a hidden venture in Bangladesh. Therefore, nobody is there to look after its development. There are no proper rules and regulations and even awareness among its users regarding its management. It has been seen that there is no policy or guidelines by the Government to boost up the potential of this aqua-resource of Bangladesh in sustainable manner. To protect these precious resources, Government should concentration in research and baseline studies. Also try to establish a advance culture techniques.



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List of Abbreviation

SW	South Western
KD	Kakra Depot (a place where large amount of mud crab are stored)
K	Katcha (In terms of construction materials, the depot were made of bamboo, bamboo-fence and Nypa-leafs.)
SP	Semi-pacca (In terms of construction materials, the depot were made of bamboo, wood and tin roof)
P	Pacca (In terms of construction materials, the depot were made of bricks and concrete)
MT	Metric Ton.
g	Gram
J	January
F	February
M	March
A	April
M	May
J	June
J	July
A	August
S	September
O	October
N	November
D	December
Fig.	Figure
Forias	The persons who purchase mud crabs from catcher
GPS	Geographic Positioning System

Chapter One: Introduction

The mud crab, *Scylla serrata* (Forsk., 1755), popularly known as mangrove crab has emerged as one of the most important coastal aquatic resources after the tiger shrimp (*Penaeus monodon*) in Bangladesh. Mud crabs occurs abundantly in the whole coastal region of the Bangladesh particularly in the estuaries, tidal rivers Sundarbans mangrove swamps and vast coastal gheras (Khan and Alam, 1992). Mud crab belongs under the family portunidae of the class crustacean. Among the four species of mud crabs, *Scylla serrata* is common in Bangladesh coastal waters.

The mud crab, *Scylla serrata* (Forsk., 1755), one of the biggest crustaceans under the Portunidae family, may attain 2 kg in weight and 22-25 cm in carapace width (Piatek, 1981). Mud crab is widely distributed in the Indo-West-Pacific region as mangrove associated fauna (Macintosh *et al.*, 2002). It is one of the most popular and costly seafoods in the South-East Asian countries (Pripanapong and Tongdee, 1998).

It is commonly known as "green crab" or "mangrove crab" and locally called as "Habba kankra", "Silla Kankra" or "Kankra". It occurs abundantly in the tide fed rivers, estuaries, mangrove swamps and the entire low saline coastal waters of Bangladesh (Shafi and Quddus, 1982; Bhuiyan and Das, 1976; Mahmood, 1977; Islam, 1977). Bangladesh earns considerable amount of foreign exchange though exporting the animal in live condition (Azam *et al.*, 1998). It's fishery support the livelihood of millions of poor fishers, traders and transporters.

Scylla serrata has a major ecological significance in mangrove ecosystem. Its burrows characteristic shape and form permeate the mangrove floor which help to aerate the substratum and provide refuge for many other animals including mudskippers, frogs and sea slugs (Azam *et al.*, 1998). The mud crab is an omnivorous opportunistic feeder feed on slow moving and sessile benthic invertebrates and prefer small crabs (mainly grapsid), bivalves and detritus (Macintosh, 1982; Hill, 1976; Prasad, *et al.*, 1985; Christopher 1991). It is also a voracious predator of young fish and prawns (Azam, *et al.*, 1998). Mud crabs are nocturnal animal, remaining buried during the day and emerging at



sunset (Christopher, 1991). However, *S serrata* can not catch fast moving prey (Hill, 1976).

The mud crab was first exported in 1977-78 fiscal year and become a stable business in 1982 (SEAFDEC, 1998). Before 1977 mud crab was a virgin stock and the local market was very small which was only comprised of Non-Muslim communities. The Muslim community in Bangladesh doesn't accept mud crab as a regular food item in their table.

Once considered as a minor fishery, the mud becomes an important export commodity in 1982 and ranked 3rd among frozen the food export earnings from Bangladesh (SEAFDEC, 1998 and BEPB, 2001). Of several crab species, the mud crab in Bangladesh holds the prime position in international markets in term of price because of its excellent table quality, nutritional value as well as larger size.

The export of live mud crabs from Bangladesh has increased many folds in the last decades (BEPB, 2001). The export earning from mud crabs even exceeded shrimp in 1996-97 fiscal year (BEPB, 2001). The export earning from mud crabs has sharply increased US\$ 31,000 in 1989-90 to US\$ 5792000 in 1995-96 and sharply decreased US\$ 55,35,000 in 1996-97 to US\$ 283000 in 1999-2000.

Due to the steady growth in demand and price of live mud crabs in export market, the species has already been threatened by it's over fishing from the wild sources in Bangladesh. The entry of new fishers in crab harvesting from coastal waters has been continued. In addition, huge number of local people has become involved in its fattening, transportation and trading related business.

Virtually no information is available on the marketing and transportation of mud crabs in Bangladesh. Therefore, the present study was conducted in order to asses the following aspects of the mud crab marketing and transportation:

- to estimate approximate production of mud crab from the South-Western region;
- to assess the marketing channel and methods;

- to assess the transportation system for the mud crabs;
- to estimate the mortality during transportation within country; and
- to estimate the return on investment (ROI) and cost-benefit ratio in the mud crab business.

Chapter Two: Literature review

Khan and Alam (1992) reported that the development of an export market is a recent phenomenon in Bangladesh. They estimated the countrywide production at 1937-2085 Mt/annum. Major exports market is Hong Kong and Singapore. A high proportion of catch was rejected as undersize.

Jayamanne (1992) reported that Singapore received 90 percent of Sri Lanka's export. He also reported that there was very little availability of large meaty crab in the local market due to high price offered by the exporters.

Ahmed (1992) reported that two types of markets exist for crab in Bangladesh: (a) local markets in the vicinity of fishing villages, and (b) consumer markets away from the fishing areas. The non-Muslims and the tribal people were the major consumers of crab. Direct sell by fishermen in the local market or in the consumer markets was the general mode of marketing. Previously, there were no middlemen in this trade. Each pair of medium sized crab was sold at Tk. 8-12 in the local market. Mud crab are exported in the live condition from Bangladesh through Dhaka airport. Female crab fetched a better price than males. During transportation, mortality generally varies from 10-20 percent. The export value of live crab was 2-3 US\$/kg. Hong Kong, Malaysia and Singapore were the principal buyers of live crab from Bangladesh. Export quality crabs were packed in knitted bamboo baskets after tying their claws. Each basket contained 10-20 kg of crab. The baskets bottom was covered with polythene sheets to avoid leakage.

Tookwinas *et al* (1992) stated that frozen crab is the most exported product in followed by salted, dried and smoked meat in airtight containers.

Lee stated (1992) that the price of mud crabs varied seasonally, depending on fluctuating landings and seasonal demand. The texture of mud crab is affected by long-term storage above -20⁰ c, while loss of texture was insignificant after three months at -30⁰ c.

Gillespie and Bruke (1992) reported that mud crab, usually packed in waxed cardboard cartons, and are distributed in Australia using air and road transport. The mortality rate is high during transportation. Relative humidity of 95 percent at 16-20⁰ C was found to be

optimal transport condition. Temperatures below 20°C significantly enhanced survival time relative to those of 24°C. Exposure to direct sunlight for long time has a negative effect on survival.

Ladra and Lin (1992) reported that females with mature ovaries were particularly expensive in the Philippines. Experienced farmers could tell whether the ovaries were full examining against the light and also pressing its shell to feel if the crab is full and firm. Mud crab in the Philippines can be classified into three major groups. Mud crab of 15-18 pcs/kg was used utilized for culture. Transport mortality was 5-40 percent depending on the mode of transport.

Christensen (1992) reported that due to differences in grading, the prices of marketable crab are different country name.

Srinivasagam and Kathirvel (1992) observed a survival rate of 55-100 percent b of 50-120 mm crab collected from the wild were transported by road in open containers, without any packing, over a distance of 20-53 km for stocking in indoor tanks and culture ponds from country name. Liong (1992) reported a higher mortality of mud crab due to stress during the long transportation.

How-Cheong (1967) and Amandakoon (1992) reported that marketing of crab posed no problem, as they had a good demand in local markets. Srilanka crabs were preferred in Malaysia, Singapore and Hong-Kong. Good quality crab were selected and purchased by the purchasing agents on the basis of body weight, prices paid at 2.85 US \$ /kg and above 4.28 US \$ /kg for crabs of 300-500 g and > 500 g respectively.

Raj (1992) reported that the medium and large crab of more than 14 cm CW and weighing more than 400 g were collected exclusively for export in India. Crab stay alive out of water only for maximum of about 72 hours. Generally, train to the cities transported the crabs. The crabs are packed in bamboo basket and each basket contains about 25-30 kg. The grading system of crabs were 1 kg upwards crabs are called extra large, 500g-1kg large, 300g-500g medium, 200g-300g crabs small, 200g- 300g crabs water crab and 200 g- 400g crabs were also called red crab.

Chapter Three: Materials and Methods

3.1 Study Area

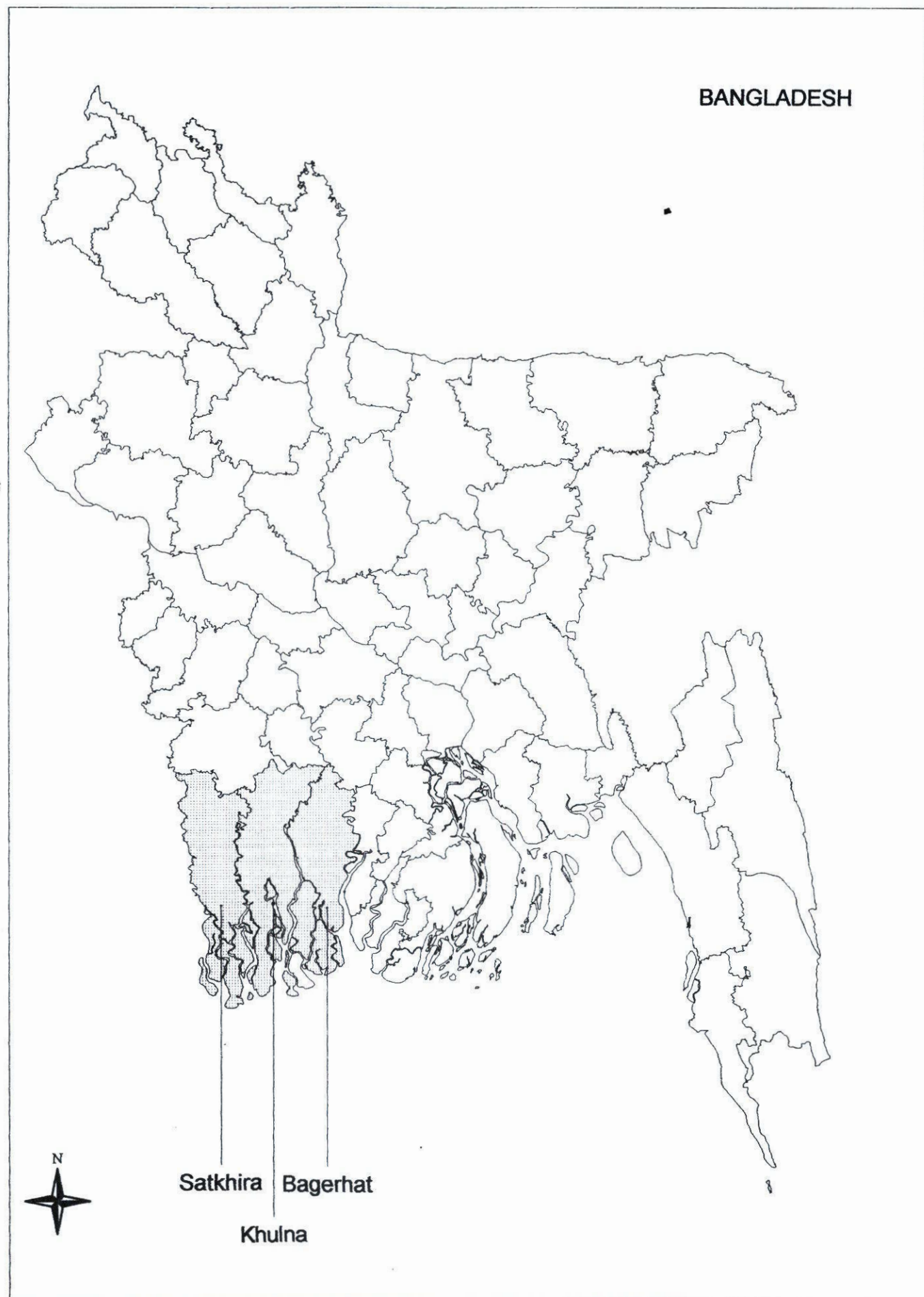
The survey work was carried out at monthly interval in Paikgacha, Dumuria, Batiaghata, Dacope and Koyra Upazilla in Khulna District, Ashashuni, Shamnagar, Kaligong, Debhata and Tala Upazilla in Satkhira District, Bagerhat Sadar, Rampal, Mongla, Morelganj and Shoronkhola Upazilla in Bagerhat District during the period of January to December, 2001 (Fig-1).

3.2 Field Survey

Data were collected through interviewing different stakeholders involved in mud crab marketing and transportation (catchers, middleman, depot owners and exporters) by a prescribed questionnaire (Appendix) covering following key issues:

- ⇒ Number of mud crab depots;
- ⇒ Number of mud crab traders in depots;
- ⇒ Production of mud crab at Upazilla level;
- ⇒ Marketing channel and methods;
- ⇒ Transportation system;
- ⇒ Grading and pricing system ;
- ⇒ Causes of mortality or losses of mud crab;
- ⇒ Geographical Position of the mud crab depots;

In addition, relevant information was also collected secondary sources, viz., published reports, journals, grey literatures etc



Map-1: Location of study area in the SW Region

3.3 Data Analysis

All the collected data were analyzed by using a PC. Using Microsoft Excel software did statistical analyses.

The monthly grade-wise production of mud crab was estimated from three randomly selected depots at each upazilla level from the South-Western region of Bangladesh. The total numbers of mud crab depots were multiplied by the average production from three randomly selected depots as follows

Monthly Production at Upazilla = Average production from 3 depots × depot number in the upazilla.

One-way ANOVA estimated seasonal and geographical variations in mud crab production separately. Linear regression analysis was used for measuring relationship between production and depot size, production and price, production and manpower etc using following formula:

$$y = a + bx \quad (\text{Hosmand, 1988})$$

Where,

y= coordinate value along the vertical axis (dependent variable);

x= coordinate value along the horizontal axis (independent variable);

a= Intercept of the curve; and

b= Slope of the curve.

The correlation coefficient 'r' was calculated through the last square method by using the following equation:

$$r = \frac{\sum xy}{N \sigma_x \sigma_y}$$

Where,

$x = x - \bar{x}$;

$y = y - \bar{y}$;

σ_x = Standard deviation of series x;

σ_y = Standard deviation of series y; and

N = Number of pair of observation.

3.4 Cost-benefit analysis

Cost-benefit ratio in mud crab business at local depot level was calculated by the following formula given by Usry and Matz (1984).

Gross benefit = Sales – Cost of goods sold;

Total cost = Sales – Cost of goods sold + Commercial expenses;

Operating income or Total benefit = Sales – Total cost;

Cost-benefit ratio = Total benefit / Total cost;

Net benefit = Total benefit - Total cost;

Return on investment (ROI) = Net benefit / Total initial investment.

Chapter Four: Results

4.1. Mud Crab Trading

4.1.1. Sources of mud crabs: Major sources of mud crabs in the depots were varied seasonally. The Sundarbans mangrove swamp and tidal rivers were the main sources during the post monsoon (November to January) and shrimp ghers are the major source during the monsoon (June to August). The maximum catching attained during spring tides of fool moon and new moon phases (locally called *goon*). Juvenile crabs enter into the traditional shrimp ghers and grown up there until harvest.

4.1.2. State of Art of Mud Crab Harvesting

4.1.2.1 Gears: A total of 6 types of gears were found to be used in mud crab harvesting from different sources. Rope line, hook line and set bagnet were the most widely used gears for mud crab catching from wild sources (the tidal river and mangrove areas). Iron hook, boom, thopa, baited stick etc. were found in capturing crabs from shrimp ghers.

The rope line (locally called *don*) essentially consists of a main line of coir rope (about 200-300 m long). Hundreds of small (2-3 ft.) made of coir rope branched line attached to it (Figure-1) at an interval of 4-5 ft. small piece of eel fish (locally called Kuicha) is tied to the end of each branch line. The one end of the rope is tied to a pole fixed on the bank and other end is towed by boat to the extent the rope permits. The rope line is operated at shallow depth of 4-8 ft. The line is allowed to rest undisturbed at the bottom of the water for 20-30 minutes. The rope line is then hauled slowly by moving the craft towards the pole. Crabs are clinging to the bait and they are collected by using a small scoop net. Two people generally operate this gear during the daytime.

The hook line, consists of a single line made of nylon filament with a hook attached at its end is used in the tidal rivers and the Sundarbans. Eel fish is used as bait. The line is immersed into the water to attract the crab. As soon as a crab grabs the bait, the line is slowly hauled and the crab is trapped in a scoop net.

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Iron hooks are also known as fishing hooks and widely used along the shrimp *ghers* in South-Western region. An iron rod 3-4 ft. in length is used to make a hook and is fitted with a wooden or bamboo handle.

Boom trap is made of bamboo, mainly used in shrimp *gher* and occasionally in tidal rivers, estuaries, and mangrove Swamps. *Thopa* is an angling type of device, consists of polyester line, wooden stick, sinkers and thread for tying bait and nets. Bait strikes and bamboo baskets are also used.

4.1.2.2 Crafts: A single type of craft is widely used for mud crab harvesting along the SW region. It is a small wooden boat, with or without engine. Small wooden boats are popularly used in the mangrove areas and the tidal rivers. During spring tide, crab fishermen are usually made a 2-3 days trip, which extended to 5-8 days during neap tide.

Mud crabs are highly cannibalistic animals. They have two powerful claws by which they can cause serious injury. Thus, the claws of live mud crab are tied with plastic tape or coir rope to prevent human injury and the physical damage or mortality of harvested crabs.

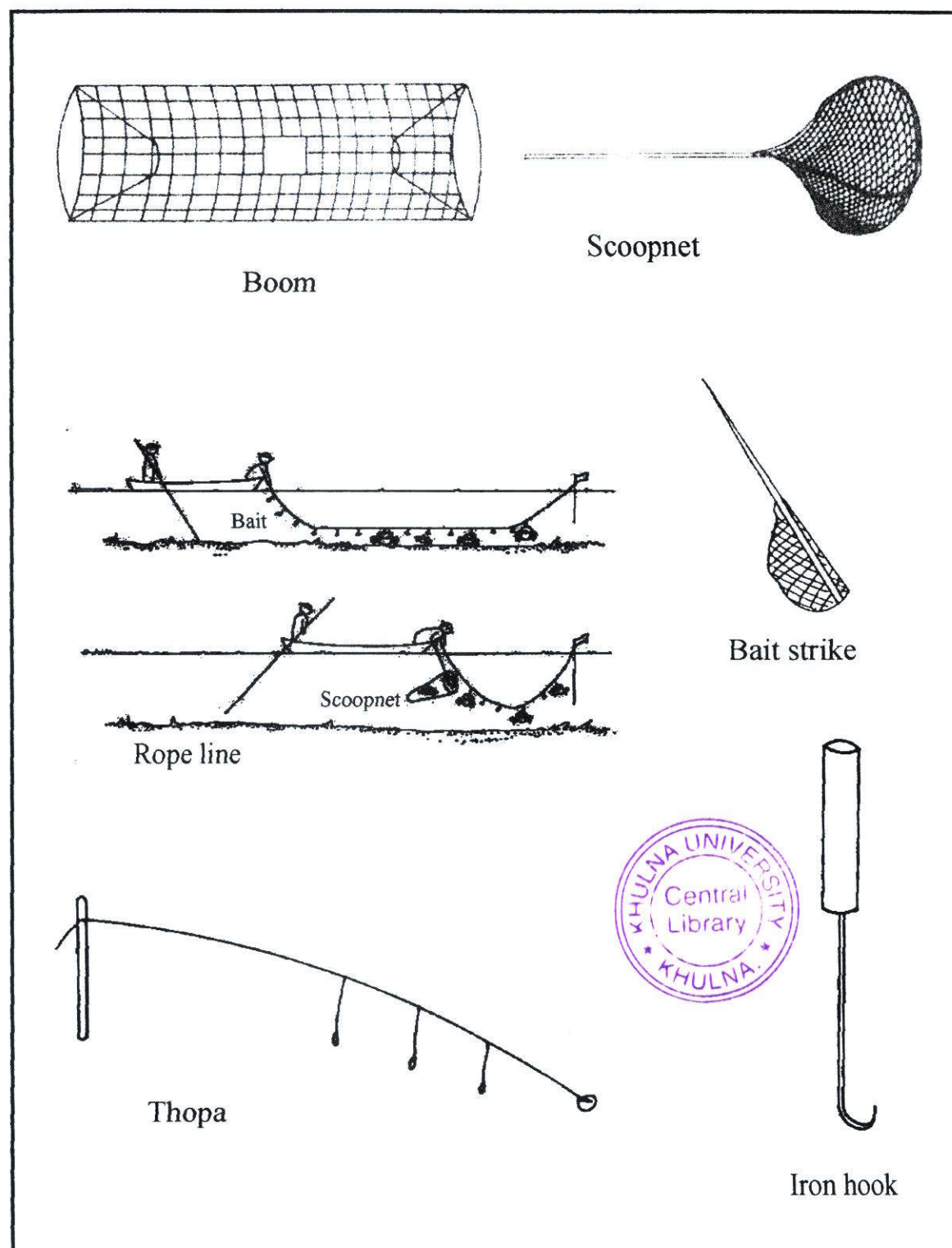


Fig-1: Gears used for catching mud crab (*Scylla serrata*) in the SW region of Bangladesh.

4.1.3. Distribution and manpower of mud crab trading depots:

Out of 25 Upazillas in Khulna, Satkhira and Bagerhat districts, mud crab trading depots were found in 15 Upazillas namely Paikgacha, Koyra, Dumuria, Batiaghata and Dacope in Khulna; Ashashuni, Shamnagar, Kaligong, Debhata and Tala Upazilla in Satkhira and Bagerhat Sadar, Rampal, Mongla, Morelganj and Shoronkhola in Bagerhat district. The total number of crab depots and manpower involved in South-Western region was estimated to be 292 and 702 respectively in 2001. The distribution of mud crabs depots with number of person involved in each depot are shown in Table-1.

Table-1: Distribution and manpower of mud crab trading depots of the SW region in 2001.

District	Upazilla No.	Locality	Depot No.	Manpower
Khulna	5	13	122	305
Satkhira	5	12	76	204
Bagerhat	5	16	94	193
Total	15	41	292	702

Source: Field survey, 2001.

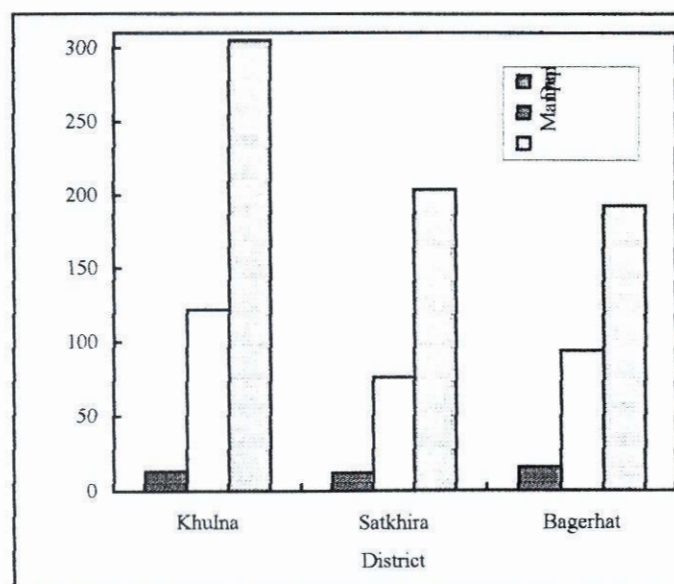


Fig-2: Distribution and manpower of mud crab trading depots of the SW region in 2001.

Khulna: The total number of depots and manpower involved in crab business in Khulna district were estimated to be 122 and 305 respectively. The number of locality where mud crab depots available was counted to be 13 in Khulna district in 2001 (Table-2).

The number of crab depots and manpower in Paikgacha, Koyra, Dumuria Batiaghata and Dacope were counted to be 83 and 215; 10 and 17; 12 and 31; 5 and 15; and 10 and 27 respectively. The number of depots and Persons involved in crab business at depots were maximum in Paikgacha (83 and 215) and the minimum (5 and 15) in Dumuria Upazilla.

Table-2: Distribution and manpower of mud crab trading depots in Khulna district in 2001.

