Effect of Stocking Density on the Survival of Shrimp (*Penaeus monodon*) Post Larvae in Earthen Pond Acclimatization System

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S.M. Mostain Hossain

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Effect of Stocking Density on the Survival of Shrimp (*Penaeus monodon*) Post Larvae in Earthen Pond Acclimatization System

Approved as to style and content by

D. Kamal

Professor Dipak Kamal
Head

Fisheries and Marine Resource Technology Discipline
Khulna University
Khulna-9208, Bangladesh

DECLARATION

The results submitted in this thesis are entirely of the candidate's own investigations and no part of the results has been accepted for any degree, nor it is being concurrently submitted for any degree

Supervisor

Dr. Khandaker Anisul Huq
Associate Professor

Fisheries and Marine Resource Technology Discipline
Khulna University
Khulna

Candidate

S.M. Mostain Hossain

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Abstract

Shrimp PL acclimatization is an effective and establish industry practicing in the Satkhira District. The acclimatization of shrimp PL is highly demanded among the shrimp culturist and they believe that the earthen pond acclimatization shrimp PL would survive in higher percentage in the earthen ground. The present study was taken in Satkhira district from 22nd September 2004 to 26th September 2004 to establish suitable stocking density, its effect on survival and subsequent economic return from the operation. Three different stocking densities were taken and three replications were taken in 9 same sized ponds and the stocking densities were 800, 1200 and 1600 PL/m^2 as T_1, T_2, and T_3, respectively. Before stocking, pond construction, fencing, shading, pond preparation etc. were conducted and stocking was done during afternoon and after stocking water quality were monitoring, the range of water temperature, dissolved oxygen, pH and salinity were 27 to 29^0 C, 4.7 to 7.88 mg/l, 7 to 4.5 and 23 to 25 ppt respectively and that were within the tolerance range. The average survival rates were 82.64±1.28, 72.73±4.82 and 57.78±1.95% for T_1, T_2, and T_3 respectively. Total fixed cost was observed 43900 taka for all treatments, while total operating costs were 335016, 511704 and 673992 Tk/9 ponds/8cycles (2 months) for T_1, T_2 and T_3 respectively. The net returns were 64233.92, 29462 and -15821.36 Tk for T_1, T_2 and T_3 respectively. The returns on investment were 16.95, 5.30 and -20.34% for T_1, T_2 and T_3 respectively. From the present study T_1 was found best where stocking density was lower than other treatments. This suggests that if the management strategies will be improved such as use of feed, water quality management, and aerators use etc. then higher survival rate would be found from high stocking density acclimatization pond.

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CHAPTER- ONE

INTRODUCTION

1.0 Introduction

Shrimp farming is the second largest key to economy of Bangladesh. Shrimp is known as white gold of Bangladesh. Bangladesh produces 2.5% of the global production of shrimp. There are 6,00,000 people are employed in shrimp sector in Bangladesh generating US$ 301 millions annually from *Penaeus monodon* (bagda) and *Macrobrachium rosenbergii* (golda) farms, of which contribution of golda farms is US $243. There are now approximately 37,397 farms culturing bagda having average farm size 4.5 hector. 25,000 tons of bagda was produced in 2001. Bagda production has increased by 20% per annum in the last 15 years. There 1, 05,000 golda farms mostly located in the Khulna Division. Now a day the golda farming is being more popular and spreading rapidly to other parts of Bangladesh. Unlike brackish water cultivation of bagda freshwater golda cultivation is not restricted in the coastal region and is expanding at a rate of 10-20% per annum. Shrimp seed comes from both natural stocks and hatcheries. In case of bagda hatchery fry is being more popular in the country. While wild fry of golda is more popular to the farmers than that of hatcheries in Bangladesh. It is estimated that 4, 43,024 persons were engaged in shrimp fry collection in the coastal zone of Bangladesh. The farmers collected around 296, 389, 900, 000, 000 fries in 2000-2001 (Frankenberger 2002). The number of people engaged in shrimp fry collection inside the SRF was 20,000-25,000 (Rahman *et. al.* 1996).