Upazilla	Locality		GPS		Depot No.	Manpower
			Lat N	Lon E		
Paikgacha	1	Mosque road	89°19.367'	22°35.178'	13	45
	2	Minaz market	89°19.227'	22°36.126'	20	34
	3	Main Bazar	89°19.270'	22°35.121'	07	22
	4	Shibsha Ghat	89°19.375'	22°35.167'	26	56
	5	Kopilmuni	89°18.400'	22°41.181'	17	58
Koyra	6	Haiatkhali	89°17.498'	22°22.219'	04	06
	7	Koyra Bazar	89°16.400'	22°21.181'	05	08
	8	Katakhali	89°15.400'	22°20.181'	01	03
Dumuria	9	Dumuria Bazar	89°25.144'	22°48.288'	07	15
	10	Noakathi Bazar	89°25.154'	22°48.263'	05	12
	11	Chuknagar Bazar	89°17.800'	22°50.416'	02	04
Batiaghata	12	Batiaghata Bazar	89°31.194'	22°44.324'	05	15
Dacope	13	Chalna Bazar	89°25.357'	22°38.120'	10	27
Total	13				122	305

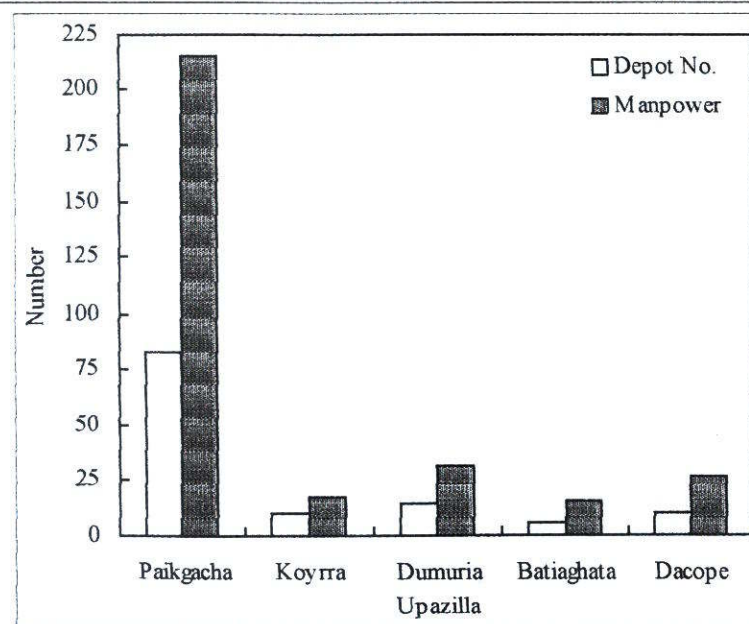
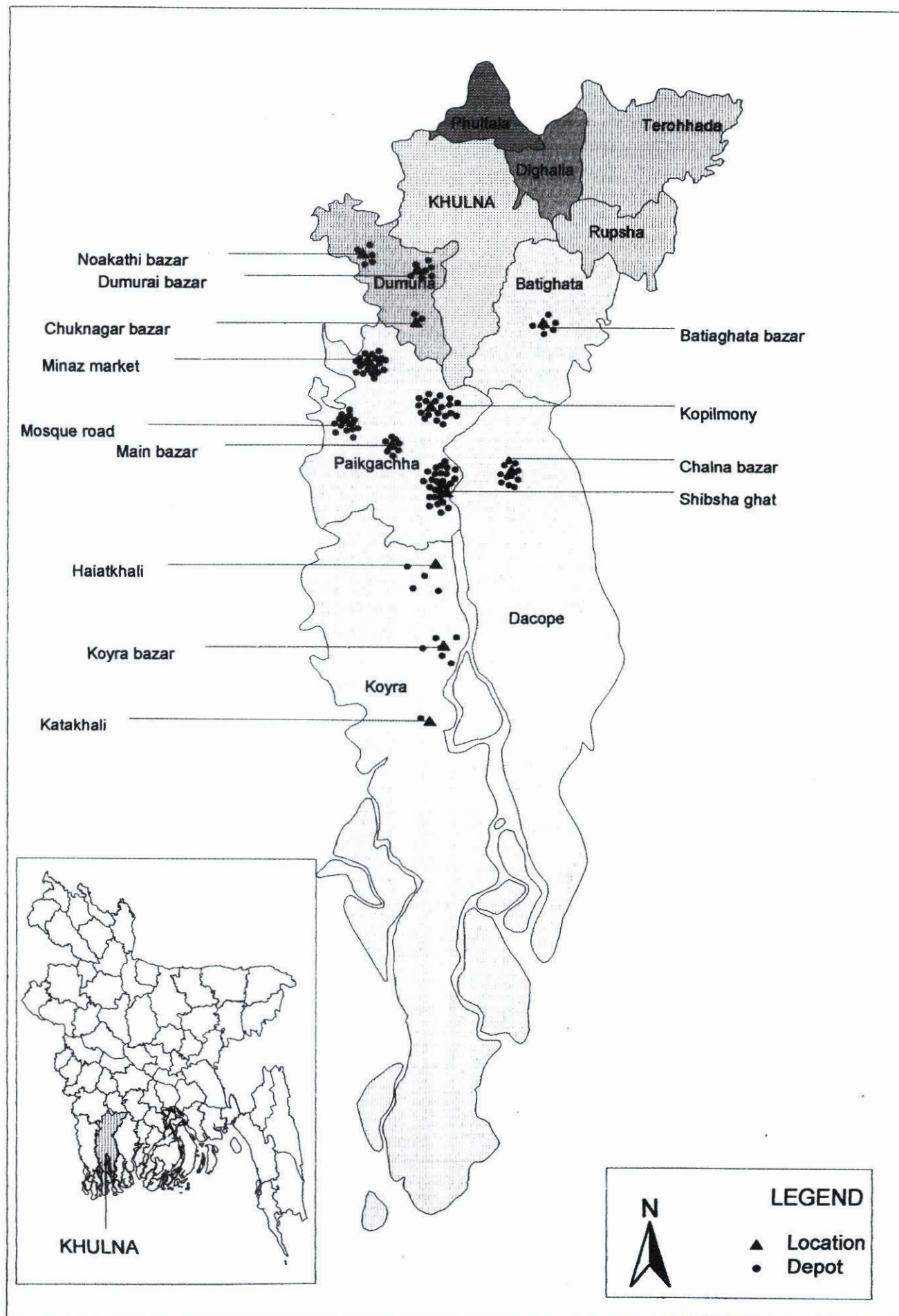


Fig-3: Distribution and manpower of mud crab trading depots in Khulna district in 2001.



Map-2: LOCATION AND NUMBER OF MUD CRAB DEPOT IN KHULNA DISTRICT

Satkhira: A total of 12 localities were recorded where the mud crab depots available in this district in 2001. The number of depots and manpower involved in crab trading were counted to be 11 and 17; 20 and 29; 20 and 54; 21 and 94; and 4 and 10 at Ashashuni, Shamnagar, Kaligong, Debhata and Tala Upazilla respectively. A total of 76 depots and 204 persons were enumerated in Satkhira district. The maximum depots (21) and manpower (94) in depots was found in Debhata, while the minimum (4 and 10) in Tala Upazilla (Table-3).

Table-3: Distribution and manpower of mud crab trading depots in Satkhira district in 2001.

Upazilla	Locality	GPS		Depot No.	Manpower
		Lat N	Lon E		
Ashashuni	1 Main bazaar	89°10.561'	22°32.878'	05	8
	2 Galdanga	89°10.618'	22°32.882'	04	6
	3 Kalibari bazaar	89°07.928'	22°31.724'	02	3
Shamnagar	4 Munshiganj bus stand	89°11.731'	22°16.080'	05	10
	5 Kolbari	89°12.162'	22°16.317'	04	8
	6 Datnakhali	89°13.265'	22°14.842'	11	11
Kaligonj	7 Main bazer	89°02.001'	22°27.506'	14	42
	8 Uzirpur bazer	89°07.659'	22°30.838'	06	12
Debhata	9 Parulia	89°00.101'	22°35.867'	15	86
	10 Devhata bazaar	89°00.006'	22°35.810'	01	1
	11 Gazirhat	89°00.507'	22°35.323'	05	7
Tala	12 Main bazaar	89°15.334'	22°44.830'	04	10
Total	12			76	204

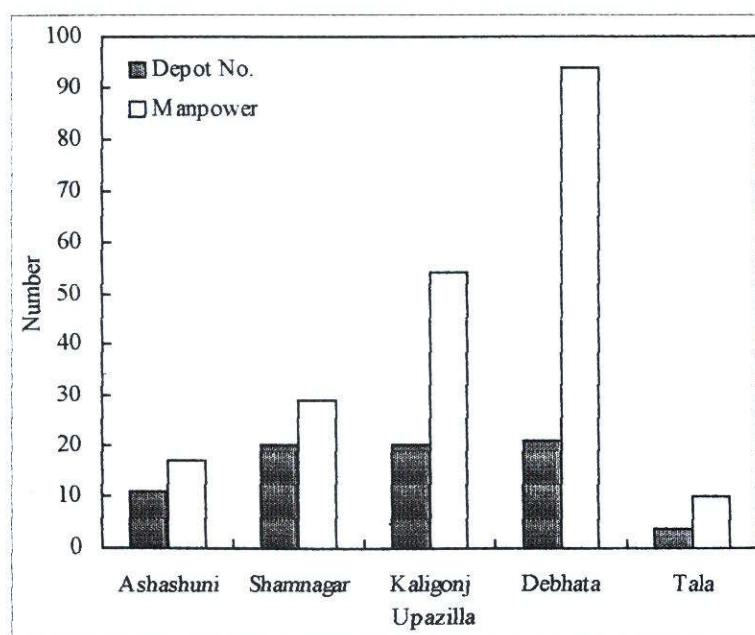
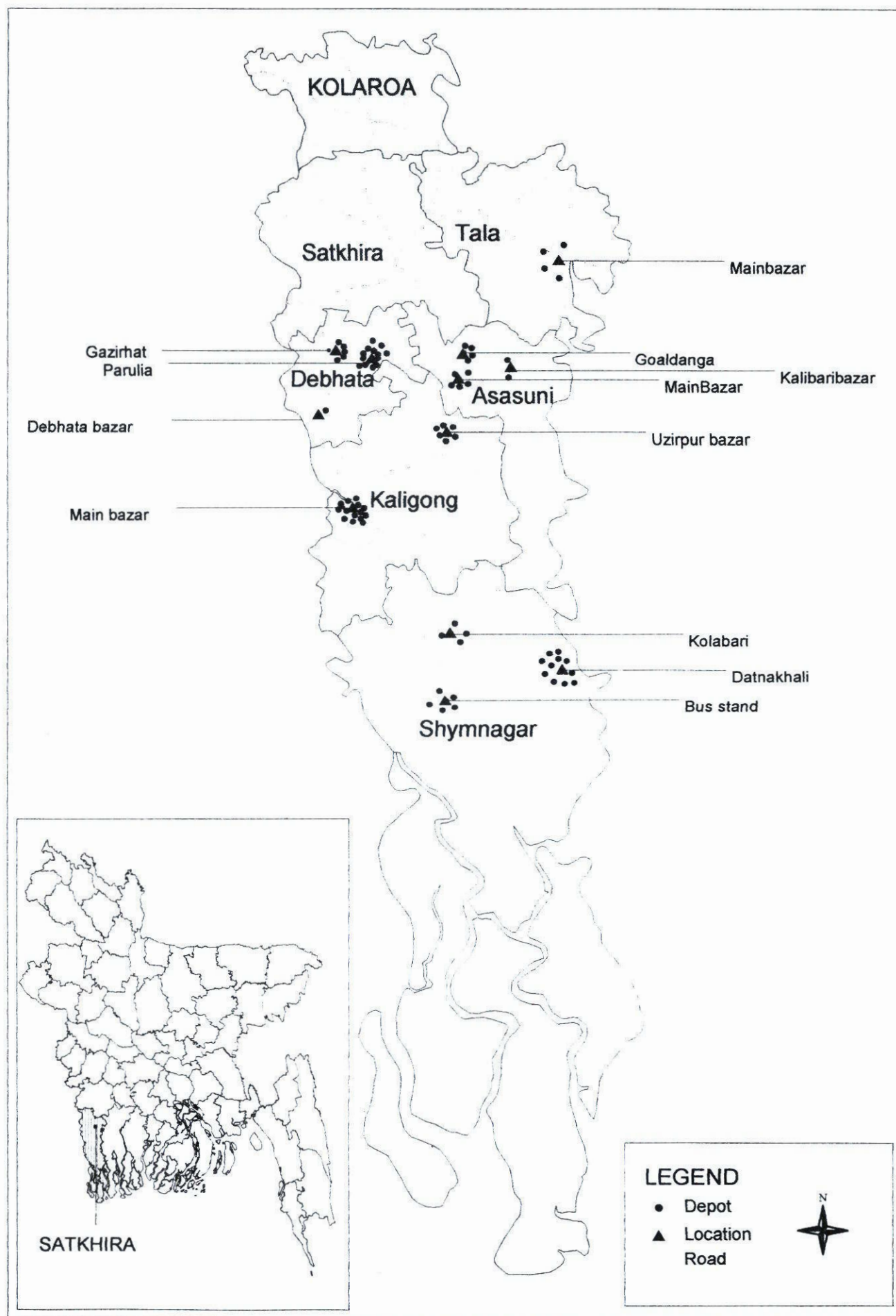


Fig-4: Distribution and manpower of mud crab trading depots in Satkhira district in 2001.



Map-3: LOCATION AND NUMBER OF DEPOT IN SATKHIRA DISTRICT

Bagerhat: The number of depots and manpower in Bagerhat Sadar, Rampal, Mongla, Morelganj, and Shoronkhola Upazilla were recorded to be 16 and 48; 28 and 63; 18 and 37; 5 and 5; and 18 and 39 respectively. The number of mud crab depots and manpower involve in crab depots were maximum (28 and 63) in Rampal and minimum (5 and 6) in Morelganj Upazilla. The total crab depots and manpower in depots were 94 and 193 respectively I Bagerhat district. Mud crab depots were available in 16 places in Bagerhat district in 2001 (Table-4).

Table-4: Distribution and manpower of mud crab trading depots in Bagerhat district in 2001.

Upazilla	Locality	GPS		Depot No.	Manpower
		Lat N	Lon E		
Bagerhat Sadar	1 Kathpotty	22°39.538'	89°47.864'	10	23
	2 Nager bazaar	22°39.326'	89°47.654'	06	25
Mongla	3 Chila	22°31.848	89°35.470'	05	8
	4 Joymoni	22°31.850'	89°35.409'	03	6
	5 Digraz	22°25.712'	89°36.770'	10	23
Morelganj	6 Nobby roshi	22°27.144	89°51.457	02	03
	7 Mash bazaar	22°27.192'	89°51.404'	03	03
Rampal	8 Bhaga	22°36.667'	89°38.527	32	51
	9 Rampal	22°36.684	89°38.536'	02	04
	10 Foila	22°36.681'	89°38.541'	03	08
Shoronkhola	11 Raenda bazaar	22°18.965	89°51.261	01	02
	12 Tafal bari	22°15.530	89°49.746'	02	02
	13 Bogi	22°15.082'	89°49.871'	03	05
	14 Sonatola	22°15.018	89°49.816'	03	07
	15 Shoronkhola	22°15.225'	89°47.187'	08	22
	16 Gabtola	22°15.331'	89°47.124'	01	01
Total	16			94	193

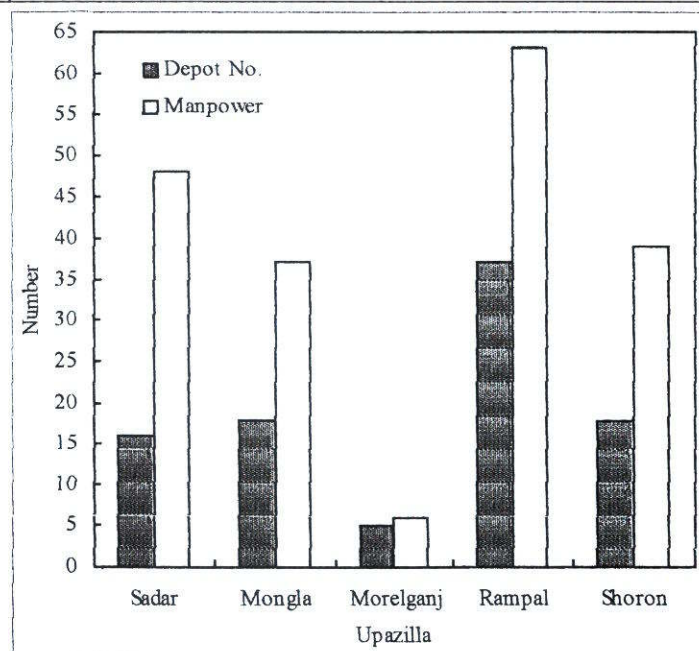
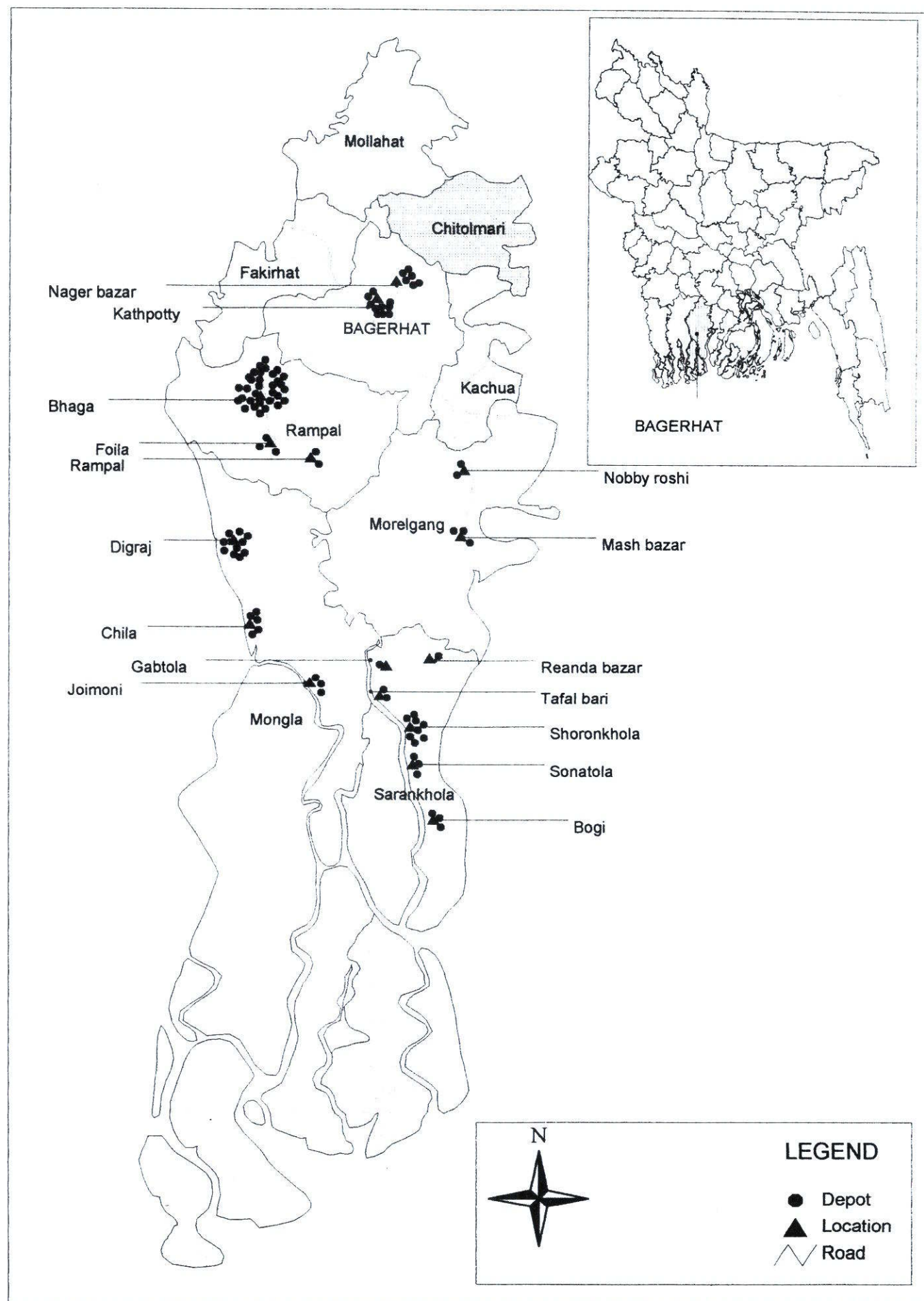


Fig-5: Distribution and manpower of mud crab trading depots in Bagerhat district in 2001.



Map-4: LOCATION AND NUMBER OF MUD CRAB DEPOT IN BAGERHAT DISTRICT

4.1.4. Physical Condition of Mud Crab Trading Depots: Physical condition of mud crabs depots in Southwestern region of Bangladesh are shown in Table-5 and Figure-6. Most of the mud crab depots were located nearby the river and/or road and easily connected with the high ways. The location of the depots depends on supply of mud crab from various sources.

In terms of construction materials, the depots were categorized into 'Katcha' (made of bamboo, bamboo-fence, and by Nypa-leafs with earthen floor), 'Semi-pacca' (made of bamboo, wood and tin roof with concrete floor), and 'Pacca' (made of bricks, RCC and concrete). Out of 292 mud crab depots in the SW region, 46.92%, 41.10% and 11.98% were 'Katcha', 'Semi-pacca' and 'Pacca' respectively.

The Upazilla wise distribution of 'Katcha', 'Semi-pacca' and 'Pacca' type depots in Khulna, Satkhira and Bagerhat district are shown in Table-6 through 8 respectively. The numbers of 'Katcha', 'Semi-pacca' and 'Pacca' crab depots were estimated to be 36 and 66, 20 and 27, 10 and 62, 27 and 5 in Khulna, Satkhira and Bagerhat District respectively.

About 46.92%, 41.10% and 11.98% of 292 depots in the south- western region were Katcha, semi- pacca and pacaa . The number of katcha depots was maximum (46.92%) followed by semi-pacca (41.10%) and Pacca (11.98%) in south- western region (table-5).

The physical condition of the majority of the depots in Satkhira and Bagerhat districts were different from Khulna where the maximum depots were kacca in Satkhira (51.31%) and Bagerhat (65.96%) followed by semi-pacca type depots. Pacca type depots were lowest in number in Bagerhat (5.31%) and Satkhira (13.16%) districts (table 7 and 8) .

Table-5: Physical condition of mud crab depots in SW region of Bangladesh in 2001.

Condition	District			Total	%
	Khulna	Satkhira	Bagerhat		
<i>Katcha</i>	36	39	62	137	46.92
<i>Semi-pacca</i>	66	27	27	120	41.10
<i>Pacca</i>	20	10	5	35	11.98
Total	122	76	94	292	100

Source: Field survey, 2001.

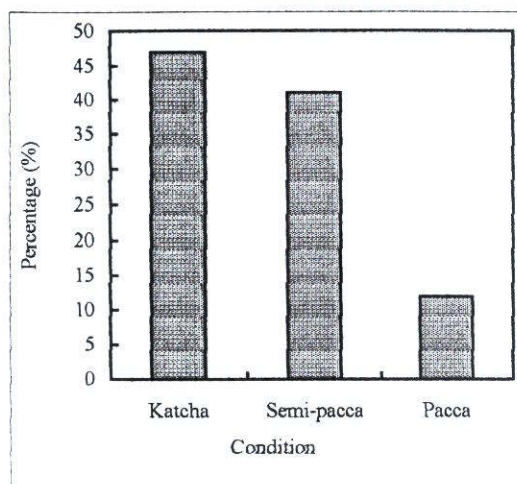


Fig-6: Physical condition of mud crab depots from SW region of Bangladesh in 2001.

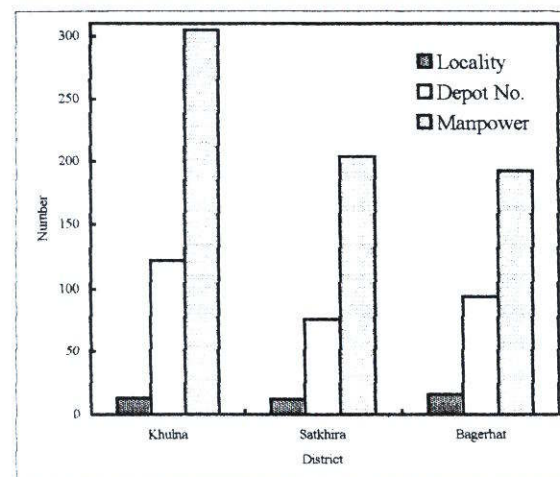


Fig-7: District wise variation in physical condition of mud crab depots in 2001.

About 29.51%, 54.10% and 16.39% of 122 depots in Khulna district were Ketcha, semi-pacca and pacha respectively. The number of semi-pacca depots was maximum (54.10%) followed by Katcha (29.51%) and Pacca (16.39%) in Khulna district. Similar trend was found to be true for all the Upazilla in Khulna district (Table- 6).

The physical condition of the majority of the depots in Satkhira and Bagerhat districts were different from Khulna where the maximum depots were kacca in Satkhira (51.31%) and Bagerhat (65.96%) followed by semi-pacca type depots. Pacca type depots were lowest in number in Bagerhat (5.31%) and Satkhira (13.16%) districts (table 7 and 8) .

Table-6: Physical condition of mud crab depots at different Upazilla in Khulna District in 2001.

Condition	Upazilla					Total	%
	Paikgacha	Koyra	Dumuria	Batiaghata	Dacope		
<i>Katcha</i>	14	10	5	2	5	36	29.51
<i>Semi-pacca</i>	51	—	9	3	3	66	54.10
<i>Pacca</i>	18	—	—	—	2	20	16.39
Total	83	10	14	5	10	122	100

— = Not available

Source: Field survey, 2001

Table-7: Physical condition of mud crab depots at different Upazilla in Satkhira District in 2001.

Condition	Name of Upazilla					Total	%
	Ashashuni	Tala	Kaligong	Devhata	Shamnagar		
<i>Katcha</i>	5	1	10	8	15	39	51.31
<i>Semi-pacca</i>	6	1	10	7	3	27	35.53
<i>Pacca</i>	0	2	—	6	2	10	13.16
Total	11	4	20	21	20	76	100

— = Not available

Source: Field survey, 2001

Table-8: Physical condition of mud crab depots at different Upazilla in Bagerhat District in 2001.

Condition	Upazilla					Total	%
	Bagerhat sadar	Rampal	Mongla	Morelganj	Shoronkhola		
<i>Katcha</i>	4	32	9		17	62	65.96
<i>Semi-pacca</i>	8	4	9	5	1	27	28.73
<i>Pacca</i>	4	1				5	5.31
Total	16	37	18	5	18	94	100

Source: Field survey, 2001.

4.1.5 Grading System: Mud crabs are sold at various ranges of price depending on size (i.e. present of fat) and sexes. There are 2 types of grading system for mud crabs in local and in international markets.

4.1.5.1 Local Grading System: The grades of the mud crab depend on sex, size, body weight, gonadal maturation and hardness of the carapace of the animal. The grading system is different for male and female crabs. Generally, both the male and the female mud crabs were graded into some fixed categories in all districts of the SW region.

The female crabs having over 180 g in weight with full hepatopancreas (i.e. fat) are called F1, over 180 g with partial hepatopancreas are KS-1, over 150 g with poor hepatopancreas are F2 and over 120 g without hepatopancreas are called F3. For male crabs the grading system is the same for all locations in the SW region. Male crabs having body weight over 400 g, 300 g, 250 g and 200 g with hard shell are called XL, L, M and SM respectively (Table-9). Sometimes KS1 called F2, in this case the F2 grade female crabs are called as F3 and F3 grade female crabs are called as F4.

Table-9: Grading system of mud crab (*Scylla serrata*) by sex and weight in local market.

Male				
Grade	XL	L	M	SM
Weight (gm)	>400	>300	>250	>200
Gonad condition	+	-	-	-
Shell condition	Hard	Hard	Hard	Hard
Female				
Grade	F1	KS-1	F2	F3
Weight (gm)	>180	>180	>150	>120
Gonad condition	Full	Partial	Poor	Nil
Shell condition	Hard	Hard	Hard	Hard

Source: Field survey, 2001.

* KS-1 (greater than 180 gm in weight with partial hepatopancreas, locally called *Khosa*)

+ = Available

- = Not available.

4.1.5.2 International Grading System: The international grading system varies from local grading system. Male crabs having body weight greater than 500 g, 400 g, 300 g, 250 g, 200/150 g are called XXL, XL, L, M and SM respectively. The female crabs having over 200 g in weight with full hepatopancreas are called FF1, over 180 g in weight with full hepatopancreas are called F1, over 180 g in weight with partial hepatopancreas are called KS1, over 150 m poor hepatopancreas are called F2, over 120 g in weight with no hepatopancreas are called F3 and the females having body weight less than 180 g are called KS-3 (Table-10).

Table-10: Grading system of mud crab (*Scylla serrata*) by sex and weight in international markets.

<i>Male</i>						
Grade	XXL	XL	L	M	SM	
Weight (gm)	>500	>400	>300	>250	>200/150	
<i>Female</i>						
Grade	FF1	F1	KS1	F2	F3	KS3
Weight (gm)	>200	>180	>180	>150/100	>120	<180

Source: Field survey, 2001.



4.1.6. Production of Mud Crabs from the SW Region of Bangladesh

The annual average production of mud crab from 3 districts of SW region has been estimated to be 69,45.627 MT. The production was maximum 11,34.000 MT in July and minimum 2,23.540 MT in March 2001.

Of these 2512.560; 1777.150; 2655.917 MT were produced in Khulna, Satkhira and Bagerhat district respectively. The maximum (2655.917 MT) production was found in Bagerhat district and the minimum (1777.150 MT) in Satkhira district (Table-11). The production of mud crab showed a sharp seasonal variation in the SW region. The production was maximum (557.300 MT) in July. The monthly variation of production of mud crab in Khulna district was shown in Table -12, Fig 9a and 9b.

The monthly variation production in Satkhira district has been shown in Table -13 and Fig-10a, and 10b. The maximum production of mud crab was found in 272.580 MT and the minimum 43.140 MT in February in Satkhira district.

In Bagerhat district maximum (304.120 MT) production was achieved in July and the minimum 91.430 Mt in April. The monthly variation of production in Bagherhat district has been shown in Table -14 and Fig-11a, and 11b.

ANOVA test shows that there is a significant relationship among the production of three districts in SW region (ANOVA Table:-1).

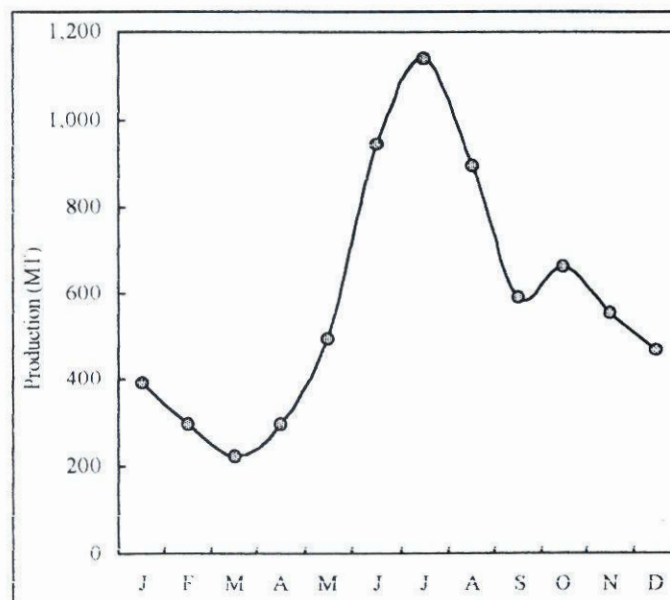
ANOVA Table 1: ANOVA test for production of SW region

Source of Variation	SS	df	MS	F	P-value	F crit
Sample	2.21542E+11	2	1.11E+11	20.77	3.45E-06	3.354
Columns	37236331718	2	1.86E+10	3.491	0.044818	3.354
Interaction	85400510167	4	2.14E+10	4.003	0.011211	2.727
Within	1.43984E+11	27	5.33E+09			
Total	4.88162E+11	35				

Table-11: The monthly production (MT) of mud crab (*Scylla serrata*) from SW region in 2001.

Month	Khulna	Satkhira	Bagerhat	Total
Jan	59.500	60.510	2,71.790	3,91.800
Feb	51.640	43.140	1,98.637	2,93.417
Mar	78.450	45.600	99.490	2,23.540
Apr	1,29.450	74.350	91.430	2,95.230
May	2,45.150	1,30.160	1,19.460	4,94.770
Jun	4,54.300	2,24.820	2,64.750	9,43.870
Jul	5,57.300	2,72.580	3,04.120	11,34.000
Aug	3,59.800	2,47.910	2,89.270	8,96.980
Sep	1,82.800	2,27.020	1,83.190	5,93.010
Oct	1,74.500	2,26.310	2,61.220	6,62.030
Nov	1,26.600	1,28.310	2,95.680	5,50.590
Dec	93.070	96.440	2,76.880	4,66.390
Total	2512.560	1777.150	2655.917	6945.627

Source: Field survey, 2001.

Fig-8: Monthly production of mud crab (*Scylla serrata*) From SW region in 2001.

In Khulna district, the maximum production of mud crab was found in the July, 2001 where September and October in 2001, the production of mud crab was almost same. The productions of mud crab were also almost same in March and December in 2001. The minimum production of mud crab was found in the February 2001. (Fig.9a) The maximum production of mud crab was found in the Paikgacha upazilla (Fig.9b) in Khulna district. There were a lot of difference between the production of mud crab in Paikgacha upazilla and other upazilla in Khulna district. The minimum production of mud crab was found in the Dumuria upazilla.

Table-12: The monthly production (MT) of mud crab (*Scylla serrata*) from 5 Upazilla in Khulna District in 2001.

Month	Paikgacha	Koyra	Dumuria	Batiaghata	Dacope	Total
Jan	35.600	17.000	1.300	1.900	3.700	59.500
Feb	34.190	10.000	1.250	2.200	4.000	51.640
Mar	60.250	6.000	2.900	3.800	5.500	78.450
Apr	102.000	4.500	5.450	7.200	10.300	129.450
May	205.900	4.500	7.450	9.300	18.000	245.150
Jun	410.500	3.000	9.100	11.200	20.500	454.300
Jul	505.000	3.500	12.000	14.000	22.800	557.300
Aug	312.200	7.000	10.500	12.500	17.600	359.800
Sep	120.600	22.000	8.000	14.000	18.200	182.800
Oct	110.500	27.800	8.400	13.800	14.000	174.500
Nov	75.000	30.500	4.300	7.500	9.300	126.600
Dec	55.400	26.500	2.270	3.000	5.900	93.070
Total	2027.140	162.300	72.920	100.400	149.800	2512.560

Source: Field survey, 2001.

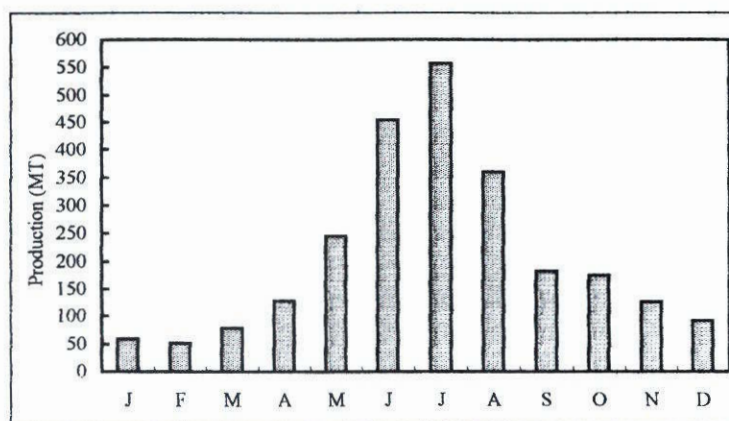


Figure-9a: Monthly production of mud crab (*Scylla serrata*) in Khulna District in 2001

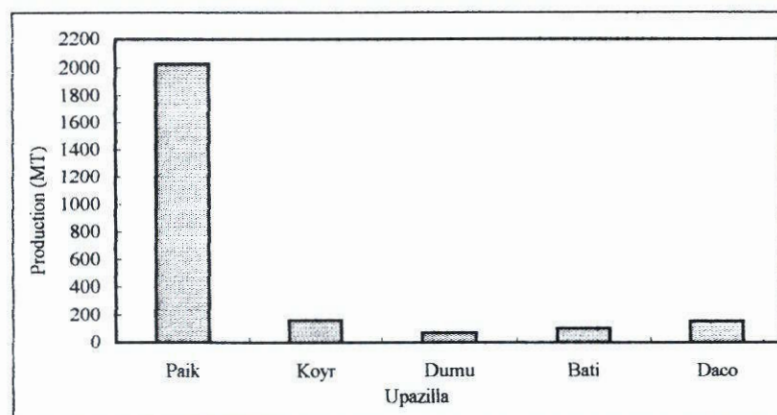


Figure-9b: The production of mud crab (*Scylla serrata*) by Upazilla in Khulna District in 2001.

In Satkhira district, the maximum production (272.580 MT) of mud crab was found in the July, 2001 where September (227.020MT) and October (226.310MT) in 2001, the production of mud crab was almost same. . The minimum production (430.140 MT) of mud crab was found in the February 2001. (Fig.10a) The maximum production () of mud crab was found in the Kaliganj upazilla in Satkhira district.. The minimum production of mud crab was found in the Tala upazilla. (fig.10b)

Table-13: The monthly production (MT) of mud crab (*Scylla serrata*) from 5 Upazilla in Satkhira in 2001.

Month	Ashashuni	Shamnagar	Kaligong	Devhata	Tala	Total
Jan	5.000	42.620	8.680	3.260	.950	60.510
Feb	3.570	23.200	10.700	5200	.470	43.140
Mar	2.000	15.500	16.250	11.140	.710	45.600
Apr	3.550	12.400	32.900	23.350	2.150	74.350
May	3.000	13.380	62.790	45.420	5.570	130.160
Jun	3.700	36.000	92.420	82.500	10.200	224.820
Jul	4.000	52.500	110.350	96.350	9.380	272.580
Aug	5.200	78.400	85.760	72.370	6.180	247.910
Sep	9.000	105.300	72.300	38.150	2.270	227.020
Oct	11.500	48.600	46.200	18.280	1.730	226.310
Nov	7.200	88.750	22.050	9.060	1.250	128.310
Dec	6.000	69.470	15.280	4.600	1.090	96.440
Total	63.720	686.120	575.680	409.680	41.950	1777.150

Source: Field survey, 2001.

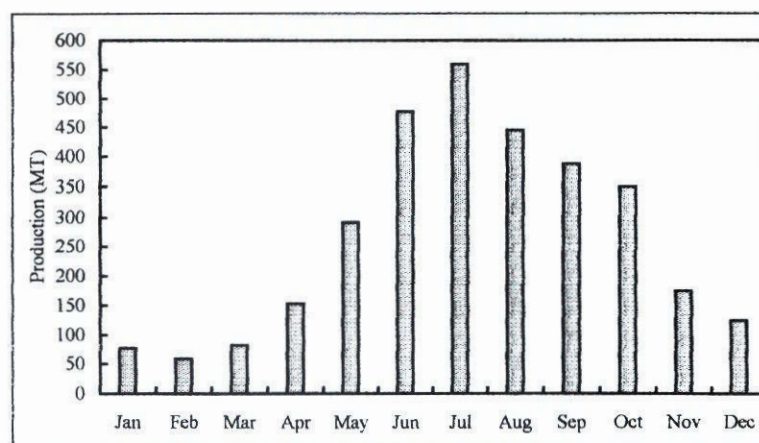


Fig-10a: Monthly production of mud crab (*Scylla serrata*) in Satkhira District in 2001.

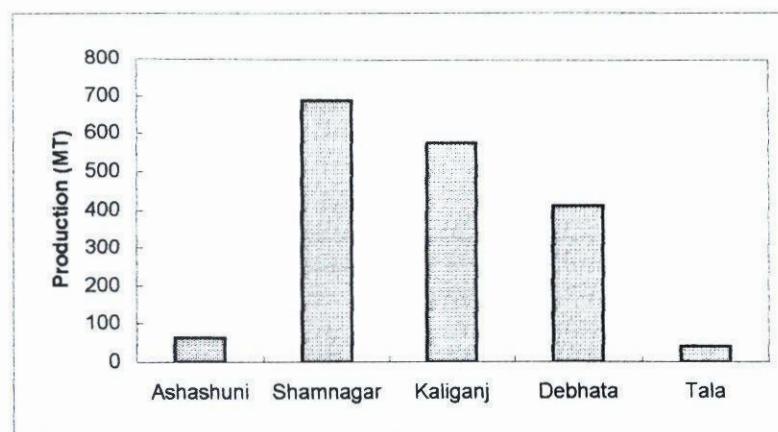


Fig-10b: The Production of mud crab (*Scylla serrata*) by Upazilla in Satkhira District in 2001.

The maximum production of mud crab was found in the July 2001 in Bagherhat district. The production of mud crab was almost same in August, October, November and December in 2001. The minimum production of mud crab was found in the April 2001. (fig.11a) The maximum production of mud crab was found in the Rampal upazilla in Bagherhat district. There was a lot of difference between the production of mud crab in Rampal upazilla and other upazilla in Bagherhat district. The minimum production of mud crab was found in the Morelganj upazilla in Bagherhat districts (fig.11b).

Table-14: The monthly production (MT) of mud crab (*Scylla serrata*) from 5 Upazilla in Bagerhat District in 2001

Month	Bagerhat Sadar	Mongla	Rampal	Morelganj	Shoronkhola	Total
Jan	10.100	7.800	220.000	.690	33.200	271.790
Feb	9.200	4.507	170.000	.180	14.750	198.637
Mar	4.700	2.900	90.000	.190	1.700	99.490
Apr	3.100	1.700	85.000	.130	1.500	91.430
May	3.900	3.200	110.000	.160	2.200	119.460
Jun	4.500	7.500	250.000	.250	2.500	264.750
Jul	11.200	8.200	281.000	.620	3.100	304.120
Aug	12.300	8.500	265.000	.670	2.800	289.270
Sep	10.500	7.700	160.000	.490	4.500	183.190
Oct	11.700	8.200	215.000	.720	25.600	261.220
Nov	11.900	8.500	245.000	.780	29.500	295.680
Dec	11.600	8.700	220.110	.770	35.700	276.880
Total	104.700	77.407	2311.110	5.650	157.050	2655.917

Source: Field survey, 2001.

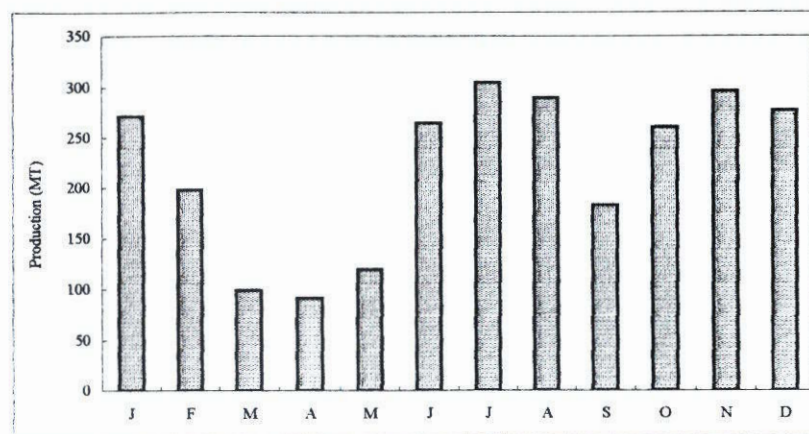


Fig-11a: Monthly production of mud crab (*Scylla serrata*) in Bagerhat District in 2001.

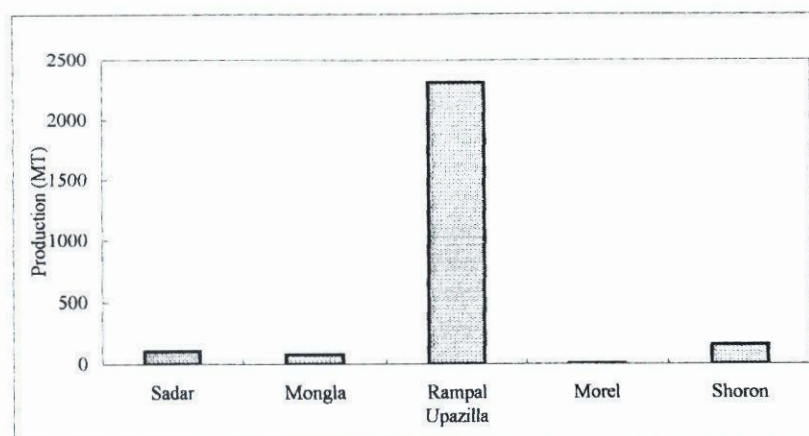


Fig-11b: The production of mud crab (*Scylla serrata*) by Upazilla in Bagerhat District in 2001.

4.1.7 Monthly variation of Mud Crab Production by Grade: The grade wise monthly production was calculated from randomly selected three depots at each upazilla from SW region during January to December 2001 (table-15 and 16 and figure –12a and 12b)

Female Mud Crab: The monthly variations of production of female crab are shown in Table-15 and Figure-11a. The production was found to be maximum (916.843 kg) in July for F1, 270.277 kg in August for KS-1, 157.420 kg in July for F2 and 170.210 kg in October for F3 female crab. The minimum production was seen for F1 (291.077 kg) in March, KS-1 (121.163 kg) in April, F2 (59.757 kg) in April and F3 (61.240 kg) in April.

Male Mud Crab: The maximum production was found to be 1261.053, 272.697 and 201.493 kg for XL, L and SM respectively in July, and 151.240 MT for M grade male crab in October. The production was minimum 379.533, 56.547 and 94.207 MT for XL, M and SM respectively in March and 108.027 kg for L in April (Table-16 and Fige-12b).

Table-15: Monthly production (Mt) of female grade crab (*Scylla serrata*) in SW region in 2001.

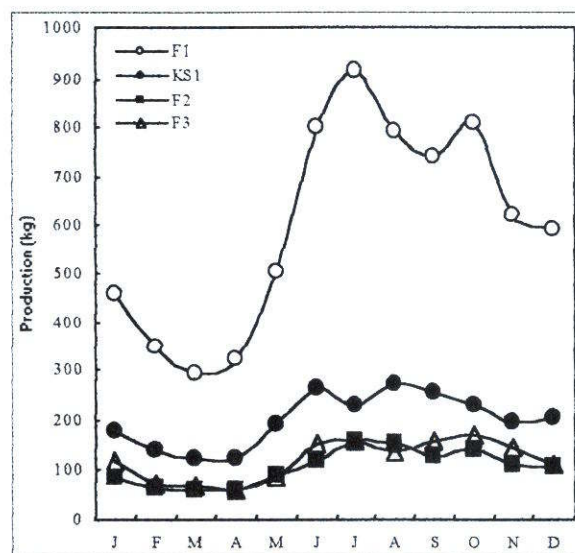
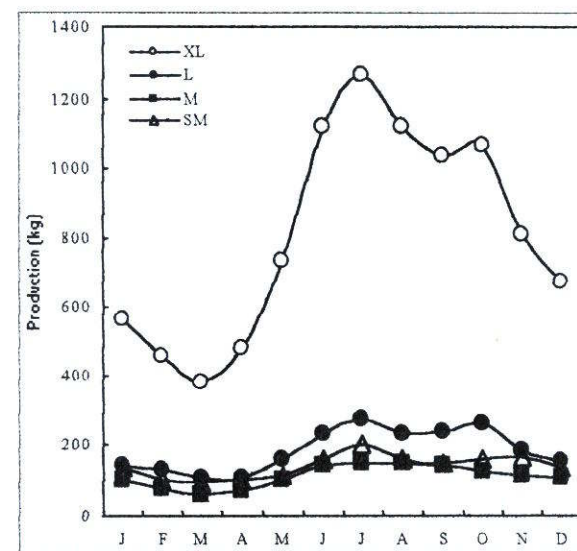
Month	F1	KS-1	F2	F3	Total
Jan	456.83	176.84	86.59	118.00	838.26
Feb	345.97	138.44	63.35	74.08	621.84
Mar	291.08	121.50	60.70	66.22	539.50
Apr	323.24	121.16	59.76	61.24	565.40
May	503.64	188.74	87.60	86.73	866.71
Jun	800.84	264.23	120.12	151.46	1336.65
Jul	916.84	229.30	157.42	156.85	1460.42
Aug	794.08	270.28	151.23	135.05	1350.63
Sep	740.04	254.19	129.21	155.22	1278.66
Oct	810.70	227.29	139.83	170.21	1348.03
Nov	622.69	195.91	110.13	143.65	1072.38
Dec	593.99	205.41	106.36	108.77	1014.53
Total	7199.93	2393.30	1272.30	1427.48	12293.01

Source: Field survey, 2001.

Table-16: Variation in production of male grade crab (*Scylla serrata*) in SW region in 2001.

Month	XL	L	M	SM	Total
Jan	565.74	143.83	100.79	133.88	944.24
Feb	459.5	127.56	80.04	103.1	770.20
Mar	379.53	108.3	56.54	94.2	638.57
Apr	479.93	108.02	69.84	101.03	758.82
May	733.42	163.03	98.94	109.94	1105.33
Jun	1118.77	231.32	140.25	160.98	1651.32
Jul	1261.05	272.69	148.77	201.49	1884.00
Aug	1122.62	230.71	151.24	160.29	1664.86
Sep	1036.09	236.98	141.31	148.76	1563.14
Oct	1069.69	261.58	124.92	159.26	1615.45
Nov	813.76	185.57	112.87	168.08	1280.28
Dec	675.18	156.93	105.69	133.89	1071.69
Total	9715.28	2226.52	1331.20	1674.90	14947.90

Source: Field survey, 2001.

Figure-12a: Monthly variation in production of female crab (*Scylla serrata*) in SW region in 2001.Figure-12b: Monthly variation in production of male crab (*Scylla serrata*) in SW region in 2001.

Production F1 for female and XL for male crabs were the highest among different grade, i.e. weight classes. It is clear from Fig. 11a and 11b that larger size male and female mud crab was fished maximum, therefore the population of sexually matures or most potential reproductive groups in the crab population were over fished.

4.1.8. Seasonal Variation in Production of Mud Crabs: Monsoon season was found to be the peak production time for mud crab followed by winter and summer season. The highest (356.86 MT) and the lowest (1306.96 MT) were found during monsoon and winter season respectively (Fig-13a)

During monsoon, the production of mud crab was 1554.200 MT, 972.330 MT and 1041.330 MT in Khulna, Satkhira and Bagherhat district respectively. In summer, the production was 504.690 MT, 293.250 MT and 509.017 MT in Khulna, Satkhira and Bagherhat district respectively. In winter, the production of mud crab was 453.670 MT, 511.570 MT and 1105.570 MT in Khulna, Satkhira and Bagherhat district respectively (Table-17 and Fig-13b).

Table-17: Seasonal variation in production (MT) of mud crab from SW region in 2001.

Season	Khulna	Satkhira	Bagerhat	Total
Summer	504.690	293.250	509.017	1306.67
Monsoon	1554.200	972.330	1041.330	3567.86
Winter	453.670	511.570	1105.570	2070.81
Total	2512.560	1777.150	2655.917	6945.63

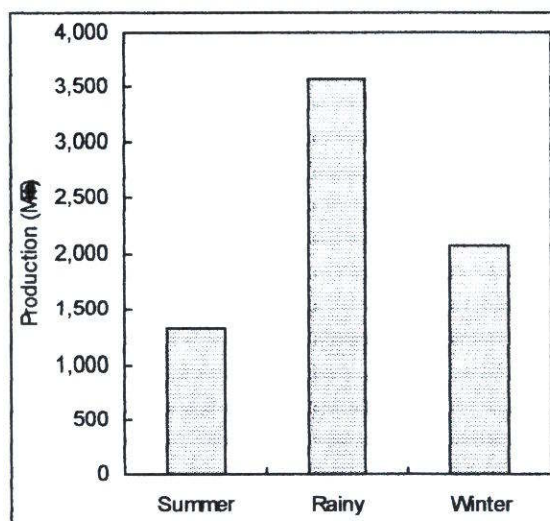


Fig-13a: Seasonal variation in production of mud crab (*Scylla serrata*) from SW region in 2001.

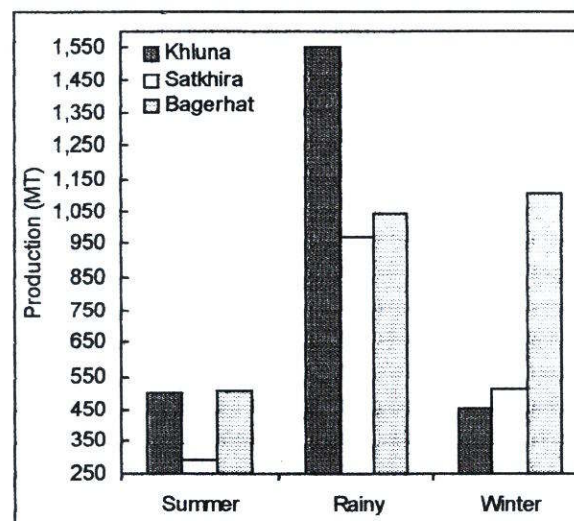


Fig-13b: Seasonal variation in production of mud crab (*Scylla serrata*) in Khulna, Satkhira and Bagherhat districts in 2001.

4.1.9 Grade Wise Seasonal Variation in Production: During the summer season, the maximum production was recorded 3.83737 MT for XL grade crab in Khulna district and the minimum at 0.18626 MT for F3 grade crab in Satkhira district from the SW region.

During the monsoon, the maximum production was estimated to be 5.18544 MT for F1 grade crabs in Satkhira district and the minimum 0.41143 MT for M grade crab in Khulna district.

During the winter, the maximum production was found to be 4.679 MT for XL grade crab in Bagerhat district and the minimum 0.123.51 MT for M grade crab in Khulna district.

The grade-wise seasonal variation in mud crab production from the SW region is shown in Table 18 and table19

Table.18 Grade wise seasonal variation in the production (MT) of mud crab from SW region in 2001

	<i>F1</i>	<i>KS-1</i>	<i>F2</i>	<i>F3</i>	<i>XL</i>	<i>L</i>	<i>M</i>	<i>SM</i>	<i>Total</i>
Summer	6.96408	2.5827	1.3304	1.8444	8.56517	2.1275	1.3781	2.1044	26.8901
Monsoon	10.4773	3.552	1.8901	2.1821	13.5239	3.0086	1.9062	2.4586	38.9991
Winter	7.11273	2.3995	1.2765	1.7124	8.42304	2.1235	1.2822	1.8489	26.1880
Total	24.5416	8.5343	4.4970	5.7390	30.5212	7.2686	4.5666	6.4120	92.0841

Table-19: Grade wise seasonal variation in production (MT)

	F1	KS-1	F2	F3	XL	L	M	SM
Khulna								
Summer	3.4421	1.13809	0.65895	1.13773	3.83737	0.96582	0.66477	1.06275
Rainy	2.27801	0.86078	0.4568	0.61404	2.37037	0.58111	0.41143	0.73059
Winter	0.62606	0.21988	0.09533	0.20576	0.67811	0.18684	0.12351	0.2221
Satkhira								
Summer	1.60439	0.62316	0.23712	0.18626	2.50905	0.45229	0.28387	0.22242
Rainy	5.18544	1.69143	0.86897	0.58552	7.822	1.5599	0.89133	0.77175
Winter	2.15735	0.53984	0.33001	0.2241	3.06593	0.78074	0.34461	0.21751
Bagerhat								
Summer	1.91759	0.82149	0.43434	0.52048	2.21875	0.70941	0.42953	0.81928
Rainy	3.0139	0.99979	0.56438	0.98255	3.33162	0.86759	0.60348	0.95635
Winter	4.32932	1.63986	0.8512	1.2826	4.679	1.16496	0.81411	1.40933

Among different grade crabs, the highest (3.05122 MT) and the lowest (4.56664 MT) production were recorded XL and M grades respectively (table-18)

4.1.10 Relationship between production and depot Size

The production of mud crab was found to be positively related with size of the crab depots in all the three districts studied. The relationship between mud crab production and depots size was poor but statistically significant (Table 20). However a negative but significant relationship between production and depots size was found at Dacope of Khulna, Kaligonj and Tala of Satkhira and Shoronkhola of Bagerhat district (Table 21,22,23). A strong to moderate relationship with 1% significance level was found in Batiaghata and Koyra of Khulna, Debhata of Satkhira and Shoronkhola and Bagerhat sadar of Bagerhat district (Table 21,22,23).

Table-20: Relationship between depot size and production of mud crab (*Scylla serrata*) in SW region in 2001.

District	Regression equation (y on x)	df	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)
Khulna	$y=8099.063817+67.0511178x$	121	0.26014	6.584591**	1.979765
Satkhira	$y = 20369.8+14.93117x$	75	0.075518	5.425346**	1.992103
Bagerhat	$y = 13321.34+108.9772x$	93	0.181855	3.924774**	1.9858

** = Significant at 1% level.

Table-21: Relationship between depot size and production of mud crab (*Scylla serrata*) in Khulna district.

Upazilla	Regression equation (y on x)	df	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)
Paikgacha	$y=9790.60578+79.3285252x$	82	0.292136	5.37877**	1.98932
Koyra	$y = 8776.16+49.9587x$	9	0.48878	6.17025**	2.262
Dumuria	$y = 3942.243+6.025035x$	13	0.107418	3.22721**	2.160
Batiaghata	$y = -2589.58+110.2606x$	4	0.752824	4.58707*	2.776
Dacope	$y = 22609.02-38.8443x$	10	-0.36862	5.0428**	2.262

** = Significant at 1% level, * = Significant at 5% level.

Table-22: Relationship between depot size and production of mud crab (*Scylla serrata*) in Satkhira district.