Shrimp, a non-piscine fisheries organism, is the most precious fishery commodities, occupying top rank among the popular and highly quality foods for human beings. The culture of this shrimp has attracted considerable attention in recent years not only because of its value as food supply but also of its high potential as a foreign exchange earner. Shrimp farming is a century-old practice in many Asian countries. Until a decade ago, this commodity was generally considered as a secondary crop in traditional fish farming practices. Shrimp fry trapped in salts beds, coastal paddy fields or brackish water fishponds are allowed to grow to marketable size and harvested as secondary crop. However, in recent years when higher income are derived from the harvest of shrimp than the principal crops, many farmers have converted their rice fields, salt beds and fish ponds into shrimp farms.

1.1 Background of the study

Shrimp aquaculture is an important economic activity in the coastal areas of many tropical and sub-tropical countries and offers opportunities to contribute to poverty alleviation, employment, community development and foreign exchange income generation. The global production of farmed finfish, crustaceans and molluscs reached over 35 million Mt in 2000 – whilst production of the three main shrimp species (*Penaeus monodon*, *P. chinensis* and *P. vannamei*) was only 2.6% of the total quantity, they contributed to over 12% of the value with *P. monodon* ranked highest (Tim Hungtington, 2002).

Table1: Status of shrimp in world aquaculture production – 2000.

Species	Quantity		Value	
	Mt	Percentage (%)	US $ ('000)	Percentage (%)
Penaeus monodon	5,71,497	1.6	$ 4046751	8.0
P. chinensis	2,19,152	0.6	$ 1324969	2.6
P. vannamei	1,43,737	0.4	$ 878324	1.7
Sub total	9,34,386	2.6	$ 6250044	12.3
Other species	34650725	97.4	$ 44609103	87.7
Total	35585111	100%	$ 50859147	100

Source: FAO, 2002

Development of coastal aquaculture and shrimp farming in particular has generated considerable international debate in recent years over the actual environmental and social costs and benefits tropical and sub-tropical countries and offers opportunities to contribute to poverty alleviation, employment, community development and foreign exchange income generation. The degree of interaction between shrimp aquaculture and the environment depends on a wide variety of interrelated factors such as the species being cultured, the type; scale and intensity of culture practices used, the location of the farm.

Shrimp farming is a key to the economy of Bangladesh. Currently, Bangladesh produces 2.5 percent of the global production of shrimp, and the shrimp sector is the second largest export industry. There are 600,000 people employed in the shrimp sector in Bangladesh generating U$$ 301 million annually, from Bagda and Galda farms (U$$243 million from bagda alone. The combined production from marine and brackish water ponds and fresh water ghers is estimated to be around 42,900 mt (unprocessed weight), 76% being

Penaeus monodon tiger shrimp (known locally as bagda) coming from extensive aquaculture and 24% galda (*Macrobrachium rosenbergii*) from inland farming. The total area under production is estimated to be equivalent to 200,000 ha of which 170,000 ha is aimed at the production *P. monodon* culture, whilst the remaining 30,000 ha is for *M. rosenbergii.* This compares with a total 52,000 ha and 3,500 ha in the mid 1980s respectively. The total production area is believed to have expanded by approximately 20 per annum in the last 15 years. However, despite the comparative lower levels of production of *Macrobrachium,* the growth in this species production has more than doubled over the same period (DoF, 2002).

Bangladesh shrimp culture is practiced in brackish, saltwater and in fresh water. The main cultivated species is *Penaeus monodon.* The total farm production of this species in 2001 was 25,000 Mt (representing 58% of total). The other cultivated species include *Macrobrachium,* accounting for 11,942 Mt or 28% of total, *Metapenaeus monoceros* (Horina or brown shrimp), *P. indicus* (Chaka or Indian white shrimp), *P. semisulcatus* (Green tiger shrimp) and *P. merguinensis* (Banana shrimp) that make up a further 2,891 Mt (7%), 850 Mt (2%) and 2,221 Mt (5%) respectively. Whilst production focuses on producing bagda and galda, a small amount of other shrimp species are also grown as a result of the influence of poor screening and wild shrimp PL being trapped in the tidal ponds (Tim Huntington, 2002).

Wild PL has a great demand for its high rate of survival. So fry collection tendency increase among some poor farmers. They use small mesh size net in rivers and estuaries for fry collection. During fry collection they also catch some other untargeted species that shrimp fry by catch comprises a wide variety of shrimp and fin fish species of some of have economic importance and others are important for ecological balance of the estuary. These include: Penaeid (*Metapenaeus brevicornis, M. ensis, Parapenaeposis sculptilis, etc.*), Sergestidae (*Acetes indicus*), Palaemonidae *(Macrobrachium rude, Macrobrachium sp.*), Clupeidae (*Hilsha spp.*), Mugilidae (*Mugil sp.*) Engralidae(*Stolephorus sp.*), Sillaginidae *(Illago domina*), Gobiidae (*Glossogobius giuris, Apocryles bata),* Tetradontidae (*Tetradon spp.*) etc (Anon ,2001).

To reduce the pressure on bio-diversity Govt has made a ban on the collection of natural shrimp PL in 1999. With some exception the shrimp farmers are bound to stock the hatchery produced PL. But there is a negative attitude regarding hatchery produced shrimp PL that they have relatively lower survival rate in the farmers' farms. This problem is caused by various issues depending on the farm condition, culture system, water quality management, feeding management etc. There is a great variety of differences between the farmers' grow-out ponds/farms regarding habitat, temperature, salinity, oxygen, feed etc. Shrimp PL in the hatchery condition remain in a controlled condition where temperature, salinity, oxygen, feed etc. are maintained at an optimum level. But in case of farmers ponds these parameters are not maintained at an optimum level. Thus the hatchery produced shrimp PL, if directly stocked in the ponds, fall in danger to cope with environmental disturbances and as well as feeding competition in a large water area. Moreover, due to transport stress the PL become very weak. So they need intensive care prior to stocking in the ponds. Thus the thought of nursing came in to the consideration of shrimp farming. A base line survey was done in the study area. It was known from the survey that the shrimp PL nursing practice in the study area is a recent one. And this earthen pond nursing system is originated from the neighboring country India.

1.2 Rationale of the Study

However, very little information available on shrimp (*Penaeus monodon*) PL nursing in earthen pond system although it has a great demands to the shrimp farmers of Bangladesh. Shrimp PL, nursing in earthen pond, have a great demand to the shrimp farmers due to their good survival rate as because the habitat environment of the earthen nursing pond and of the shrimp farm is more or less the same. But a nursery operator possesses no or very little scientific nursing knowledge. This sector needs a comprehensive study. To develop the earthen pond nursing system the farmers need information regarding optimum stocking density, temperature, dissolve oxygen, salinity, suitable feed, rearing duration etc. This study is a fulfillment of the above. Thus the present study has been undertaken to investigate the survivability of shrimp (*Penaeus monodon*) PL nursing in earthen pond.

1.3 Limitation of the Study

The rate of survival rate of shrimp (*Penaeus monodon*) PL has been investigated for only one cycle i.e., five (5) days due to lack of financial assistance. It is noted that the study has been carried out in a farmer's nursery pond. All the expenditure was provided by the nursery owner and he was convinced for only one cycle.