Upazilla	Regression equation (y on x)	df	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)
Ashashuni	$y=4638.684+8.69485x$	10	0.155983	3.228249*	2.228139
Shamnagar	$y=32351.07+20.48781x$	19	0.0609	6.556946*	2.093024
Kaligong	$y=38146.3-30.0604x$	19	-0.1029	2.0535762	2.093024
Debhata	$y=5504.806+59.01647x$	20	0.529232	3.4513050*	2.085962
Tala	$y=11156.3-3036078x$	3	-0.23713	15.716906*	3.182449

**= Significant at 5% level, * = Significant at 1% level.

Table-23: Relationship between depot size and production of mud crab (*Scylla serrata*) in Bagerhat district.

Upazilla	Regression equation (y on x)	df	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)
Bagerhat Sadar	$y = 3340.483 + 10.35985x$	15	0.530934	6.57655**	2.228139
Rampal	$y = 24254.59 + 304.7657x$	36	0.347771	3.73693**	2.085962
Mongla	$y = 4622.162 + 54871x$	17	0.014193	5.54457**	3.182449
Morelganj	$y = 1746.338 - 12.8404x$	4	-0.97512	4.27951**	2.093024
Shoronkhola	$y = -6895.24 + 117.3964x$	17	0.794979	5.13459**	2.093024

**= Significant at 1% level.

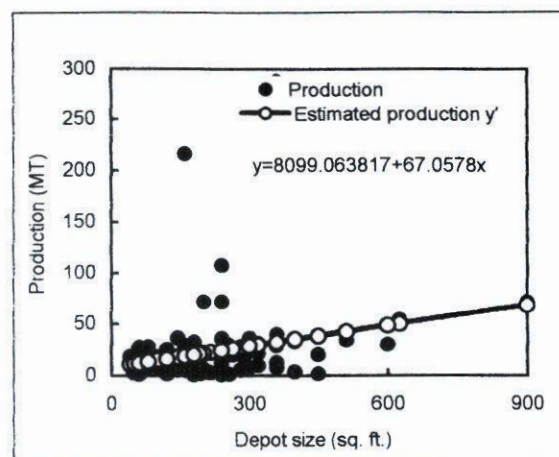


Fig-14a: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Khulna district.

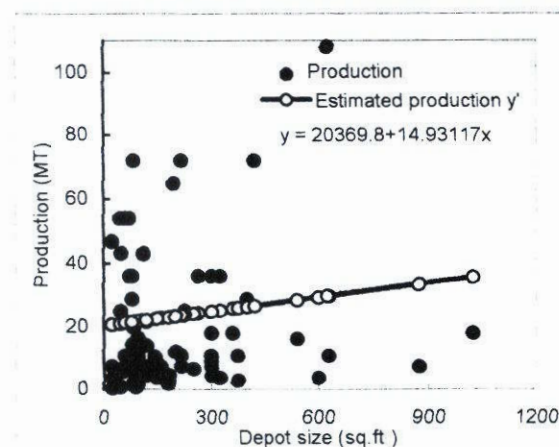


Fig-14b: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Satkhira district.

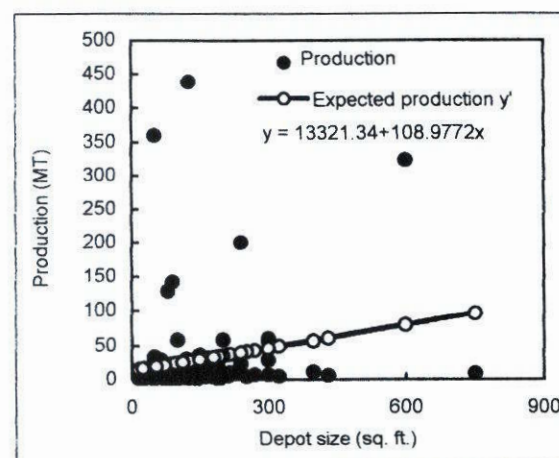


Fig-14c: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Bagerhat district.

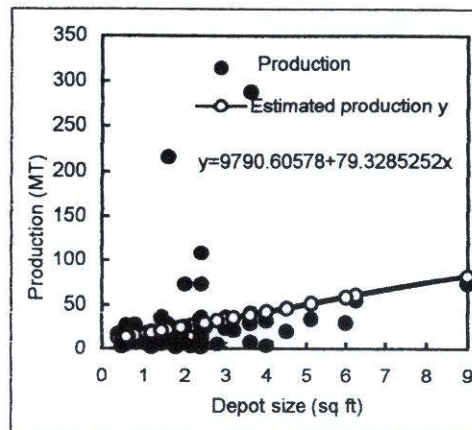


Fig-15a: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Paikgachai upazilla in 2001.

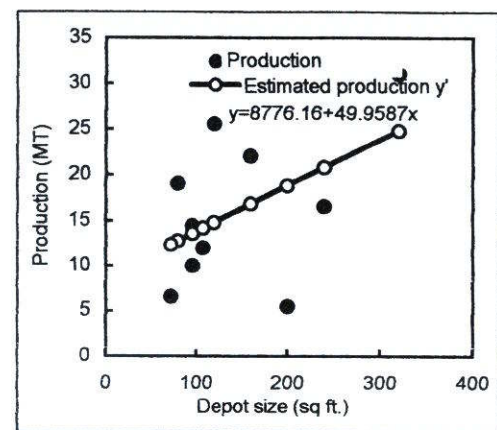


Fig-15b: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Koyra upazilla in 2001.

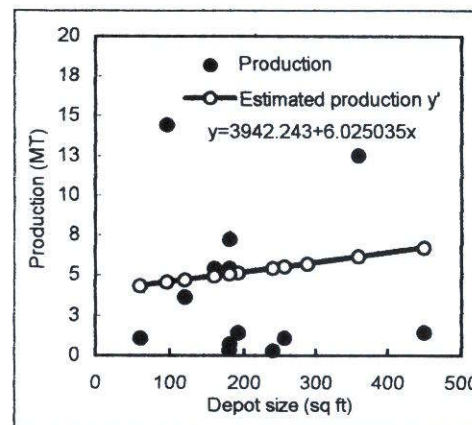


Fig-15c: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Dumuria upazilla in 2001.

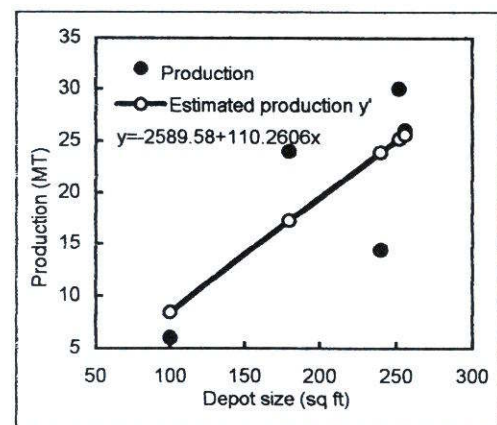


Fig-15d: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Batiaghata upazilla in 2001.

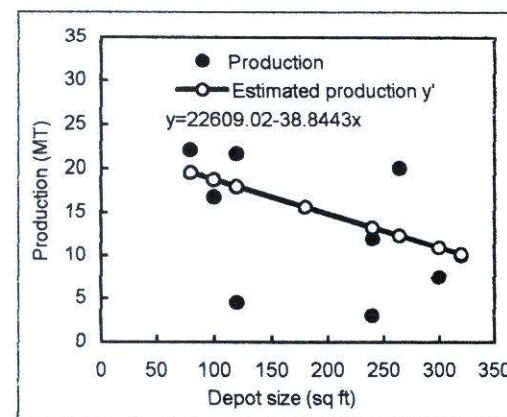


Fig-15e: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Dacop upazilla in 2001

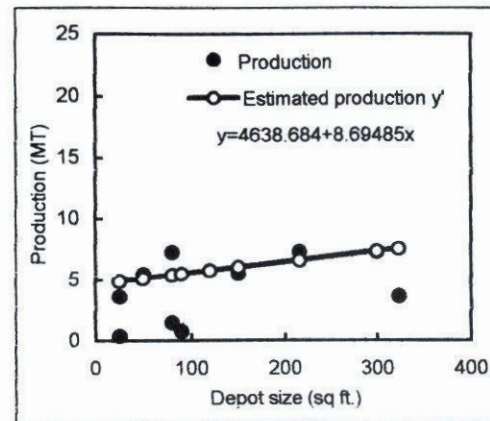


Fig-16a: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Ashashuni upazilla in 2001.

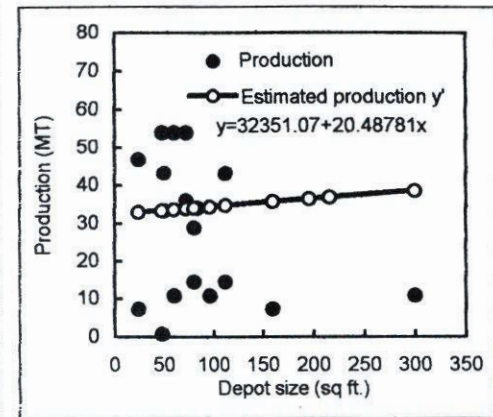


Fig-16b: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Shamnagar upazilla in 2001.

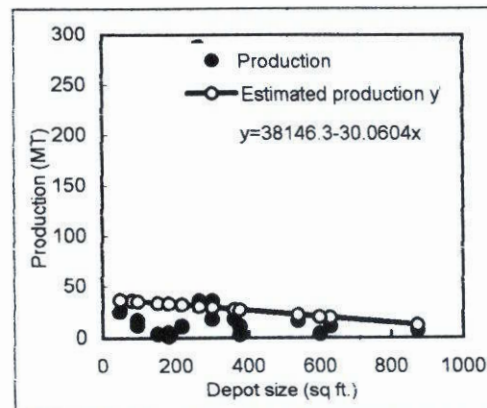


Fig-16c: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Kaligang upazilla in 2001.

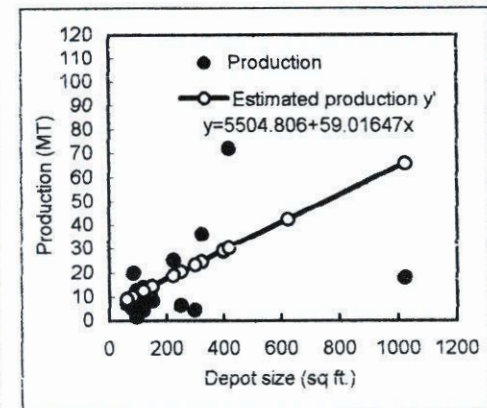


Fig-16d: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Devhata upazilla in 2001.

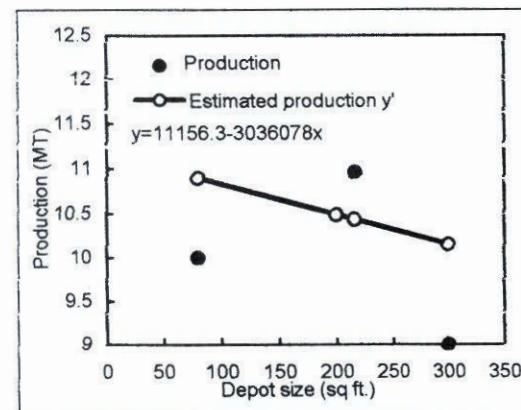


Fig-16e: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Tala upazilla in 2001.

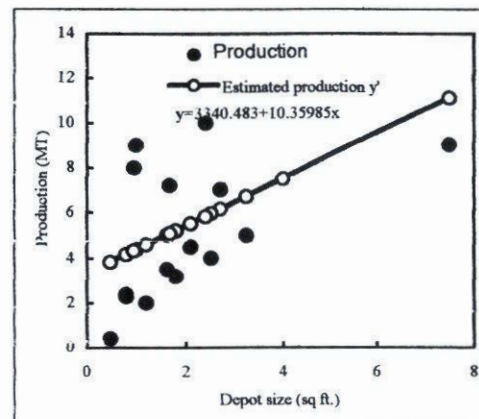


Fig-17a: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Bagerhat sadar upazilla in 2001.

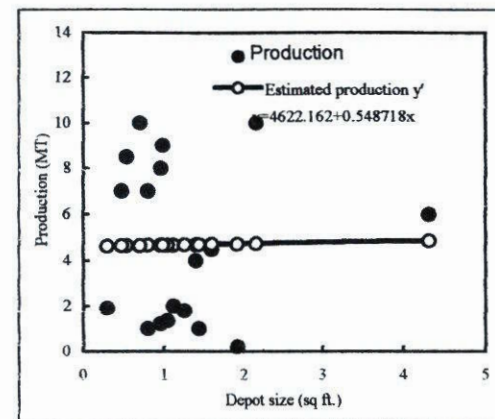


Fig-17b: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Mongla upazilla in 2001.

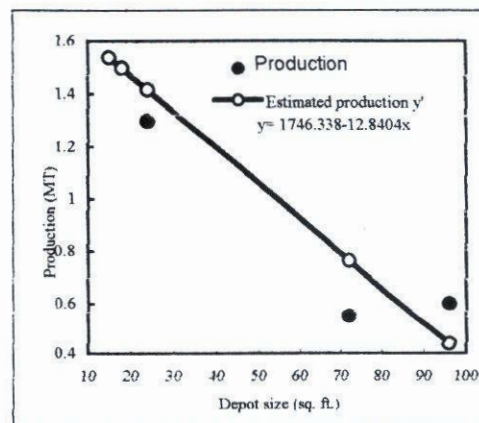


Fig-17c: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Morelgang upazilla in 2001.

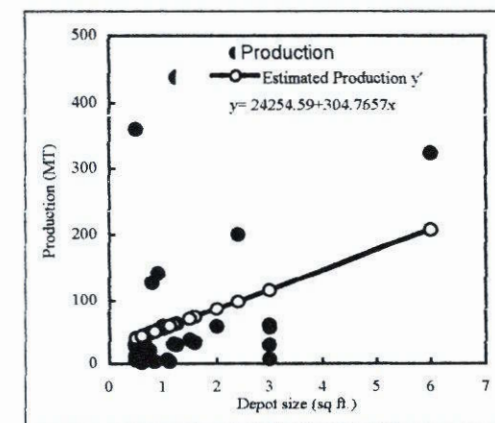


Fig-17d: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Rampal upazilla in 2001.

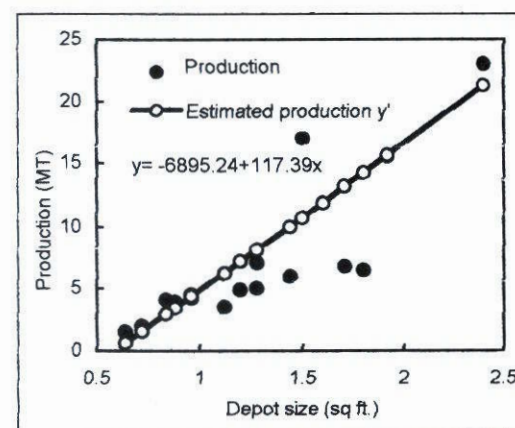


Fig-17e: Regression of y between depot size and production of mud crab (*Scylla serrata*) at Sarankhola upazilla in 2001.

4.1.11 Relationship between Manpower in Depots and Production of Mud Crab

A poor but statistically significant relation was estimated between mud crab production and the number of manpower in crab depots all the districts studied (Table 24). A strong positive and statistically significant relationship was found in Koyra in Khulna, Debhata and Tala of Satkhira and Shoronkhola and Bagerhat sadar of Bagerhat district (Table 25,26,27). While a negative relationship was found between production of mud crab manpower in crab depots in Dumuria and Batiaghata of Khulna, Kaligonj of Satkhira and Morelganj of Bagerhat (Table 25,26, 27).

Table-24: Relationship between manpower and production of mud crab (*Scylla serrata*) in SW region in 2001.

Upazilla	Regression equation (y on x)	df	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)	't' crit. Value (1% level)
Khulna	$y=7071.83825+5373.92747x$	121	0.2265198	6.637311*	1.979765	2.617071
Satkhira	$y = 17318.05+E6*2269x$	75	0.2517727	5.470451*	1.992103	2.642992
Bagerhat	$y = 26582.62+958.9292x$	93	0.016318	3.942606*	1.9858	2.629731

* = Significant at 1% level

Table-25: Relationship between manpower and production of mud crab (*Scylla serrata*) in all Upazilla in Khulna district in 2001.

Upazilla	Regression equation (y on x)	df	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)	't' crit. Value (1% level)
Paikgacha	$y = 9431.31295+5734.29044x$	82	0.22502346	5.48628*	1.98932	2.6391
Koyra	$y = 2882.93+7851.22x$	9	0.63994	6.19762*	2.262	3.250
Dumuria	$y = 6693.84615-670.76923x$	13	-0.0926395	3.35551*	2.160	3.012
Batiaghata	$y = 23280-1066.6667x$	4	-0.1897195	4.5877**	2.776	4.604
Dacope	$y = 6468+3152.475x$	10	0.361506	5.12715*	2.262	3.250

* = Significant at 1% level, ** = Significant at 5% level.

Table-26: Relationship between manpower and production of mud crab (*Scylla serrata*) in all Upazilla in Satkhira district in 2001.

Upazilla	Regression equation (y on x)	df	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)	't' crit. Value (1% level)
Ashashuni	$y = -828+4284x$	10	0.3837246	3.294460832*	2.22813923	3.169262
Shamnagar	$y=19048.03+10591.71x$	19	0.40147	6.574778214*	2.09302470	2.860943
Kaligong	$y=30081.22-480.454x$	19	-0.0167	2.0765868***	2.09302470	2.860943
Devhata	$y=7021.261+2789.718x$	20	0.791915	3.477304803*	2.08596247	2.845336
Tala	$y= 5550+1975x$	3	0.887528	16.32854396*	3.18244929	5.840848

* = Significant at 5% level, ** = Significant at 1% level.

Table-27: Relationship between manpower and production of mud crab (*Scylla serrata*) in all Upazilla in Bagerhat district in 2001.

Upazilla	Regression equation (y on x)	df	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)	't' crit. Value (1% level)
Bagerhat sadar	$y = 2058.036 + 1178.571x$	15	0.678133	6.66208	2.22813923	2.131451
Rampal	$y = 7822.06 + 41850.89x$	36	0.268343	3.74294	2.09302470	2.028091
Mongla	$y = 4305.39 + 187.9182x$	17	0.050433	5.69581	2.09302470	2.109819
Morelganj	$y = 2000 - 725x$	4	-0.61605	4.7933	2.08596247	2.776451
Shoronkhola	$y = -3357.78 + 5576.667x$	17	0.898833	5.18554	3.18244929	2.109819

* = Significant at 5% level.

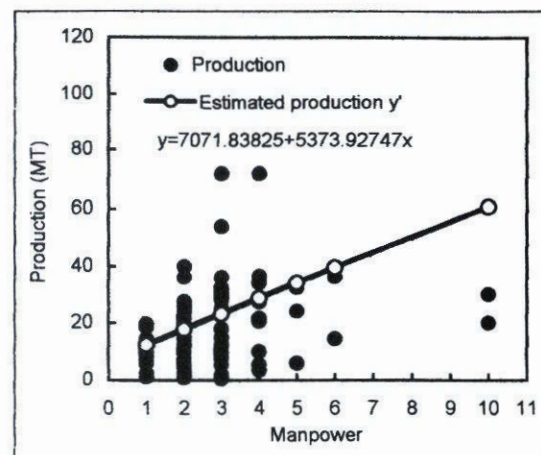


Fig-18a: Regression of y between Manpower and production of mud crab (*Scylla serrata*) at Khulna district.

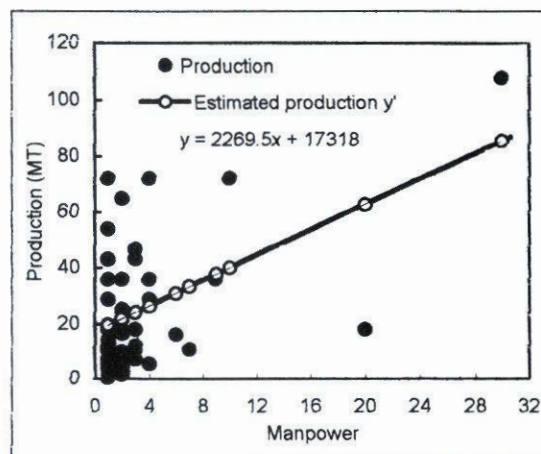


Fig-18b: Regression of y between Manpower and production of mud crab (*Scylla serrata*) at Satkhira district.

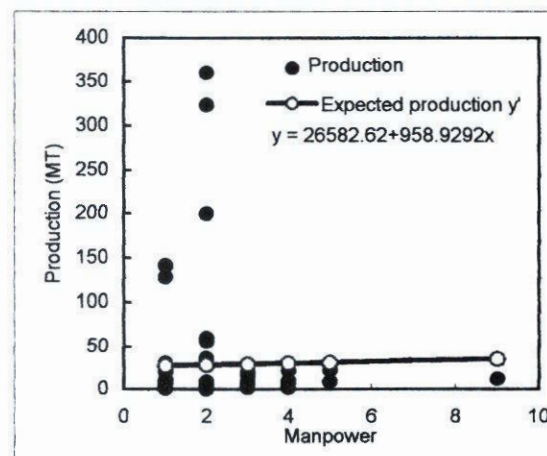


Fig-18c: Regression of y between Manpower and production of mud crab (*Scylla serrata*) at Bagerhat district.



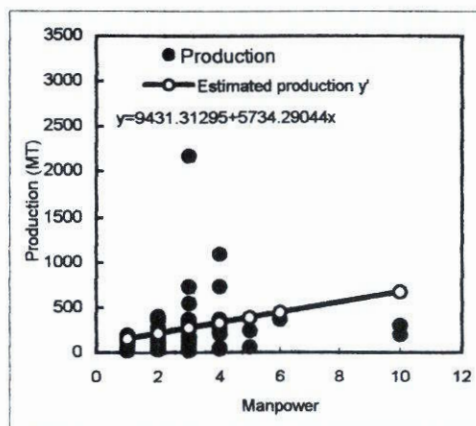


Fig-19a: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Paikpacha Upazilla in 2001.

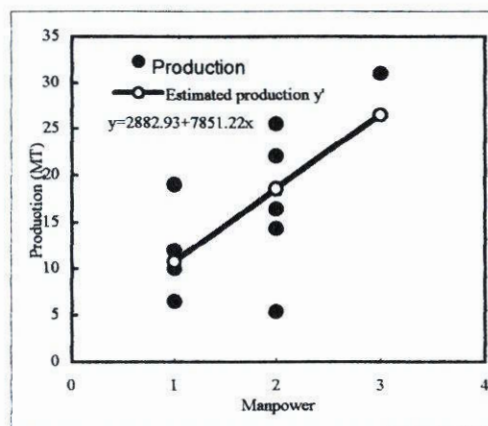


Fig-19b: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Koyra Upazilla in 2001.

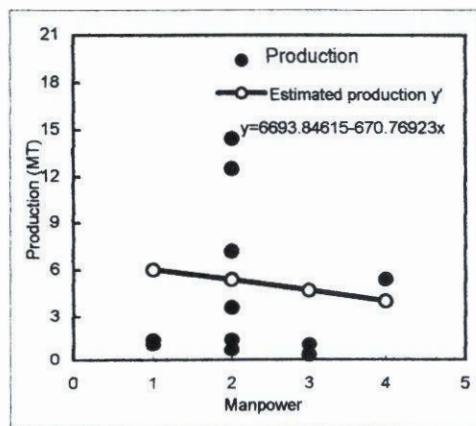


Fig-19c: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Dumuria Upazilla in 2001.

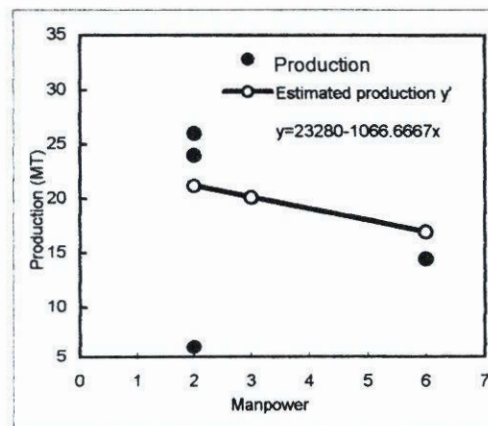


Fig-19d: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Betiaghata Upazilla in 2001.

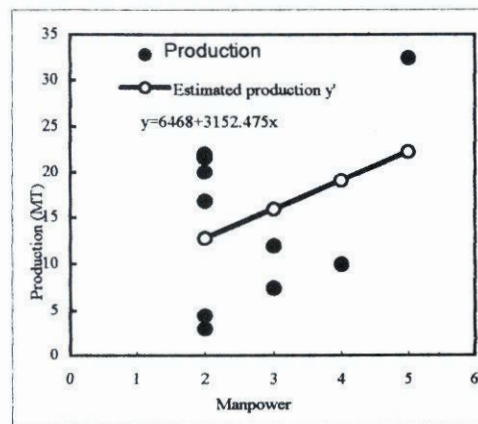


Fig-19e: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Dacope Upazilla in 2001.

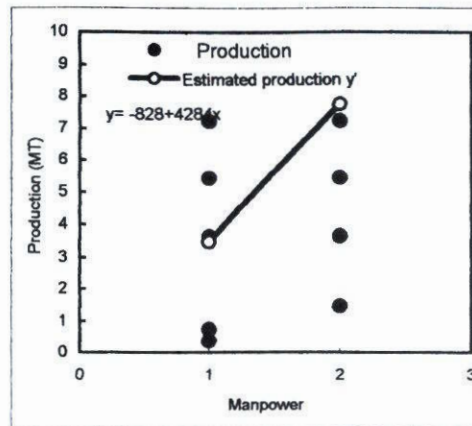


Fig-20a: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Ashashuni Upazilla in 2001.

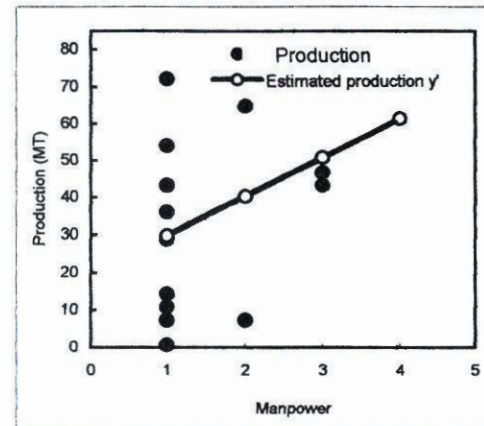


Fig-20b: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Sharnagar Upazilla in 2001.

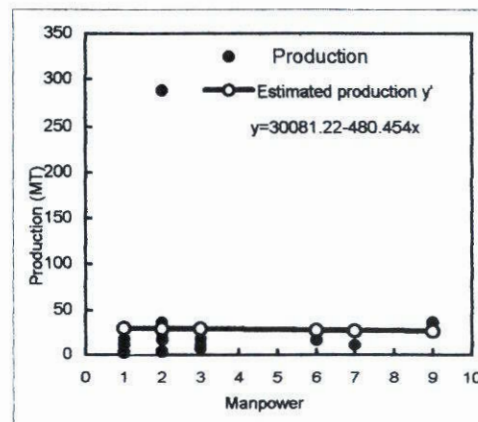


Fig-20c: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Kaligang Upazilla in 2001.

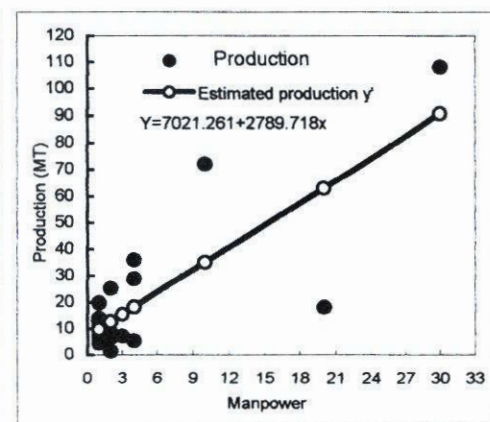


Fig-20d: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Debghata Upazilla in 2001.

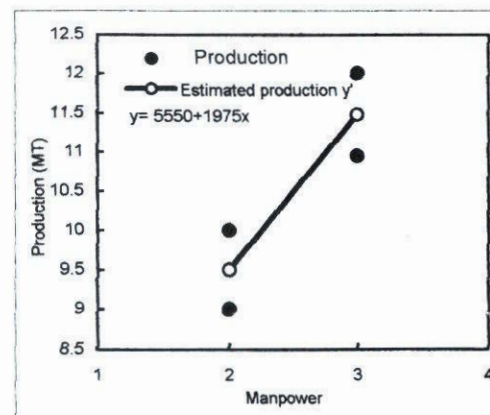


Fig-20e: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Tala Upazilla in 2001.

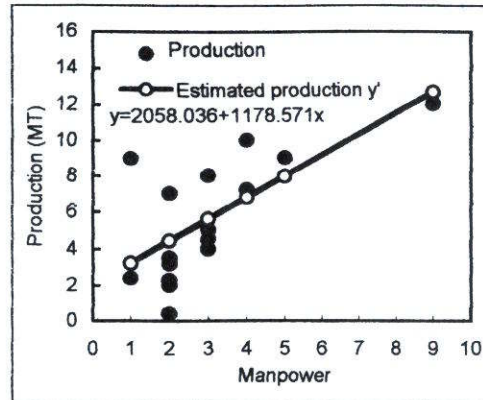


Fig-21a: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Bagerhat sadar Upazilla in 2001.

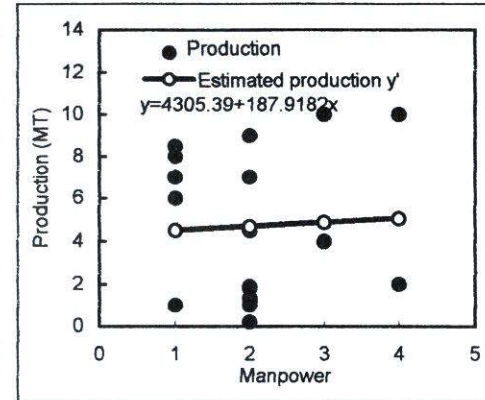


Fig-21b: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Mongla Upazilla in 2001.

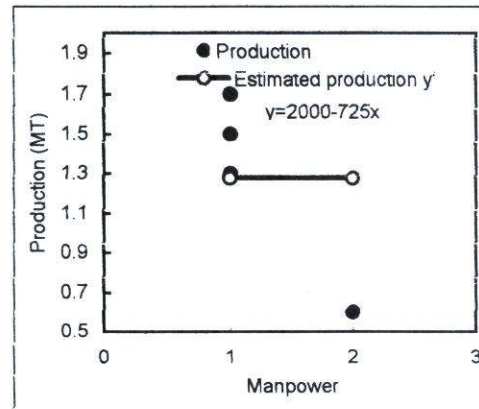


Fig-21c: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Morelgang Upazilla in 2001.

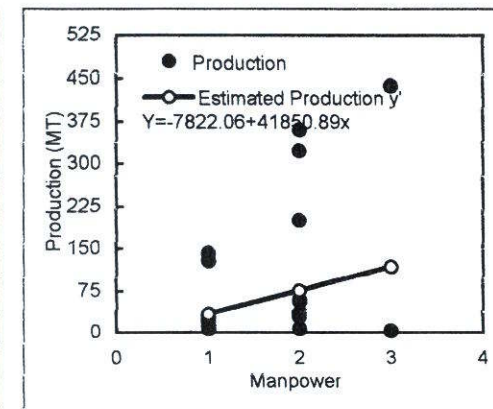


Fig-21d: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Rampal Upazilla in 2001.

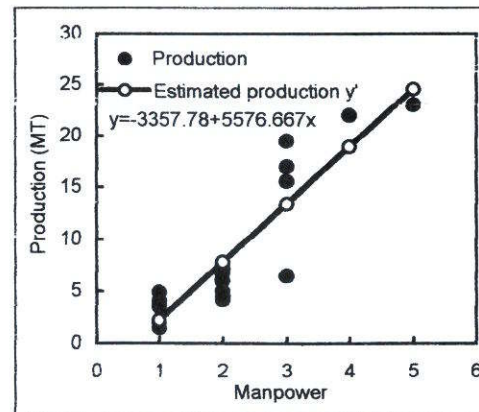


Fig-21e: Regression of y between manpower and production of mud crab (*Scylla serrata*) at Sarankhola Upazilla in 2001.

4.1.12 Price of Mud Crabs

The price of mud crab in the SW region was found to be solely fixed by the exporters which was then followed by depots owner, Forias (the persons who purchase products from catcher) and middlemen. The price at the exporter level was found to be dependent on the demand and price at international market. The price was found to vary remarkably at different season, month and even weeks. The price and profit margin for different grades mud crab for female and male at different marketing channel shown at table -28 and table-29.

4.1.12.1 Monthly Variation in Price of Mud Crab by Grade: The grade wise average monthly variation in price of mud crab in the SW region during January to December, 2001 are shown in Table-29 and 30 and Figure-23a and 23b.

Female Mud Crab: The monthly variation of average price of different grade female crabs in the SW region is shown in Table-29 and Figure-23a. The price of F1 grade mud crab was varied from Tk. 137 to 169.33, KS-1 from Tk. 67.60 to 94.47, F2 from Tk. 36.53 to 43.80 and F3 from Tk. 19.73 to 24.13 (Fig. 23a). The highest average prices were found to be Tk. $169.33 \pm 34.36/\text{kg}$ in February for F1 grade, Tk. $94.47 \pm 19.14/\text{kg}$ for KS-1 grade in May, Tk. $43.80 \pm 2.25/\text{kg}$ for F2 grade in May and Tk. $24.13 \pm 1.03/\text{kg}$ in April for F3 grade crabs. While the minimum prices were found for F1 grade crabs at Tk. $137.00 \pm 7.00/\text{kg}$ in June, KS-1 grade at Tk. $67.60 \pm 3.83/\text{kg}$ in November, F2 grade at Tk. $36.33 \pm 1.50/\text{kg}$ in March and F3 grade at Tk. $19.73 \pm 0.46/\text{kg}$ in October. The higher prices for different grades female crabs were found in winter and summer months and the lower prices during late monsoon months (Table 23).

Male Mud Crab: The price of XL grade mud crab was varied from Tk. 134.67 to 157.33, L from Tk. 63.67 to 74.13, M from Tk. 36 to 42.80 and SM from Tk. 16.93 to 23.07 (Fig. 23b). The monthly of average prices of different grade male crabs in the SW region is shown in table-30 and Fig- 23b. the highest price for XL grade crab was at Tk. $157.33 \pm 4.51/\text{kg}$ in April, for L grade at Tk. $74.13 \pm 2.00/\text{kg}$ in June, for M grade was at Tk. $43.20 \pm 2.31/\text{kg}$ in August and for SM grade at Tk. $23.07 \pm 2.84/\text{kg}$ in April. The minimum price for XL grade crab was founded at Tk. $134.67 \pm 3.06/\text{kg}$ in August, for L

grade crab at Tk. 64.73±4.10/kg in February, for M grade crab at Tk. 36.00±1.00/kg in February and for SM grade crab at Tk. 16.93±0.42/kg in November.

Table-28: Grade wise average monthly variation in price of female mud crab (*Scylla serrata*) in SW region in 2001.

	F1		KS1		F2		F3	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Jan	149.00	7.21	73.00	3.61	40.20	2.11	21.27	2.47
Feb	169.33	34.36	72.67	4.21	41.33	2.39	20.40	1.06
Mar	153.67	2.52	73.67	2.84	36.53	1.50	23.47	1.36
Apr	151.67	4.04	81.00	4.58	41.20	1.20	24.13	1.03
May	145.33	6.03	94.47	19.14	43.80	2.25	21.07	2.57
Jun	137.00	7.00	78.53	8.04	41.20	1.22	24.13	0.81
Jul	143.00	7.81	74.33	2.66	43.60	1.93	20.20	1.11
Aug	138.33	2.52	69.00	1.73	40.47	1.36	20.33	0.95
Sep	147.00	5.57	72.67	2.08	38.07	2.40	22.07	0.50
Oct	143.33	3.06	69.67	2.91	38.87	1.63	19.73	0.46
Nov	138.33	6.51	67.60	3.83	43.00	2.50	21.53	0.64
Dec	140.67	6.03	68.53	2.54	39.00	1.78	21.60	2.23
Mean	146.39	7.72	74.59	4.85	40.61	1.86	21.66	1.27
SD	8.98	8.59	7.41	4.79	2.24	0.48	1.52	0.75

Source: Field survey, 2001.

Table-29: Grade wise average monthly variation in price of male mud crab (*Scylla serrata*) in SW region in 2001.

	XL		L		M		SM	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Jan	148.00	5.29	68.40	5.05	37.00	1.56	20.73	1.62
Feb	153.73	13.25	64.73	4.10	36.00	1.00	19.87	1.03
Mar	147.67	6.66	67.60	1.44	39.27	0.64	19.67	1.14
Apr	157.33	4.51	63.67	0.58	41.27	1.81	23.07	2.84
May	146.00	3.00	70.93	1.29	36.20	1.59	19.73	0.83
Jun	142.40	9.22	74.13	2.00	36.53	0.64	20.33	2.39
Jul	140.33	3.21	69.80	0.20	42.80	1.93	17.87	2.72
Aug	134.67	3.06	72.07	3.00	43.20	2.31	20.93	0.61
Sep	141.27	3.04	65.13	0.23	40.67	1.51	17.13	1.86
Oct	146.87	3.67	64.47	3.93	41.60	2.09	19.73	0.46
Nov	135.07	1.79	69.93	3.10	41.13	0.64	16.93	0.42
Dec	143.40	3.93	70.93	4.11	40.00	0.00	17.87	1.10
Mean	144.73	5.05	68.48	2.42	39.64	1.31	19.49	1.42
SD	6.73	3.261	3.385	1.68	2.60	0.71	1.78	0.86

Source: Field survey, 2001.

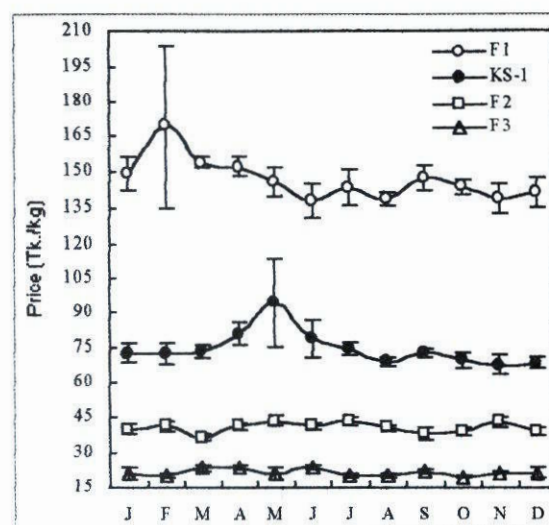


Figure-22a: Grade wise average monthly variation in price of male mud crab (*Scylla serrata*) in South-Western region in 2001.

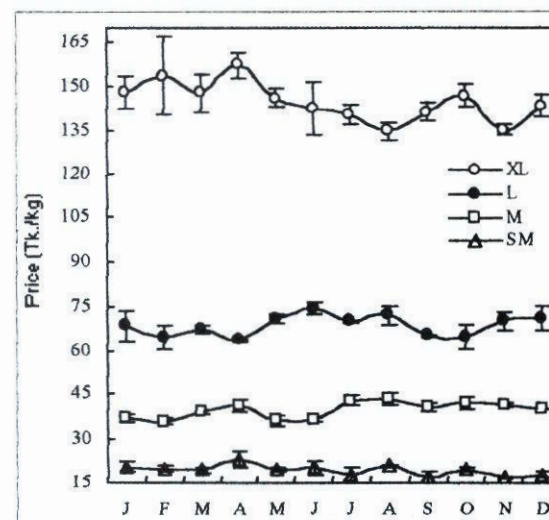


Figure-22b: Grade wise average monthly variation in price of male mud crab (*Scylla serrata*) in South-Western region in 2001.

4.1.13 Seasonal Variation in Price

SW region: The prices of different grades mud crab were found highly variable among seasons in all three districts studied.

Khulna: During summer season, the average highest price was found to be Tk.167.5 /kg s and the lowest price were found at Tk. 21.15 /kg for F1 and SM grade crab respectively. During monsoon, the average maximum and the minimum price were found to be Tk. 143.25 /kg for XL grade crab and 21.2 Tk./kg for SM grade crab in Khulna district. In winter, the average highest and the lowest prices were found to be Tk.148.25 /kg for F1 grade crab and Tk.19.15 /kg for SM grade crabs.

Satkhira: During summer season the average highest and the lowest price were found to be Tk. 152.5 /kg for XL male crab and Tk. 21.45 /kg for SM grade crab in Satkhira district during summer season. During monsoon, the average highest and the lowest price were found to be Tk. 140.5 /kg for F1 grade crab and Tk. 17.8 /kg for SM grade crab in Satkhira district. During winter, the average highest and the lowest price were found to be Tk, 144.25 /kg for Xl grade crab and Tk. 19.2 /kg for SM grade crab in Satkhira district .

Bagerhat: During summer season, the average highest and the lowest price were found to be Tk. 146.8 /kg for XL grade crab and Tk. 19.15 /kg for SM grade crab in Bagerhat district. During monsoon, the average highest and lowest prices were found to be Tk, 138.5 /kg for F1 grade crab and Tk. 18.2 /kg for SM grade crab in Bagerhat district. In winter, XL grade crabs fetched the highest price (Tk. 141.25/Kg) and the SM grade crab fetched the lowest price (Tk. 18.1/kg)

Table-30: Grade wise seasonal variation in the price (Tk/kg) of mud crab in southwestern region

	<i>F1</i>	<i>F2</i>	<i>F3</i>	<i>F4</i>	<i>XL</i>	<i>L</i>	<i>M</i>	<i>SM</i>
Summer	155.00 ±11.06	80.45 ±6.95	40.72 ±1.79	22.27 ±1.16	151.18 ±3.90	66.73 ±1.50	38.18 ±0.82	20.58 ±1.25
Monsoon	141.33 ±3.33	73.63 ±3.12	40.83 ±1.37	21.68 ±0.70	139.67 ±3.22	70.28 ±1.07	40.80 ±1.00	19.07 ±1.86
Winter	142.83 ±4.82	69.70 ±2.63	40.27 ±1.35	21.03 ±1.33	143.33 ±1.81	68.43 ±2.14	39.93 ±0.91	18.82 ±0.62

Table-31: Grade wise seasonal variation in the price (Tk/kg) of mud crab in Khulna, Satkhira and Bagerhat district

	F1	F2	F3	F4	XL	L	M	SM
Khulna								
Summer	167.5	87.5	42.1	23.5	154.25	65	38.5	21.15
Monsoon	145	76	42.35	21.75	143.25	69.5	41.45	21.2
Winter	148.25	72.25	41.35	22.5	144.5	67.25	40.1	19.15
Satkhira								
Summer	151	80.25	41.35	22.1	152.5	67.6	38.8	21.45
Monsoon	140.5	74.8	40.45	22.35	138.75	71.5	41.3	17.8
Winter	139	69.85	40.7	20.7	144.25	70.9	40.75	19.2
Bagerhat								
Summer	146.5	73.6	38.7	21.2	146.8	67.6	37.25	19.15
Monsoon	138.5	70.1	39.7	20.95	137	69.85	39.65	18.2
Winter	141.25	67	38.75	19.9	141.25	67.15	38.95	18.1

ANOVA test shows that there was a significant relationship among the production of three seasons in SW region (ANOVA Table:-2).

ANOVA Table-2: ANOVA test for seasonal variation of production of SW region.

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	3E+11	11	2.73E+10	3.971	0.002868	2.258
Columns	3.72E+10	2	1.86E+10	3.712	0.08854	3.443
Error	1.51E+11	22	6.86E+09			
Total	4.88E+11	35				

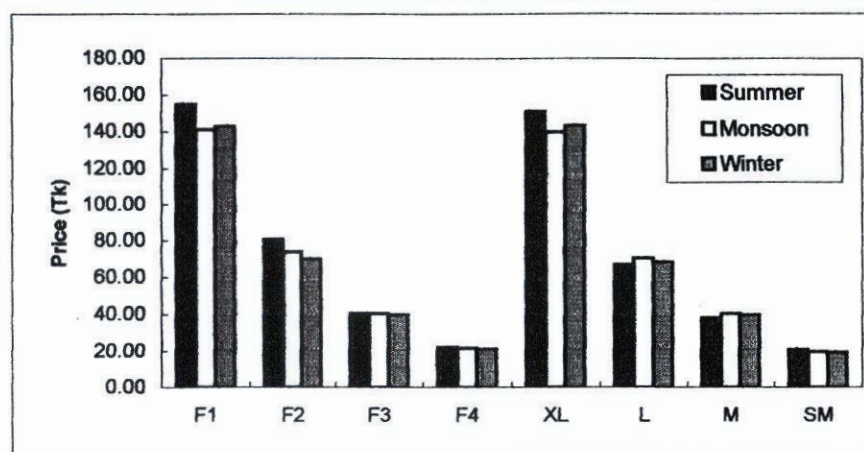


Fig-23: Grade wise seasonal variation in price(Tk/kg) in south-western region

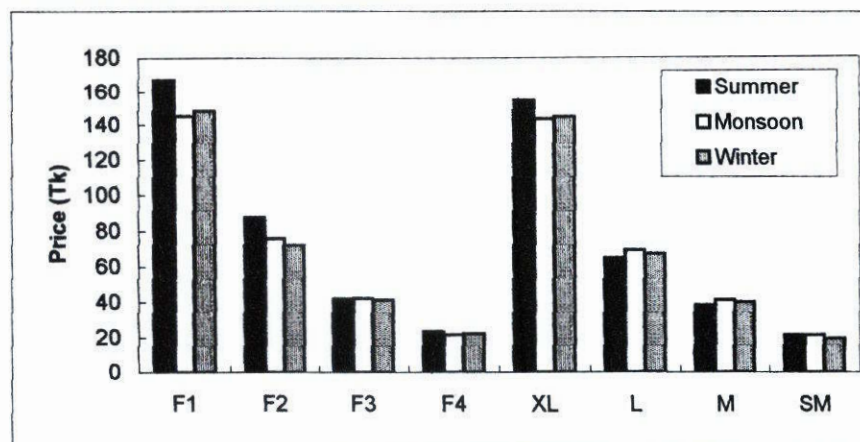


Fig-24: Grade wise seasonal variation in price(Tk/kg) in Khulna district



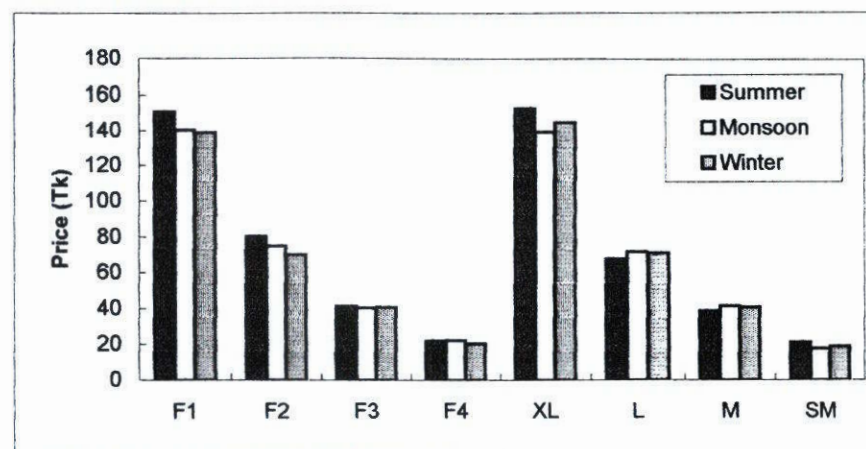


Fig-25: Grade wise seasonal variation in price(Tk/kg) in Satkhira district

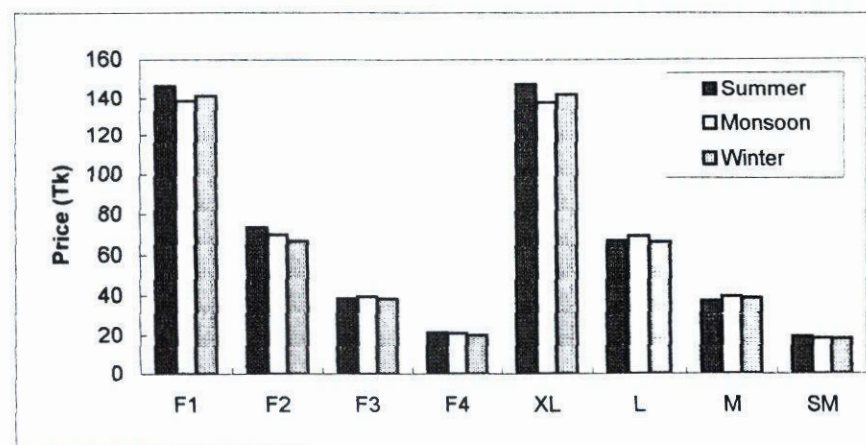


Fig-26: Grade wise seasonal variation in price(Tk/kg) in Bagerhat district

4.1.14 Relationship between the Price and Production of Different Grade Mud Crab

Generally, the price of mud crab was found to be positively related with the production of different grade mud crab. The relationship between price and production of different grade mud crab was statistically significant (table-37, 38,39). However, a negative but significant relationship between price and production of different grade mud crab was found at F1 grade (Female), KS-1 grade (Female) and XL grade (male) in Khulna district (table-37) and F1 grade (Female), KS-1 grade (Female) and XL grade (male) in Satkhira district (table-38). The relationship between the price and production of different grade mud crab in Bagherhat district are strongly positively related (table-39).

Table-32: Relationship between the price and production of different grade mud crabs (*Scylla serrata*) in Khulna district in 2001.

Grade	Regression equation (y on x)	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)	't' crit. Value (1% level)
F1	$y=164.5578-0.03883x$	-0.21787	5.836704*		
KS-1	$y=79.7477-0.01617x$	-0.04038	0.9577**		
F2	$y=41.64521+0.006508x$	0.065595	0.538819**		
F3	$y=22.31633+0.00639x$	0.083875	4.918553*		
XL	$y=150.7982-0.00753x$	-0.14681	9.201038*	2.000997	2.661764
L	$y=65.3806+0.019595x$	0.23242	3.274578*		
M	$y=39.52122+0.009486x$	0.068088	3.654226*		
SM	$y=20.36289+0.002619x$	0.03318	6.320325*		

* = Significant at 1% level at 59 degree of freedom, ** = significant at 5% level at 59 degree of freedom.

Table-33: Relationship between the price and production of different grade mud crabs (*Scylla serrata*) in Satkhira district in 2001.

Grade	Regression equation (Y on X)	Correlation coefficient "r"	Value of 't'	't' crit. Value (5% level)	't' crit. Value (1% level)
F1	$y=144.29-0.00106x$	-0.33464629	5.121626*		
KS-1	$y=75.05-0.00035x$	-0.07457795	3.8809*		
F2	$y=40.833+4.18x$	0.00077119	4.187489*		
F3	$y=21.548+0.00203x$	0.39605214	5.164591*	2.000997	2.661764
XL	$y=146.33-0.00104x$	-0.51585097	5.4814*		
L	$y=69.423+0.00248x$	0.43927851	4.414539*		
M	$y=40.5944-.002457x$	-0.61783864	4.198967*		
SM	$y=19.2054+0.00276x$	0.72336381	4.182726*		

* = Significant at 5% level at 59 degree of freedom.

Table-34: Relationship between the price and production of different grade mud crabs (*Scylla serrata*) in Bagerhat district in 2001.

Grade	Estimated price	Correlation "r"	Calculated "t" value	Critical "t" value
F1	$y=140.0653+0.002615$	0.302408	4.353944*	2.0000997
KS-1	$y=69.83998+0.001364$	0.081983	3.889251*	
F3	$y=38.3284+0.004465$	0.272471	3.860327*	
F4	$y=20.57365+0.000459$	0.078042	4.76604*	
XL	$y=141.5428+0.000165$	0.028656	4.474814*	
L	$y=68.14191+0.000254$	0.019814	3.694549*	
M	$y=38.3284+0.004465$	0.272471	3.517884*	
SM	$y=18.41303+0.000265$	0.04231	5.119198*	

* = Significant at 5% level at 59 degree of freedom.

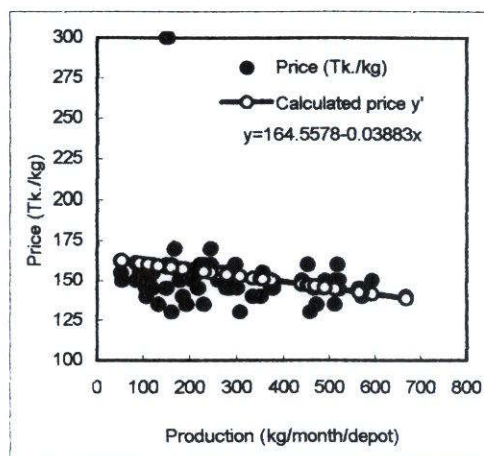


Fig-27a: Regression of y between production and price for F1 female crabs in Khulna district

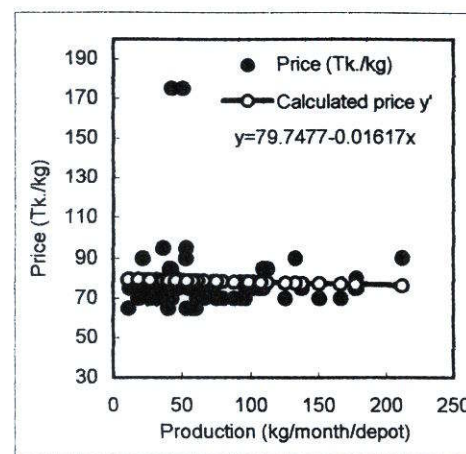


Fig-27b: Regression of y between production and price for KS-1 female crabs in Khulna district

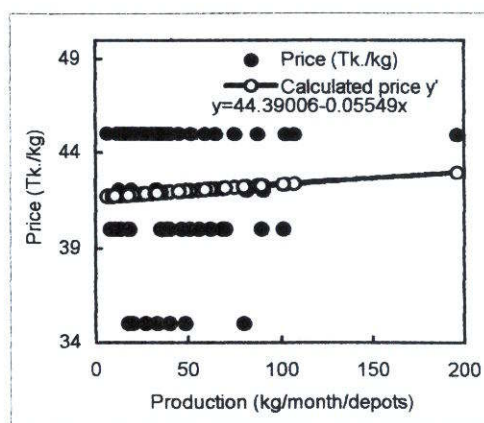


Fig-27c : Regression of y between production and price for F2 female crabs in Khulna district

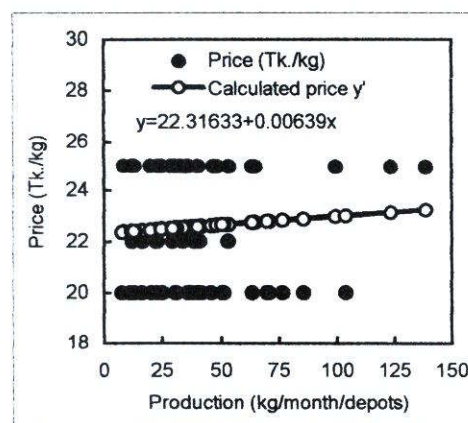


Fig-27d : Regression of y between production and price for F3 female crab in Khulna district

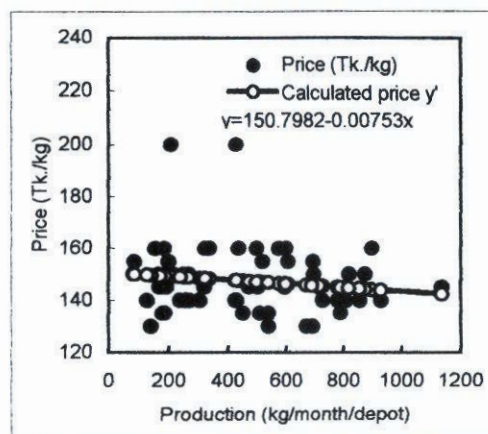


Fig-28a: Regression of y between production and price for XL male crabs in Khulna district

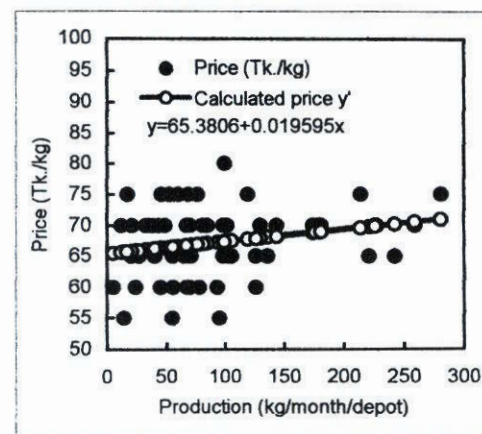


Fig-28b: Regression of y between production and price for L male crabs in Khulna district

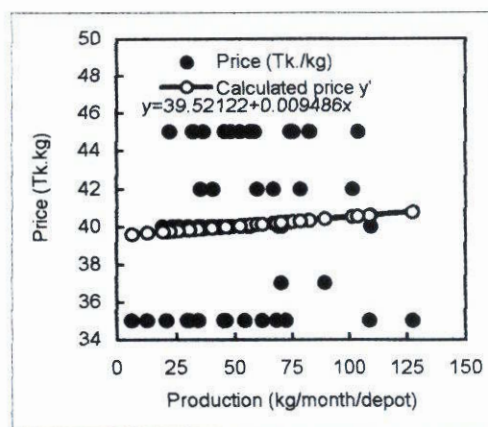


Fig-28c: Regression of y between production and price for M male crabs in Khulna district

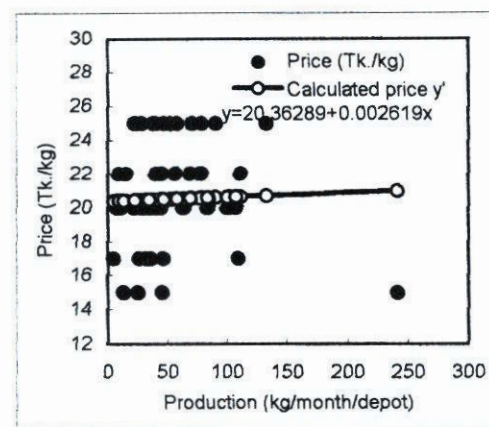


Fig-28d: Regression of y between production and price for SM male crabs in Khulna district

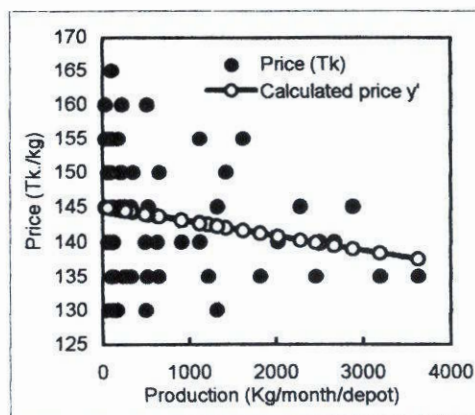


Fig-29a: Regression of y between production and price for F1 crabs in Satkhira District.

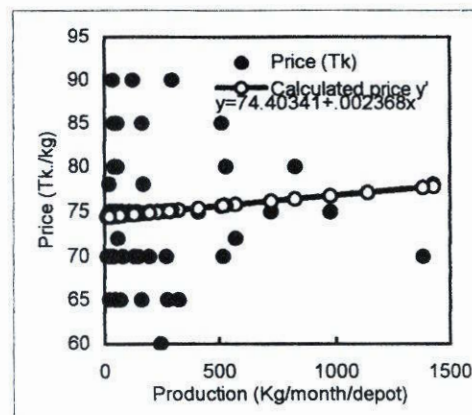


Fig-29b: Regression of y between production and price for KS-1 crabs in Satkhira District.

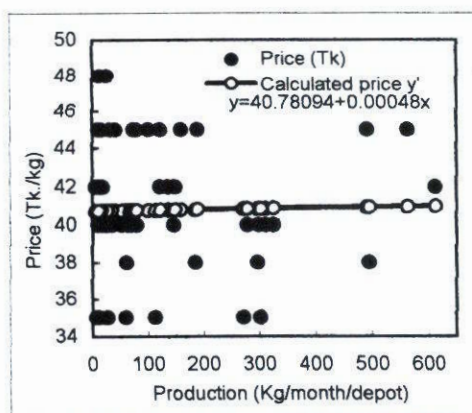


Fig-29c: Regression of y between production and price for F2 crabs in Satkhira District.

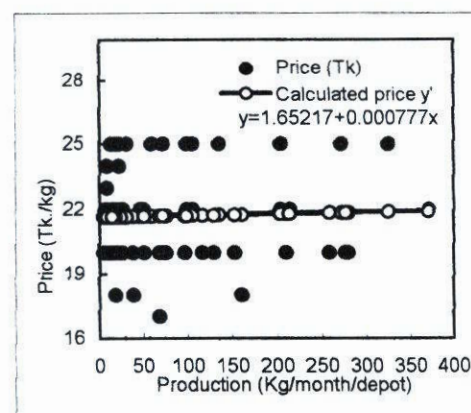


Fig-29d: Regression of y between production and price for F3 crabs in Satkhira District.

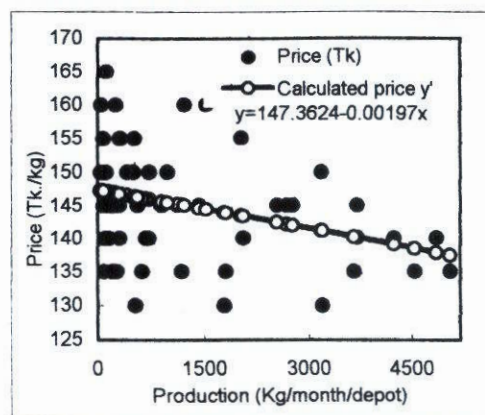


Fig-30a: Regression of y between production and price for XL crabs in Satkhira District.

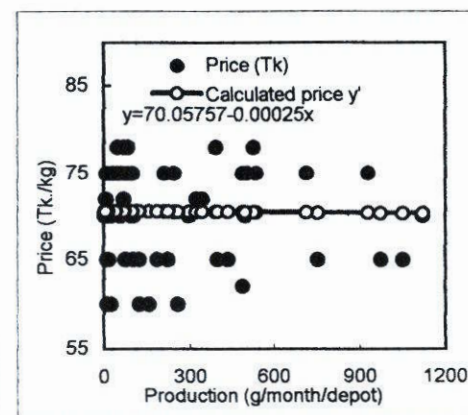


Fig-30b: Regression of y between production and price for L crabs in Satkhira District.

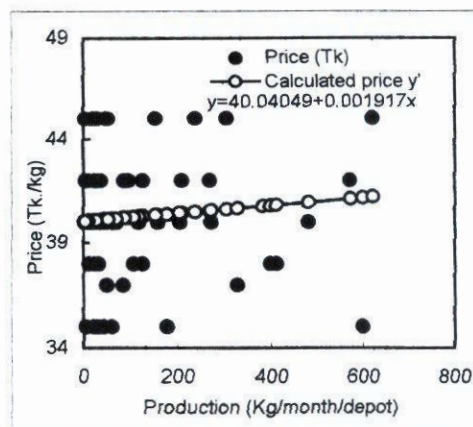


Fig-30c: Regression of y between production and price for M crabs in Satkhira District.

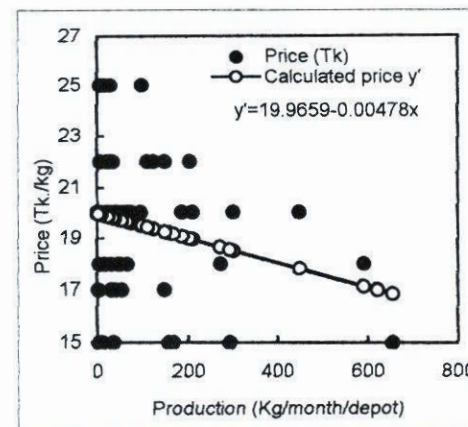


Fig-30d: Regression of y between production and price for SM crabs in Satkhira District.

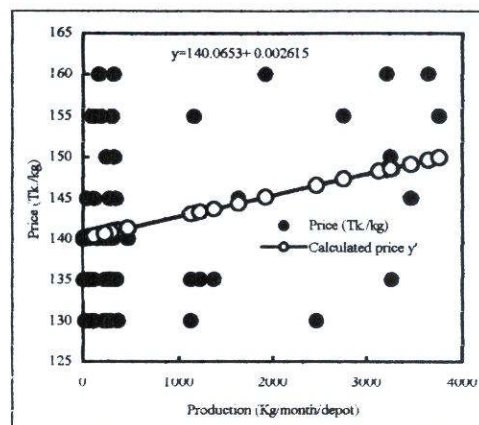


Fig-31a: Regression of y between production and price for F1 crabs in Bagerhat District.

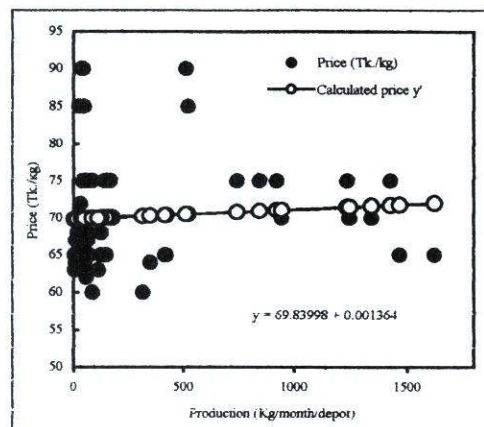


Fig-31b: Regression of y between production and price for KS-1 crabs in Bagerhat District.

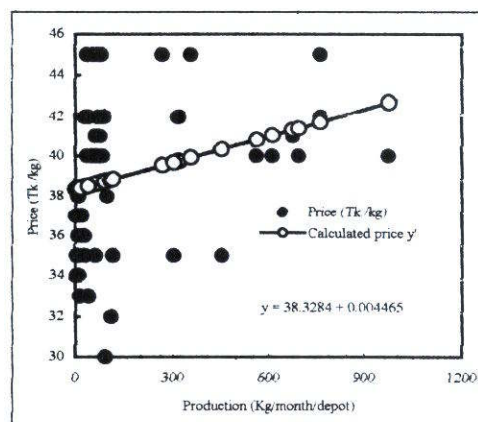


Fig-31c: Regression of y between production and price for F2 crabs in Bagerhat District.

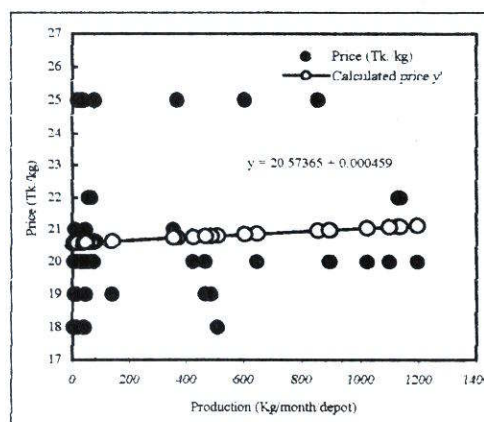


Fig-31d: Regression of y between production and price for F3 crabs in Bagerhat District.

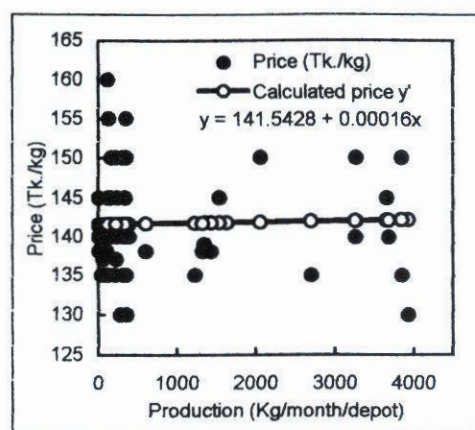


Fig-32a: Regression of y between production and price for XL crabs in Bagerhat District.

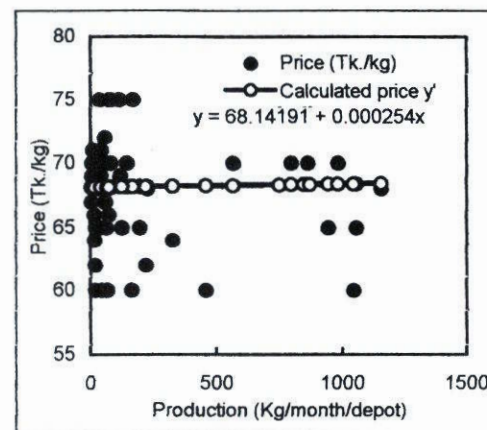


Fig-32b: Regression of y between production and price for L crabs in Bagerhat District.

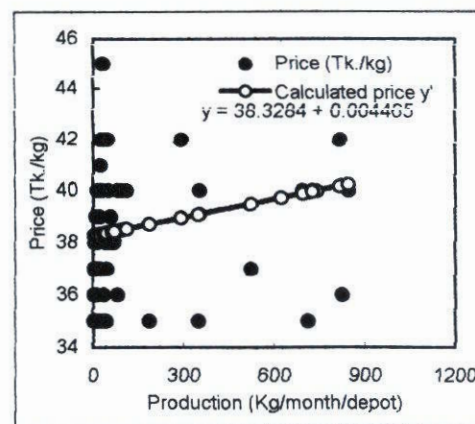


Fig-32c: Regression of y between production and price for M crabs in Bagerhat District.

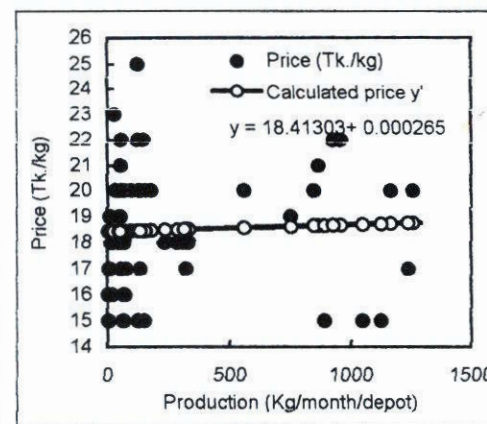


Fig-32d: Regression of y between production and price for SM crabs in Bagerhat District.

4.2 Cost-Benefit analysis: Cost-Benefit is the important issue in mud crab trading. The cost incurred for purchasing having the mud crabs and cost incurred for transporting to the exporters in Dhaka have been considered in the present study.

The detail analysis of cost-benefit scenario of a total of 15 depots in southwestern region is shown in Table-33 through Table-35.

The average initial investment of 5 depots in Khulna district was Tk. 141000 which was loan for farmers. The average net benefits Tk. 290599.3, average cost-benefit ratio 2.064665 and the Return on Investment (ROI) 4.7578 in Khulna district (Table-37).

The average initial investment of 5 depots in Satkhira district was Tk. 53000, which was loan for farmers. The average net benefits Tk. 889719.98, average cost-benefit ratio 2.9640334 and the Return on Investment (ROI) 16.33 in Satkhira district (Table-38).

The average initial investment of 5 depots in Bagerhat district was Tk. 1827200, which was loan for farmers. The average net benefits Tk. 2957073.4, average cost-benefit ratio 7.91113744 and the Return on Investment (ROI) 21.528 in Bagerhat district (Table-39).

Table-35: Profit analysis of five mud crabs depot in Khulna district in 2001.

Name of the Upazilla	Khulna					
	Paikgacha	Koyra	Dumuria	Botiaghata	Dacope	
Name of the depot	Rupa KD	Mohammad Ent	Bishwas Fish	RK Ent	Mahtab KD,	SD
Annual Production (Kg)	21600	13455.82	15020.75	19861.31	9056	14348.47 3861.684
Debt (Tk)	65000	40000	50000	50000	500000	179677.5
Depot size(Sq.ft)	64	96	96	100	320	135.2 93.30895
Man power (Person)	2	2	2	2	2	2 0
Sales (Tk)	2563384	2012580	2260534	3024304	1231275	2218415 597837.5
Cost of goods sold (Tk)	2234966	1601558	1768092	2366970	972275	1788772 497100.8
Gross benefit(Tk)	328417.8	411022.6	492442	657334	259000	429643.3 138202.2
Commercial expenses:						
Depot rent (Opportunity cost) (Tk)	4800	4800	4800	4800	4800	4800 0
Salaries(Tk)	48000	48000	48000	48000	48000	48000 0
Packaging(Tk)	17960	11773.84	13143.16	17378.65	7924	13635.93 3715.962
Utilities and services expenses(Tk)	1440	2400	2400	2400	2400	2208 384
Transportation(Tk)	76972.88	50459.33	56327.81	74479.91	33960	58439.99 15925.89
Miscellaneous(Tk)	12000	12000	12000	12000	12000	12000 0
Total cost(Tk)	161172.9	129433.2	136671	159058.6	109084	139083.9 21713.27
Net Benefit(Tk)	167244.9	281589.4	355771	498275.4	149916	290559.3 143584.5
Cost-Benefit ratio	1.037674	2.175558	2.603121	3.132654	1.374317	2.064665 0.862282
Return on investment (ROI)	2.57	7.03	7.11	6.78	0.299	4.7578 3.140557

Table-36: Profit analysis of five mud crabs depot in Satkhira district in 2001.

Satkhira							
Name of the Upazilla	Ashashuni	Shamnagar	Kaligang	Devhata	Tala		
	Vai vai		Sonamoni	Gopal	Kapatakkho,		
Name of the depot	KD	Toma KD	KD	Ent.	F	Average	SD
Annual Production (Kg)	6856	38551	68748	56212	7998	35673	27930.33
Debt (Tk)	30000	40000	50000	120000	25000	53000	38665.23
Depot size(Sq.ft)	80	112	300	324	300	223.2	117.0778
Man power (Person)	1	3	3	4	2	2.6	1.140175
Sales (Tk)	974990	5654174	10207168	8259829	1129198	5245071.8	4154893
Cost of goods sold (Tk)	766173	4433256	7998431	6455601	884121	4107516.4	3252448
Gross benefit(Tk)	208817	1220918	2208737	1804228	245077	1137555.4	902483.3
Commercial expenses:							
Depot rent (Opportunity cost) (Tk)	4800	4800	8400	4800	4800	5520	1609.969
Salaries(Tk)	24000	72000	72000	96000	48000	62400	27364.21
Packaging(Tk)	5999	33732.13	60154.5	49185.5	6998.25	31213.876	24439.04
Utilities and services expenses(Tk)	1440	2400	6000	2400	2400	2928	1766.896
Transportation(Tk)	25710	144566.3	257805	210795	29992.5	133773.76	104738.8
Miscellaneous(Tk)	12000	12000	12000	12000	12000	12000	0
Total cost(Tk)	73949	269498.4	416359.5	375180.5	104190.8	247835.64	154884.4
Net Benefit(Tk)	134868	951419.6	1792378	1429048	140886.3	889719.98	748335.9
Cost-Benefit ratio	1.823797	3.530335	4.30488	3.80896	1.352195	2.9640334	1.297173
Return on investment (ROI)	4.49	23.78	35.84	11.91	5.63	16.33	13.32624

Table-37: Profit analysis of five mud crabs depot in Bagerhat district.

Name of the Upazilla	Bagerhat						
	Sadar	Mongla	Sharankhola	Rampal	Morelgang	Monohar	SD
Name of the depot	Pratulla Ent	Nayon Ent	Farid ent	Goutom Ent.	Ent	Average	SD
Annual Production (Kg)	13985	8846	22904	128190	1625	35110	52607.46
Debt (Tk)	40000	40000	50000	9000000	6000	1827200	4009752
Depot size(Sq.ft)	750	99	160	50	15	214.8	304.1097
Man power (Person)	5	2	3	2	1	2.6	1.516575
Sales (Tk)	2535963	1833450	4198331	24657871	297784	6704679.8	10133537
Cost of goods sold (Tk)	1321865	944932	2155468	12919070	153978	3499062.6	5314959
Gross benefit(Tk)	1214098	888518	2042863	11738801	143806	3205617.2	4818636
Commercial expenses:							
Depot rent (Opportunity cost) (Tk)	12000	4800	4800	4800	4800	6240	3219.938
Salaries(Tk)	120000	48000	72000	48000	24000	62400	36397.8
Packaging(Tk)	12236.88	7740.25	20041	112166.3	1421.875	30721.261	46031.55
Utilities and services expenses(Tk)	6000	2400	2400	2400	2400	3120	1609.969
Transportation(Tk)	52443.75	33172.5	85890	480712.5	6093.75	131662.5	197278
Miscellaneous(Tk)	24000	12000	12000	12000	12000	14400	5366.563
Total cost(Tk)	226680.6	108112.8	197131	660078.8	50715.63	248543.77	240488.7
Net Benefit(Tk)	987417.4	780405.3	1845732	11078722	93090.38	2957073.4	4583014
Cost-Benefit ratio	4.355985	7.218439	9.362972	16.78394	1.835536	7.9113744	5.719841
Return on investment (ROI)	24.68	19.51	36.91	11.23	15.31	21.528	9.941399



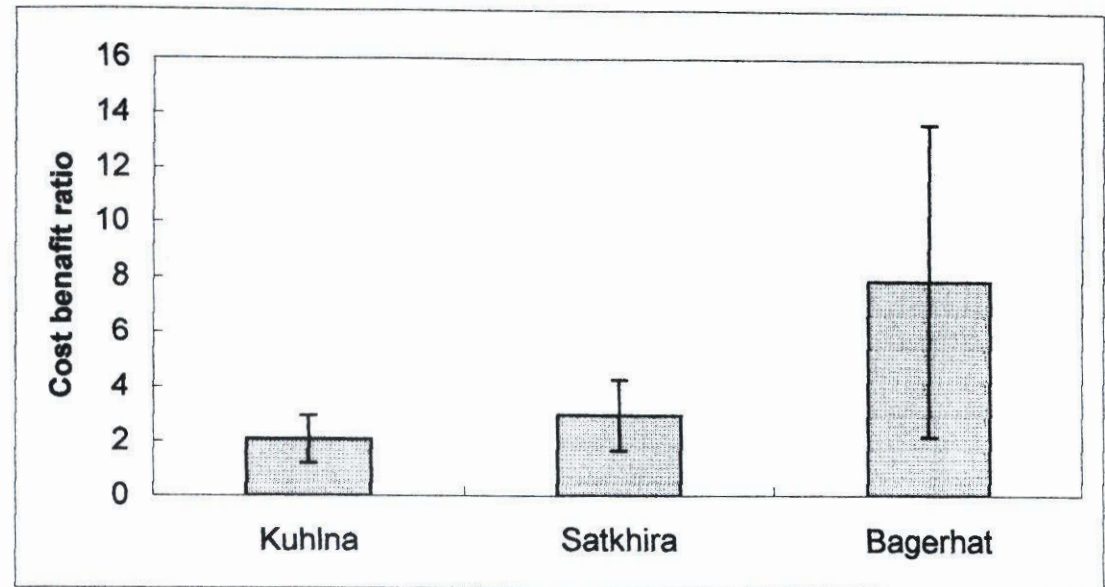


Fig-33a: Cost-benefit ratio of mud crab depots in SW region in 2001

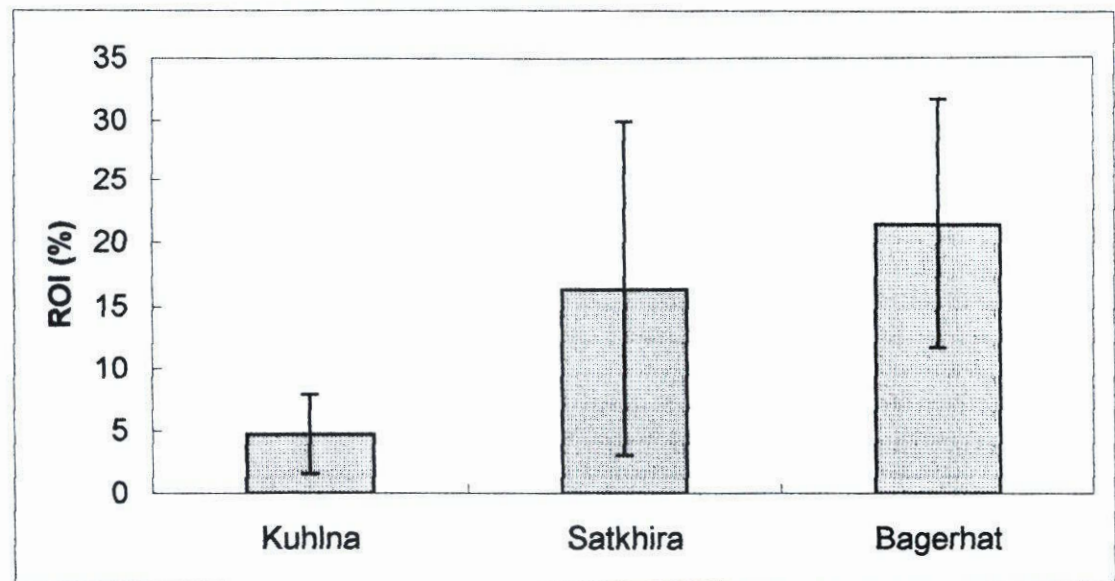


Fig- 33b: Return on investment of mud crab depots in SW region in 2001

4.3 Relationship between Debt and Production

The production of mud crab was found to be strongly positively related with the debt in all the three districts studied. The relationship between debt and production of mud crab was statistically significant (table-38). However, a negative but significant relationship between debt and production of mud crab was found to be Batiaghata in Khulna district (table-39), Kaliganj and Tala in Satkhira district (table-40) and Morelganj and Shronkhola in Bagherhat district (table-41).

Table-38: Relationship between debt and production of mud crab (*Scylla serrata*) in South-western region.

District	Regression equation (y on x)	Correlation coefficient "r"	df	Value of 't'	't' crit. Value (5% level)	't' crit. Value (1% level)
Khulna	$y = 2878.6583 + 0.2825312x$	0.839555	121	6.169133*	1.979765	2.617071
Satkhira	$y = 1909.32 + 0.3134x$	0.603535	75	6.83997*	1.992103	2.642992
Bagerhat	$y = 17834.18 + 0.042041x$	0.738845	93	1.855396**	1.9858	2.629731

* = Significant at 1% level, ** = significant at 5% level

Table-39: Relationship between debt and production of mud crab (*Scylla serrata*) in Khulna District in 2001.

Upazilla	Regression equation (y on x)	Correlation coefficient "r"	df	Value of 't'	't' crit. Value (5% level)	't' crit. Value (1% level)
Paikgacha	$y = 2478.82497 + 0.33729584x$	0.932324	82	4.88942*	1.98932	2.6391
Koyra	$y = -9836 + 0.73425x$	0.89771	9	13.4427*	2.262	3.250
Dumuria	$y = -4272.35 + 0.257734x$	0.771936	13	8.801697*	2.160	3.012
Batiaghata	$y = -4700.885 + 0.42725664x$	0.737429	4	7.272646*	2.776	4.604
Dacope	$y = 15062.058 - 0.0007528x$	-0.01151	10	2.098691**	2.262	3.250

* = Significant at 1% level, ** = significant at 5% level

Table-40: Relationship between debt and production of mud crab (*Scylla serrata*) in Satkhira District in 2001.

Upazilla	Regression equation (Y on X)	Correlation coefficient "r"	df	Value of "t"	't' crit. Value (5% level)	't' crit. Value (1% level)
Ashashuni	$Y = -1671 + 0.315773x$	0.987226	10	4.731980162*	2.22813923	3.169262
Shamnagar	$Y = 448.3068 + 0.301177x$	0.994572	19	6.480993064*	2.09302470	2.860943
Kaligong	$Y = -14056.3 + 0.789684x$	0.459019	19	2.0488305***	2.09302470	2.860943
Debhata	$Y = 113.5089 + 0.274644x$	0.998359	20	3.454282861*	2.08596247	2.845336
Tala	$Y = 5255 + 0.161x$	0.808902	3	8.05117435*	3.18244929	5.840848

* = Significant at 5% level, ** = Significant at 1% level, *** = significant at 5% level

Table-41: Relationship between debt and production of mud crab (*Scylla serrata*) in Bagerhat District in 2001

Upazilla	Regression equation (Y on X)	Correlation coefficient "r"	df	't' value	Degree of freedom	Critical value
Bagerhat sadar	$y=780.9045+0.221918x$	0.942561	15	5.771358	15	2.131451
Rampal	$y=39508.38+0.038761x$	0.724168	36	1.818543	36	2.028091
Mongla	$y=3207.354+0.096454x$	0.499366	17	2.730921	17	2.109819
Morelganj	$y=15.71429+0.278571x$	0.990218	4	4.747857	4	2.776451
Shoronkhola	$y=-1399+0.382053x$	0.979293	17	6.616456	17	2.109819

*= Significant at 5% level, ** = Significant at 1% level, ***= significant at 5% level

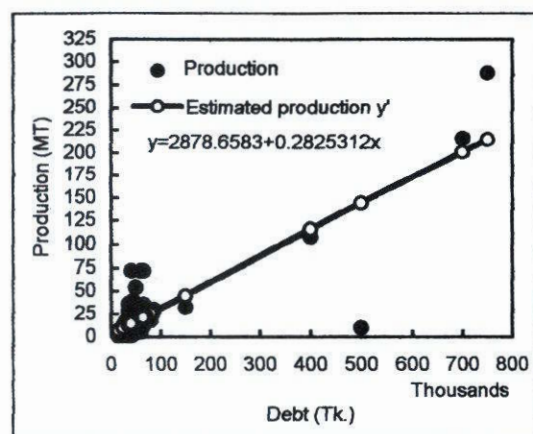


Fig-34a: Regression of y between debt and production of mud crab (*scylla serrata*) at Khulna district.

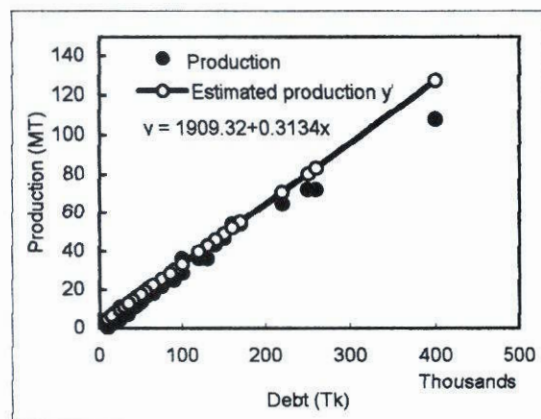


Fig-34b: Regression of y between debt and production of mud crab (*scylla serrata*) at Satkhira district.

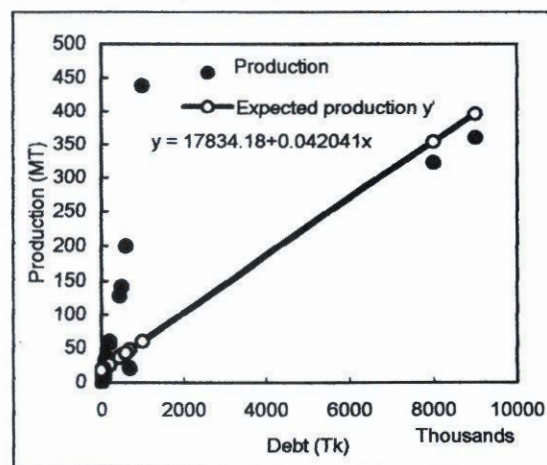


Fig-34c: Regression of y between Manpower and production of mud crab (*scylla serrata*) at Bagerhat district.

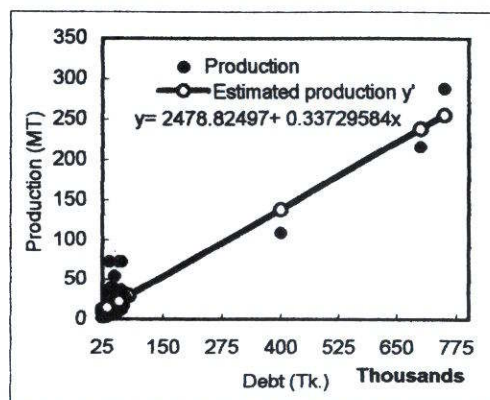


Fig-35a: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Paikgacha Upazilla in 2001.

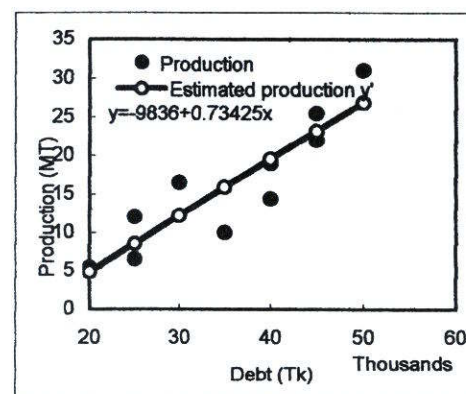


Fig-35b: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Koyra Upazilla in 2001.

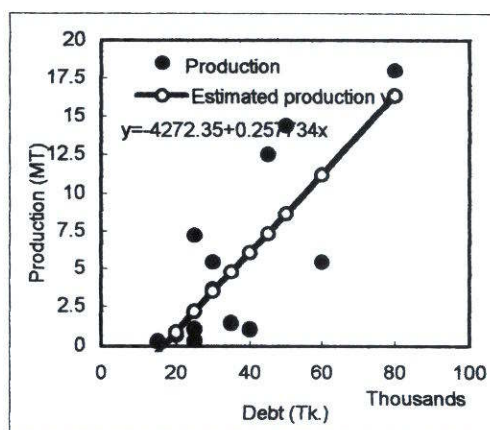


Fig-35c: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Dumuria Upazilla in 2001.

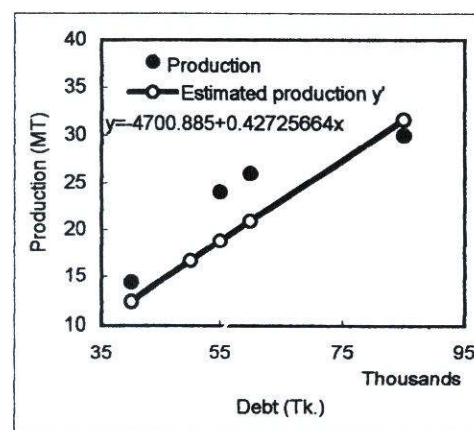


Fig-35d: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Batiaghata Upazilla in 2001.

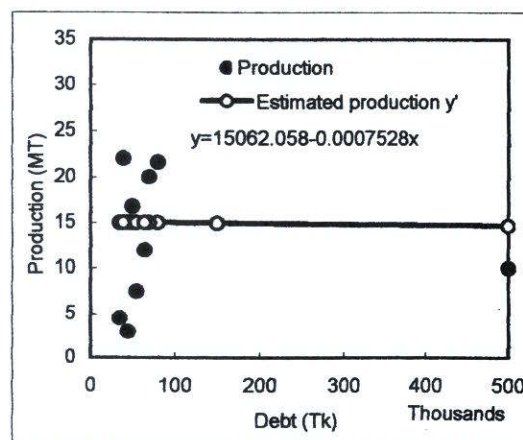


Fig-35e: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Dacope Upazilla in 2001.

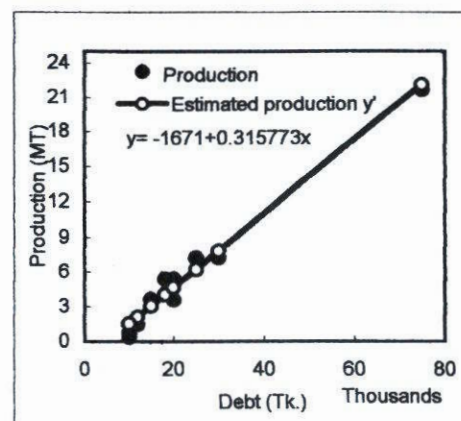


Fig-36a: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Ashashuni upazilla in 2001

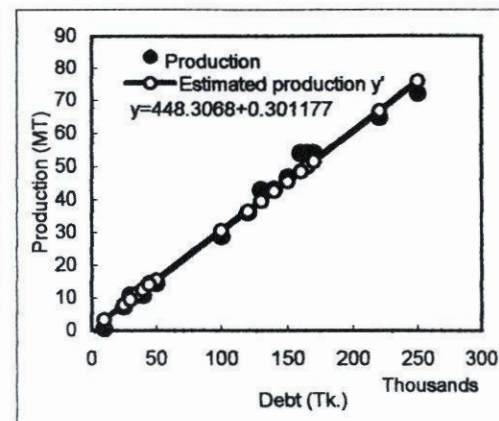


Fig-36b: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Shamnagar upazilla in 2001

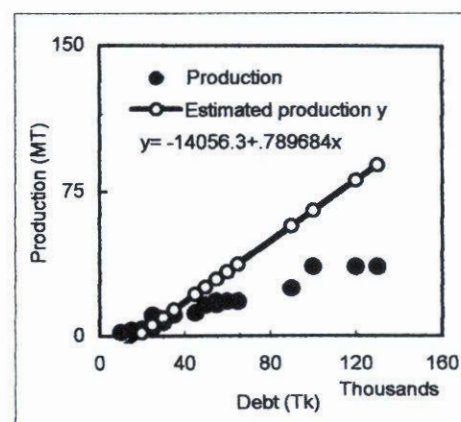


Fig-36c: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Kaligang upazilla in 2001

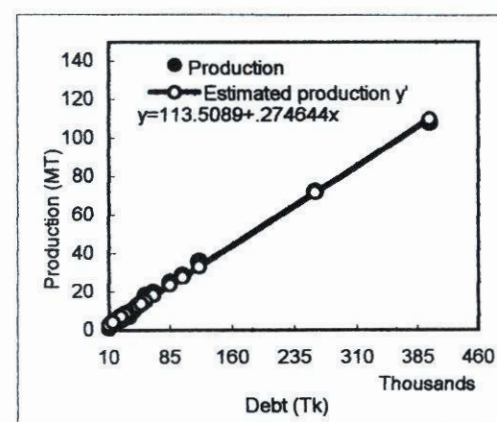


Fig-36d: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Devhata upazilla in 2001

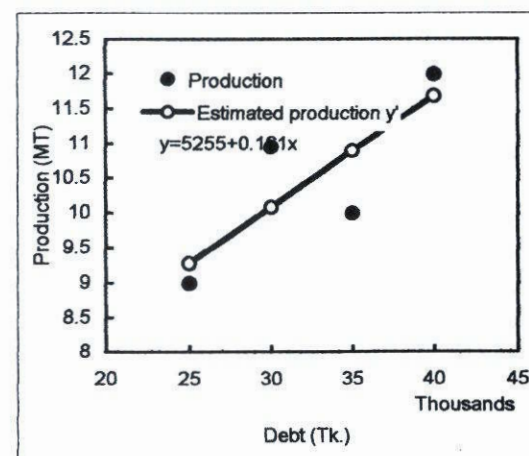


Fig-36e: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Tala upazilla in 2001

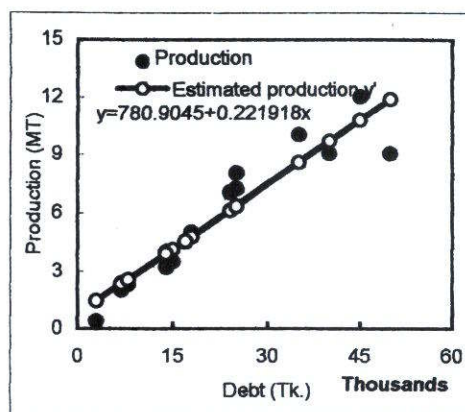


Fig-37a: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Bagerhat sadar upazilla in 2001.

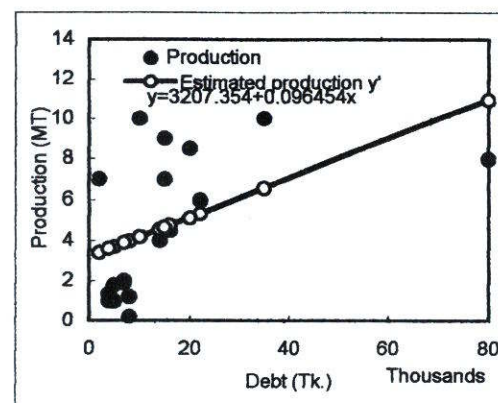


Fig-37b: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Mongla upazilla in 2001.

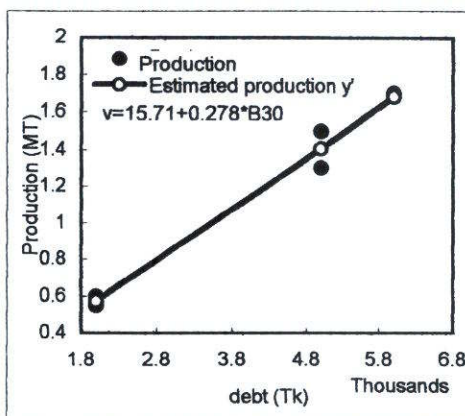


Fig-37c: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Morelgang upazilla in 2001.

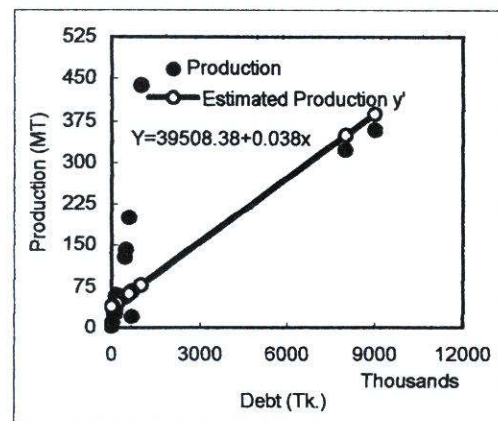


Fig-37d: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Rampal upazilla in 2001.

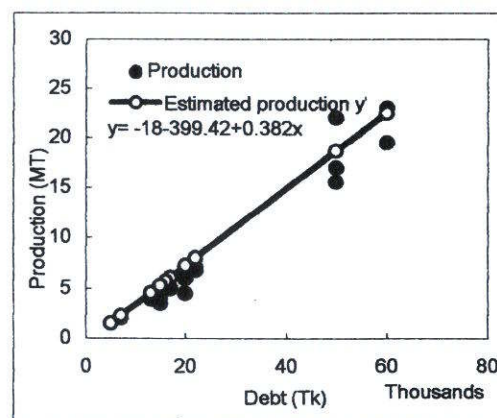


Fig-37e: Regression of y between Debt (Tk) and production of mud crab (*Scylla serrata*) at Sarankhola upazilla in 2001.

4.4 Marketing Channel in Mud Crab Trading

The marketing channel of the mud crab business in SW region was found to be consisted with the harvesters, forias (middlemen), depot owner's suppliers, agents and exporters. The trading pattern of mud crab business involves a series of intermediaries between the harvesters, suppliers, exporters and the consumers

The present marketing channel for the mud crab, in general was found to be similar at all Upazillas in Khulna, Satkhira and Bagherhat districts. The fishers harvest crabs from the various wild sources and sold to the small depots or brokers or directly to the suppliers. The marketable crabs from the small depot owner are sold to the suppliers or agent of the exporters. The exporter purchase mud crab directly from the supplier located at the Upazilla level. . Sometimes, the exporters directly purchase crabs in cash from the local depots by employing agents. A big chunk of the profit goes to middleman or brokers. Broker act as a middleman between the catchers and the suppliers/depot owners. The rejected crabs mainly under grade and broken claws or legs are transferred to the local domestic market at lower price. The soft-shell and lean (egg less) crabs are sold to the local fattener for fattening. Sometimes, the depot owners fatten the rejected crabs by their own capacity.

However; different marketing channel was observed in Paikgacha and Dacope of Khulna district, Ashashuni of Satkhira district and Shoronkhola, Morelganj and Mongla of Bagerhat district. In Paikgacha Upazilla, the exporters sometimes directly collect crabs from the catcher by employing agents. Exceptionally the harvested from Dacope Upazilla, crabs were transported to the suppliers at Vaga of Rampal Upazilla in Bagerhat District to get higher price.

The harvested crabs in and from some other areas of Ashashuni upazilla of Satkhira district were directed to Parulia of Debhata Upazilla. The exporters collects crabs directly from the catcher through their own agents at Debhata, Kaliganj and Shamnagar Upazillas of Satkhira district.

The local depots at Shoronkhola, Morelganj and Mongla Upazilla purchase crabs from the catchers and sold to the suppliers at Bagherhat Sadar upazilla of Bagherhat district.

In the whole South-Western region, three major types of marketing channels were observed as follows:

Marketing Channel-1: The exporters directly collect crab from the catcher by their employed agent. This type of marketing channel was found in Paikgacha Upazilla of Khulna district, in Debhata, Shamnagar and Kaligong Upazilla of Satkhira district (Fig.-38a)

Marketing Channel-2: The fishers harvest crabs from the various wild sources and sold to the small depots or brokers or directly to the suppliers. After grading and rejecting crabs from the small depot owner are sold to the suppliers. The exporters purchase mud crab directly from the supplier located at Upazilla level (Fig.-38b). This type of marketing channel was found at all Upazillas in Khulna, Satkhira and Bagherhat districts.

Marketing Channel-3: Some small depot owners sold their crabs to the large depots owner of other locality for eg. Chalna of Dacope of Khulna to Vaga of rampal Upazilla of Bagherhat district. This type of marketing channel was found in Dacope in Khulna district, at Ashashuni, Shamnagar and Kaligong in Satkhira district. At Morelganj, Shoronkhola and Mongla Upazilla of Bagherhat District (Fig.-38c)

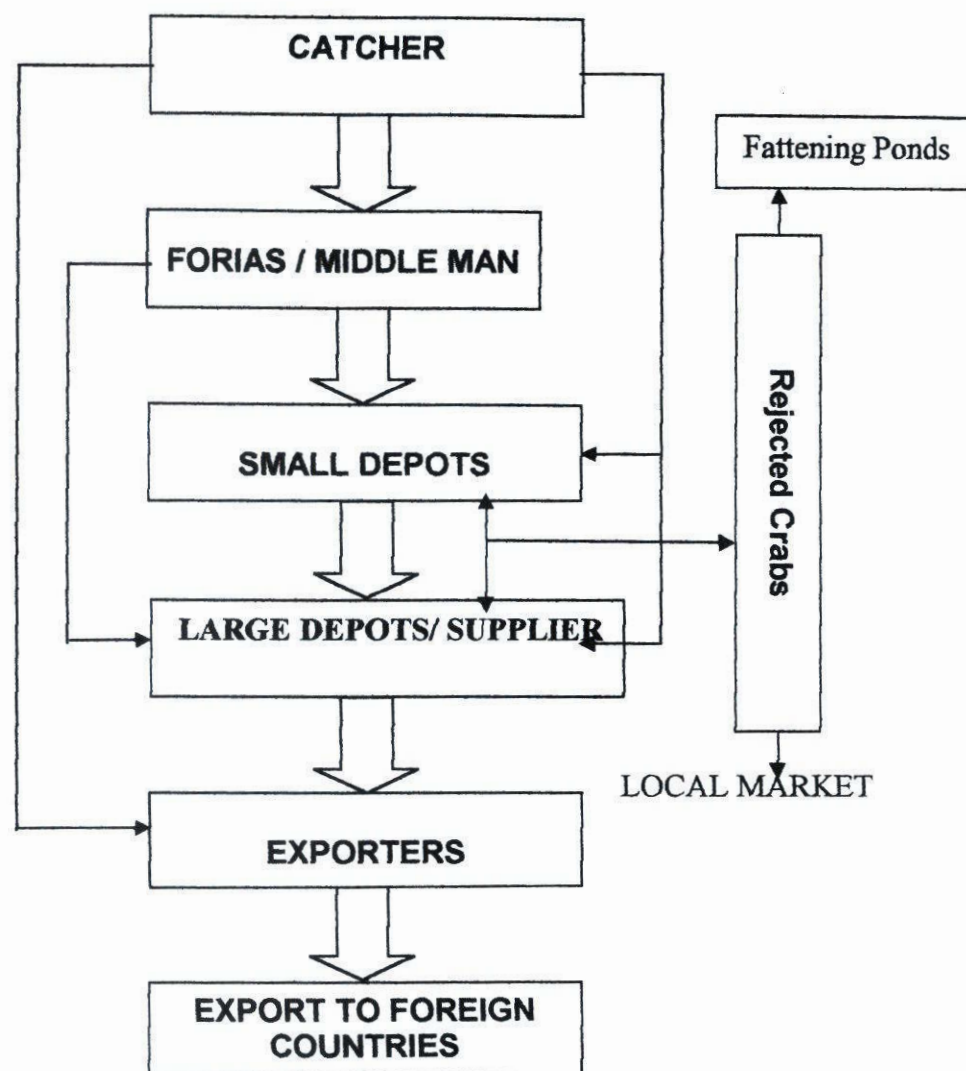


Fig.38a: Marketing Channel-1 of the South-Western region in, 2001

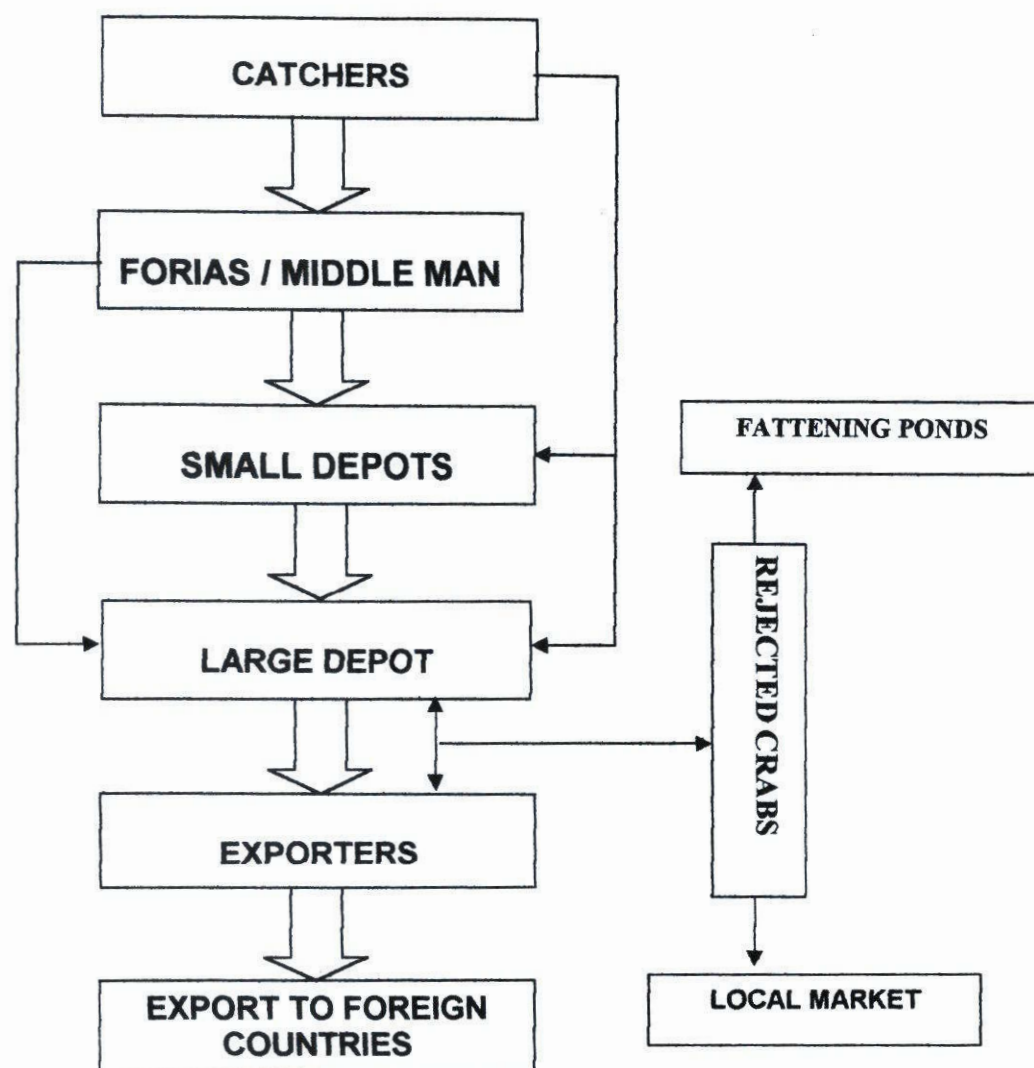


Fig. 38b: Marketing Channel - 2 of the South-Western region in, 2001

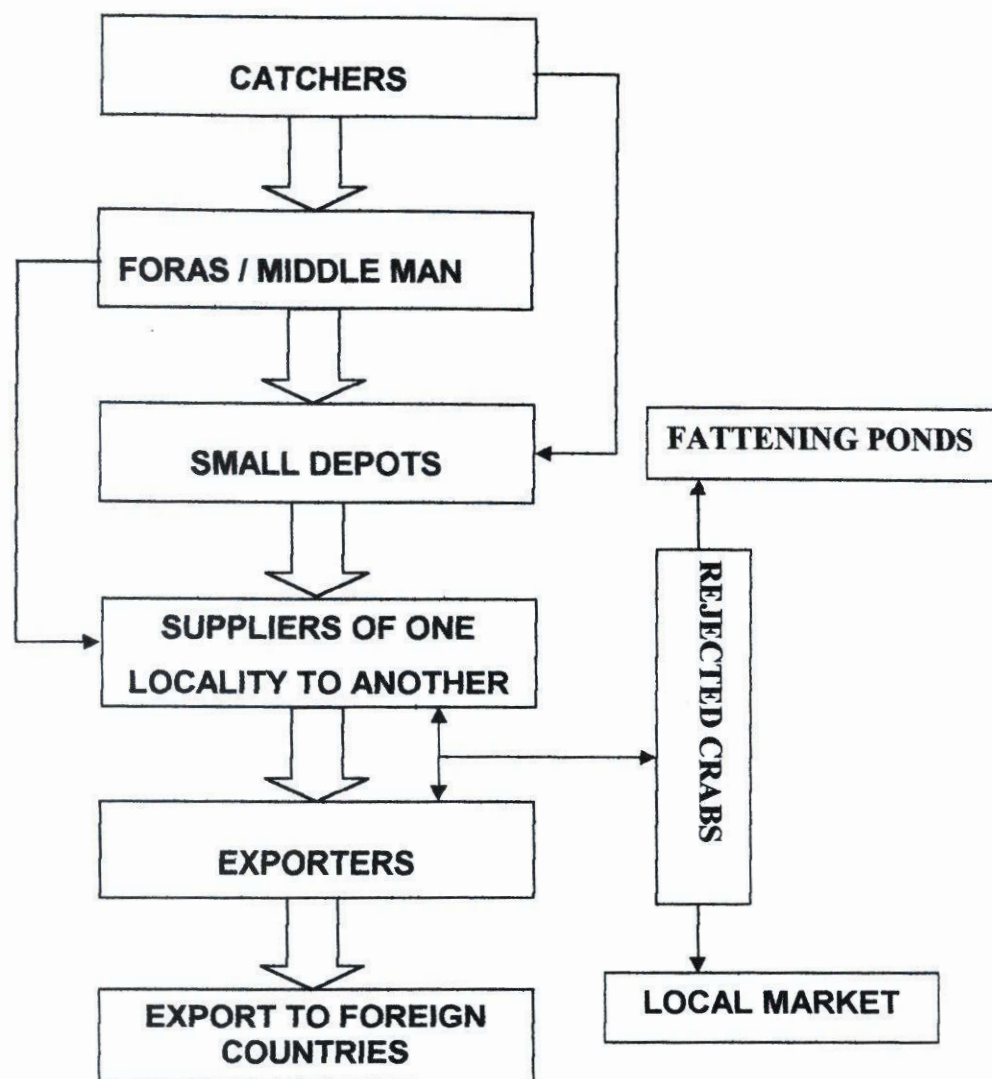


Fig. 38c: Marketing Channel -3 of the South-Western region in, 2001

4.5 Mud Crab Transportation

Harvested mud crabs from various wild sources (Sunnndarban mangrove swamps, Tidal rivers and canals) and shrimps gher are transported to Dhaka by various means. Depending on the sources of harvest, harvested crabs were reached Dhaka within 7 hours to 7 days.

4.5.1 Transport to local Depots: Harvested mud crabs were transported to the depots from tidal rivers and mangrove swamps by small wooden boats and sometimes by mechanized trawlers. From *ghers*, the mud crabs were carried in bamboo baskets, plastic pots and transported to the local depots by bi-cycle or Van. Crabs from shrimps gher usually took 3-4 hours to reach at local depots by the forias and middle men. There fore, the overall condition of crabs from shrimp gher were found more stable and fetched higher prices than the crabs harvested from the Sundarban mangrove swamps. Fishers with small non- traditional boats at usually stay 6-9 days in each fishing trip. Therefore , the crabs caught in the first days reached at depots after 9 days. Fishers kept the harvested crabs in the hole of the boat and sprayed river or canal water of the crabs to keep them moist.

4.5.2 Transport to Dhaka: Among 15 Upazilla of the South-Western region mud- crabs are transported to Dhaka from Kaligong, Dumuria, Debhata, Parulia, Rampal and Bagherhat Sadar Upazillas. Bamboo baskets of different sizes are used to transport mud crabs from local depots to Dhaka. The baskets are long-necked in shape and covered with sackcloth or gunny bags. A layer of wet betel-nut leaf is placed at the bottom of the basket to keep low temperature and to prevent dehydration. Crabs of different grades (such as XL, L, M, SM and F1, KS-1, F2, F3) are placed together in the same baskets. Each basket contains about 70-90 kg crabs. Baskets full of crabs are transported to Dhaka by bus, and mini-truck (Pick up) etc. at night hours depending on the quantity and availability of suitable vehicles. When the ambient temperature is lower. The time required to reach Dhaka varies from place to place and is shown in Table 42.

Table-42: Timing and mode of transportation for mud crab from different areas of the SW region to Dhaka in 2001.

<i>Locality</i>	<i>Mode of Transportation</i>	<i>Time required (hours)</i>
1. Paikgacha, Khulna	Bus, Pick-up	7-9
2. Dumuria, Khulna	Bus, Pick-up	6-8
3. Parulia, Debhata, Satkhira	Bus, Pick-up	9-11
4. Kaligonj, Satkhira	Bus, Pick-up	10-12
5. Vaga, Rampal, Bagerhat	Bus, Pick-up	8-10
6. Bagerhat Sadar, Bagerhat	Bus, Pick-up	9-11

4.5.3 International transportation: Immediately after reached in Dhaka at early morning hours, crabs are again graded following international grades and packed in small bamboo baskets. Each basket contains 15 kg of crabs. The baskets are stacked one over another. Bamboo baskets are used to airfreight the crabs from Zia International Airport.

4.6 Export of Mud Crab: The domestic market of mud crabs has not yet developed in the south-western region of Bangladesh because of high price and religious prohibition among the Muslims. All the harvested crabs are to the foreign countries through airfreight. Major export markets of mud crabs are Singapore, Hong Kong, Malaysia, Thailand and Taiwan. Besides this the crabs are also exported to UK, Japan, Germany, Belgium, China, France, Korea, South-Africa, Netherlands, Saudi Arabia, India, Austria, Qatar, Kuwait, Mexico, UAE, Uganda, Oman, Bahrain, Honduras, Malawi. Bangladesh earned US\$30.39 million by exporting mud crab since 1991-91 to 1999-2000 (BEPB 2001).

The highest percentage of mud crab exported in Taiwan from 1990-91 to 1999-2000 fiscal year. Whereas Singapore 28%, Hong Kong 16%, Malaysia 10%, Thailand 9%, USA 4% and the other countries 4%. In 1995-96 fiscal years Bangladesh earned US\$ 5792 thousand. Which was the highest from 1990-91 to 1999-2000 fiscal year (BEPB, 2001). The growth of mud crab export was high during 1990-91 to 1995-96 then the mud crab export has declined from 1996-97 to 1999-2000. The reason for the declining of mud crabs could be attributed to a severe fall of the wild stock in the coastal region of Bangladesh as a result of over fishing.

Table-43: Export earning from Mud crab between 1977-78 to 1999-2000 (value in '000' US\$)

Fiscal year	Amount (thousand US\$)
1977-78	2
1978-79	1
1979-80	24
1980-81	+
1981-82	+
1982-83	24.2
1983-84	35
1984-85	38
1985-86	62
1986-87	213
1987-88	318
1988-89	134
1989-90	31
1990-91	768
1991-92	1462
1992-93	3780
1993-94	4704
1994-95	5397
1995-96	5792
1996-97	5535
1997-98	1568
1998-99	1101
1999-2000	283

Source: Acharaya and Kamal, 1994

Source: Export Promotion Bureau, 2002

+=Data not available

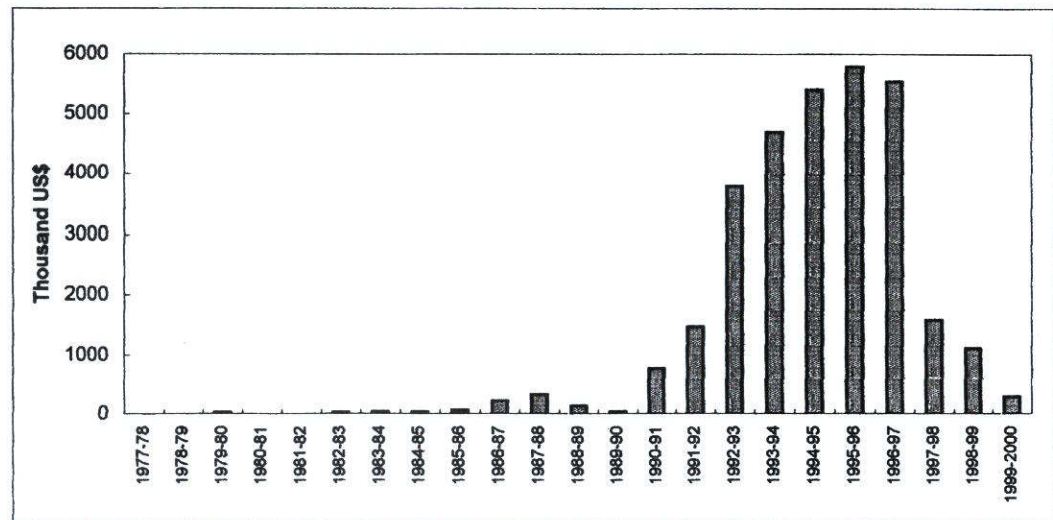


Figure-39a: Mud crab export from Bangladesh during fiscal year 1977-78 to 1999-2000 (value in '000' US\$)

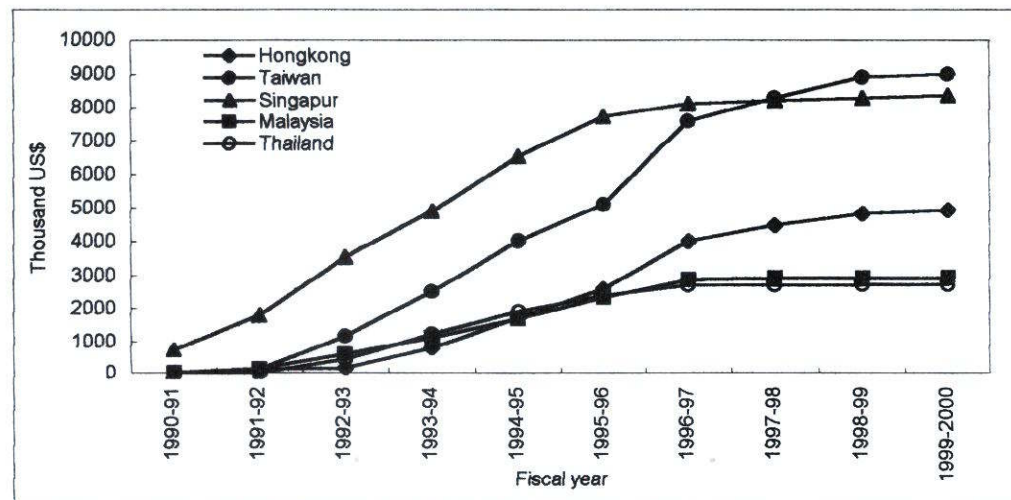


Figure-39b: Mud crab export from Bangladesh to five major country during fiscal year 1990-91 to 1999-2000 (value in '000' US\$)

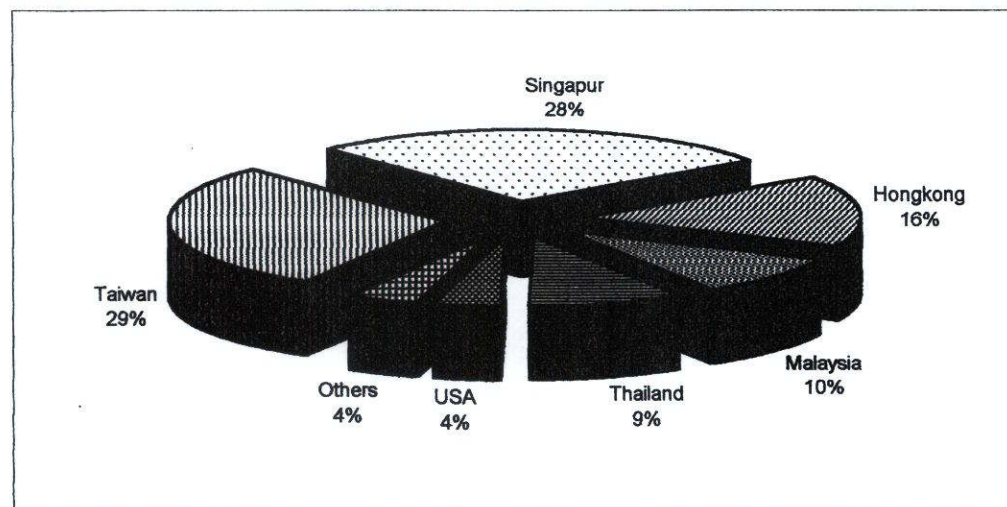


Figure-39c: Percentage of mud crab export from Bangladesh to different country during fiscal year 1990-91 to 1999-2000.

4.7 Mortality of Mud Crab from Catcher to Exporter

A considerable portion of the harvested crabs from various sources are damaged from catching point to export points for following reason:

- Physical and temperature stress causes broken legs and shells and mortality respectively.
- Lean and soft-shell crabs are more vulnerable than the fatty and hard-shell crabs. High percentage of these type crabs of died during handling and transportation.

A. Rejection of Mud Crabs at depots: About 10-15% of the harvested crabs are found to be poor in quality and hence rejected at local depots as follows:

Table-44: Causes for rejecting

Causes	Male	Female
Soft shell	Reject	No effect
Absent of hepatopancreas	No effect	Rejected
Poor meat	Rejected	No effect
Broken chela	1 chela Rejected	2 broken chela rejected
Swimming Leg	2 broken rejected	2 broken rejected
Broken Shell	Rejected	Rejected



B. Mortality: About 10% of harvested crabs died at depots due to temperature shock during summer and winter season. Even during monsoon crabs may die if receive rain water. Mortality varied from season to season. In addition, sources of crab are another variable for high mortality. Crabs from the Sundarbans showed higher mortality than the crabs from tidal rivers and shrimp ghers. Crabs with excess hepatopancreas died quickly.

4.7.1 Seasonal Variation in Mortality: Mortality of Mud Crabs at different level of marketing and transportation seems to be a very important issue. Generally mortality in Mud Crabs occurs due to soft shell, low fat content and physical and temperature stress. However mortality mainly varies with season.

The mortality rate is highest in summer season and lowest in winter season. In winter season during transportation from harvesting area to depot, the mortality rate is 7.3, 7, and 8.6 in Khulna, Satkhira and Bagherhat district respectively. During packing and handling at depot, the mortality rate is 8.3, 8.7, and 11.6 in Khulna, Satkhira and Bagherhat district respectively. During transportation from depot to Dhaka, the mortality

rate is 3.5, 3.8, and 3.1 in Khulna, Satkhira and Bagherhat district respectively. In summer season during transportation from harvesting area to depot, the mortality rate is 12.3, 10.7 and 9.8 in Khulna, Satkhira and Bagherhat district respectively. During packing and handling at depot, the mortality rate is 13.9, 14.2 and 13.8 in Khulna, Satkhira and Bagherhat district respectively. During transportation from depot to Dhaka, the mortality rate is 9.82, 5.2 and 5 in Khulna, Satkhira and Bagherhat district respectively. In rainy season during transportation from harvesting area to depot, the mortality rate is 7, 9.4 and 8.75 in Khulna, Satkhira and Bagherhat district respectively. During packing and handling at depot, the mortality rate is 9.5, 11.9 and 12.3 in Khulna, Satkhira and Bagherhat district respectively. During transportation from depot to Dhaka, the mortality rate is 3.8, 4.3 and 4.5 in Khulna, Satkhira and Bagherhat district respectively.

Table-45: Seasonal variation in mortality (%) of mud crabs from catcher to exporter from the SW region of Bangladesh in 2001.

	Catcher to depot			During packaging in depot			Transportation to Dhaka		
	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter
Khulna	12.3	7	7.3	13.9	9.5	8.3	4.82	3.8	3.5
Satkhira	10.7	9.4	7	14.2	11.9	8.7	5.2	4.3	3.8
Bagerhat	9.8	8.75	8.6	13.8	12.3	11.6	5	4.5	3.1

Table-46: Seasonal variation in mortality (%) of mud crabs from SW region of Bangladesh in 2001.

	Catcher to depot	During packaging in depot	Transportation to Dhaka	Total
Summer	10.93 ±1.266	13.97±0.208	5.07±0.190	29.97
Monsoon	8.38±1.241	11.23±1.514	4.20±0.361	23.81
Winter	7.63±0.850	9.53±1.801	3.46±0.351	20.62

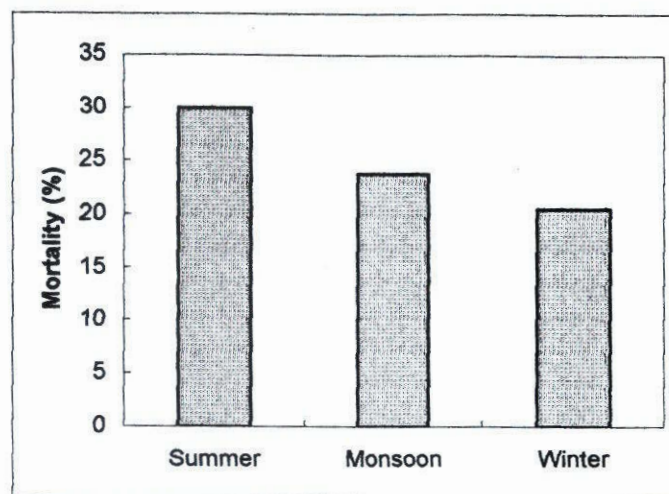


Fig-40: Seasonal variation in mortality (%) of mud crabs during marketing from south western region.

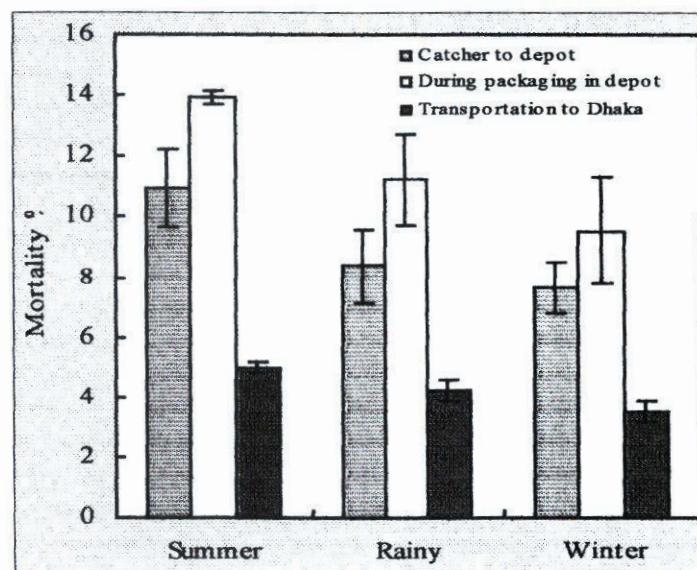


Fig-41: Seasonal variation in mortality (%) of mud crabs from catcher to exporter from the South-Western region in 2001.

4.8 Major problem in the marketing and transportation of mud crab in SW region:

The crab business is still remained as a hidden venture in Bangladesh. Therefore, nobody is there to look after its development. The most crucial problems exist in mud crab marketing and transportation is summarized as follows-

- There are no policy guidelines for the mud crab resources in the fisheries policy.
- Traditional boats takes long time to reach at the nearby market from distinct places of the Sundarbans through riverine way because inadequate number of suitable vehicles for crab transportation to the local market.
- The roads are not well constructed at local areas.
- Supply of mud crab depends fully on foreign demand;
- High mortality rate of valuable crabs due to poor handling and transportation system;
- Lack of buyer and market information;
- Lack of proper marketing facilities;
- There is no control of crab fishermen, depot owner over price fixation
- Size of mud crab basket for transportation from local depots to Dhaka is too large and causes stress to the mud crabs.
- There is huge exploitation of crab catchers by the forias and depot and depot owners in grading times.
- Delay at Daultdia-Paturia ferry terminal is one of the major concern to transportation mortality from local depots to Dhaka.
- There is common crisis is availability of credit facilities to the poor mud crab harvesters and small depot owners. Sometimes, however, local money lenders do not get return of debit from fishers and small depots owner.
- There is lack in credit facilities from government or private banks.
- The social and religious customs hinder the development of domestic market or any other value added product development.
- Strong presence of encroachers in the local community.
- Robbery is a common problem within the Sundarban mangrove swamp areas.
- Very poor living condition of the mud crab fishermen. There is no alternate income option, thus fishing pressure on mud crab resources continued to increase year by year which may in future results in total collapse of the mud crab fishery in the Sundarban mangrove ecosystem.

crabs in mini-ponds for a period of two to three weeks using trash fish. Many small crab depot owners are involved in mud crab fattening using rejected crabs at their depots during grading.

A total of 6948 MT mud crab was produced from SW region in 2001 (Source: Field Survey, 2001). Productions of mud crab from different countries are shown in table: 47.

Table 47: Production (annual) of mud crab from different countries.

Period	Country	Amount (MT)
1986	Sri Lanka	2300
1986	India	3500
1986	Burma	500
1986	Thailand (West coast only)	1500
+1983	Malaysia (West coast only)	500
1986	Indonesia	700

Source: Sivasubramaniam and Angell, 1992

In Khulna district, shrimp gher is the major source in mud crab production at Paikgacha, Dumuria, Batiaghata and Dacope upazilla. The shrimp ghers are operated mainly during monsoon. As a result, the production of mud crab was found to be maximum in all most of the upazillas (table-12 and figure-9a, 9b). However, mud crab production was highest in Koyra upazilla during winter season. Because, Koyra is located at the nearest proximity to the Sundarbans Reserve Forest (SRF) than other Upazilla. During winter season most of the crab fishers enter into the SRF as there is no other sources where they can harvest mud crabs.

The Sundarbans mangrove swamps and shrimp ghers are the main sources of mud crab production in Ashashuni, Shamnagar, Kaligong and Devhata of Satkhira district to the markets. The majority of harvested crabs at Ashashuni and Shamnagar came from Sundarbans followed by the shrimp ghers. As shrimp ghers are operated during monsoon. The maximum production of mud crab was recorded during that season in Kaligong, Devhata and Tala Upazilla during monsoon (table-13 and fig.10a,10b). Among 5 upazillas, the highest production of the mud crabs in Aashashuni is attributed to the proximity to the Sudarbans. Except Tala Upazilla, all of the Upazillas get crab from both the Sundarbans and shrimp ghers all around the years. Crab fisherman enters

into the Sundarbans mangrove swamps and tidal rivers during winter because of lower availability of mud crabs in the shrimp's ghers during this period.

There are numerous shrimp ghers in Rampal, Mongla and Bagerhat Sadar Upazilla in Bagherhat district. These ghers play an important role in supplying mud crabs during monsoon. While Morelganj and Shoronkhola are very close to the Sundarban and have numerous tidal river across the upazillas, which play a major role in mud crab supply.

The total mud crabs production is higher in Bagherhat districts than other two districts. The reason behind for such higher production is the close proximity to the Sundarban mangrove swamps with numerous criss-crossed rivers and canals. Comparatively lower salinity in the rivers in Bagherhat districts in comparison to Khulna and Satkhira and mud crab prefers lower salinity. In addition, there are substantial amount of mud crab supply from numerous shrimp ghers in some upazillas of the district. The mortality rate varies from season to season. The mortality rate is low during monsoon and high during summer. Among three districts the highest and lowest mortality were recorded in Bagherhat and Khulna respectively.

Practically the price of crab is entirely dependent on the demand in foreign market. If foreign demand goes high and the availability of crab goes low, then the price of mud crab increased significantly.

The marketing channels are mostly uniform in all districts of the SW region of Bangladesh. Sometimes, the exporters employ agents to purchase crabs directly from the crab catchers or middlemen. As a result, conflicts arise sometimes between the depot owners, suppliers and exporters.

From catching point to export, the rate of damage of harvested crabs is high in case of mangrove crabs (10-15%). Because, most of the time the crabs were transported by non-mechanized manually operated boat and it reached too late to the depots. A few crab fishermen use trawlers in transporting their harvests. On the other hand, the rate of damage is minimum (3-5%) for crab harvested from shrimp ghers.

Mud crab export was started in 1977-78. The Major export markets of mud crab are Taiwan, Singapore, Thailand, Hong-Kong and Malaysia. The highest amount of mud crabs is exported to Taiwan. In 1995-96, Bangladesh earned 5.792 million US \$ by exporting live mud crabs. Since 1977-78 to 95-96, mud crab export increased. But after 1995-96 mud crab export decreased because the availability of mud crab was reduced. The harvesting of mud crab completely depend on the natural sources. Over fishing is the main reason for decreasing the stock of mud crab in the Sundarban mangrove swamps. Beside these, there are no standard culture techniques for mud crab.

Although the mud crab business has developed since mid 1980s, the livelihood, of the crab fishermen remains unchanged. The major portion of the profit of crab business is going to the crab traders and exporters than the harvesters.

The mean cost-benefit ratio in Khulna, Satkhira and Bagherhat districts are 2.06, 3.19 and 7.91 respectively. The mean Return on investment (ROI) in Khulna, Satkhira and Bagherhat districts is 4.75, 16.33 and 21.52 respectively. From the cost-benefit analysis, it was found that the cost-benefit ratio of mud crab depots was highest in the Bagherhat district (table-46 and fig-) and lowest in the Khulna district (table-44 and fig-) and same result also shown in the return on investment i.e. the return on investment was highest in Bagherhat district (table-44 and fig-) and lowest in the Khulna district (table-44 and fig-). The crab business of Bagherhat district is more profitable than Khulna and Satkhira district in the South-Western region because the production of mud crab was highest (2655.917 MT) in the Bagherhat district, mud crabs come from the various place of South-Western region in Bagherhat laces, massive area of shrimp ghers are used for crab fattening ponds and Sundarban mangrove swamps are closely located to the Bagherhat district.

Conclusion

It has been seen in the above results and discussion that mud crab business bears huge potential for further development.

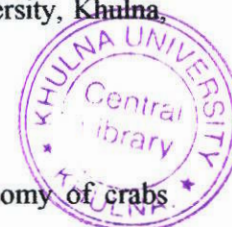
It has seen in the results that the debt and price are directly related with production but any increase in production results in a lower price of the product.

There are no proper rules and regulations and even awareness among its users regarding its management. It has been seen that there is no policy or guidelines by the Government to boost up the potential of this aqua-resource of Bangladesh in sustainable manner. Running to that way, one a day the most potential resource will be extinct from the Sundarbans. Without Government attention in research and baseline studies it is not possible to protect this potential aquatic resource. So, the government policy and management tools are very essential for the development of mud crab resource in Bangladesh.

It has been also seen the earnings from live crab export has declined significantly in the last three fiscal years. This scenario could be attributed as the future collapses of the whole crab business in Bangladesh.

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Date :	Locality :	Upazilla :	District:
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- A. Name of crab depot:
- B. Year of establishment:
- C. Number of shareholder of the business:
- D. Number of worker in depot:
- E. Number of crab collectors who have taken advance for crab collection:
- F. Peak season:
- G. Lean season:
- H. Source of crab:

Season	Sundarbans (%)	Tidal river/canal (%)	Shrimp gher (%)
Summer			
Rainy			
Winter			
Total			

Male			Female		
Name of grade	Ind. Weight (g)	Price	Name of grade	Ind. Weight (g)	price

[illegible]

K. Major problems in crab business

Capital collection:

Crab transportation:

Marketing:

Export:

Taxing:

License:

Others:

L. Means of transportation

	Media of packing	Means of transportation	Time required (hr.)
Collector to depots			
Depots to Dhaka			
Dhaka to foreign country			

M. Mortality estimation (%)

Source	Summer (%)	Monsoon (%)	Winter (%)

N. Did you take any loan to start your business

When	
From whom	
How much	
Was it sufficient	