1.4 Objectives of the study

The overall objective of the study was to determine a suitable stocking density which can provide maximum survival rate and economic return in earthen pond nursing of shrimp (*Penaeus monodon*) post larvae. However, more specifically the study was conducted to investigate the following:

- To identify the suitable stocking density of shrimp PL in earthen pond acclimatization.
- To find out the effect of stocking density on earthen pond acclimatization.
- To find out the economic return in earthen pond nursing of shrimp PL.
- To determine the affect of the water quality parameters
    - Temperature
    - Salinity
    - Dissolved oxygen
    - pH on the survival of shrimp (*Penaeus monodon*) PL acclimatization in earthen pond.

CHAPTER- TWO

REVIEW OF LITERATURE

2.0. Literature review

Aftabuzzaman (1990) also identified some environmental effects of aquaculture development-clearing or reclamation of forest areas which destroyed spawning and nursery ground of many species of fin fish, crustaceans, molluscs and other aquatic resources, destruction of shrimp and other fish-shrimp fries, excessive use of pesticides in aqua-farms, spread of viral diseases and pest through introduction of shrimp and fish from abroad.

Alam *et al.* (1989a) reported some negative effects of shrimp culture from Paikgacha, Khulna. They identified four major negative impacts- siltation, reduction of arable lands, salinity intrusion and reduction of vegetation covering in the area.

Ali (1996) reported three methods of shrimp culture practice in the coastal region of Bangladesh. He stated that 66-75% farms follow the traditional (extensive) gher operation where they stock PL of *Penaeus mondon* at the rate of 1-1.5/m^2; no control of carnivorous and weed fishes, no manure, no fed supply and no exchange of water is carried out, production cost and production rate varies between 80-90 Tk./kg and 100-250 kg/ha respectively. He showed that the production cost and production in improved extensive culture 100-200 Tk./kg and 500-2000 kg/ha respectively. He also reported that 25-30%, shrimp farms followed this method and it becoming increasingly popular.

Although shrimp culture in the coastal area of Bangladesh is relatively a new practice, a few attempts have so far been made to investigate the various environmental and socio-economic aspects of shrimp cultivation in Bangladesh by various workers (Alam *et al.,* 1989; Bashirullah *et al.,* 1989; Gain, 1998; Aftabuzzaman 1990 and Chowdhury, 1989).

Anon (1995), noted that shrimp fry by catch comprises a wide variety of shrimp and fin fish species of some of have economic importance and others are important for ecological balance of the estuary. These include: Penaeid (*Metapenaeus brevicornis, M. ensis, Parapenaeposis sculptilis, etc.*), Sergestidae (*Acetes indicus*), Palaemonidae (*Macrobrachium rude, Macrobrachium sp.*), Clupeidae (*Hilsha spp.*), Mugilidae (*Mugil sp.*) Engralidae(*Stolephorus* *sp.*), Sillaginidae *(Illago domina)*, Gobiidae (*Glossogobius giuris, Apocryles bata)*, Tetradontidae (*Tetradon spp.*) etc.

Chowdhury (1986) studied the effect of improved pond management practices on the production of shrimp. Chowdhury (1986) noted that improve pond management practice along with maintenance of controlled sluice gates and dykes could increase the yield of shrimp considerably. He also reported that, careful attention to predator control and proper acclimation of post larvae during stocking are the two most important factors, which could enhance production considerably.

Coastal embankments have also prevented flooding of intertidal areas, which previously provided nursery areas, and have damaged a number of the traditional brackish water fisheries. Flood control measures and drainage projects have removed 1.2 million ha of flood lands from fishery production (Basirullah *et al.,* 1989). The fishes inhabiting the rivers and estuaries are adapted to a pattern of flooding in the monsoon season followed by a distinct dry season; hence they are adversely affected by regulation of water flow.

Funegaard (1986), also made observation on the vulnerability of bagda fry with simultaneous destruction of zooplankton communitues along the coastal belt of Satkhira.

Gain (1998) studied the impact of embankment to the coastal environment. Gain (1998) reported that around 482 small, medium and large water and embankment projects were implemented between 1959 and 1993 in the coastal region of Bangladesh. Under this project 8,200km embankments (polders) were constructed to protect agricultural lands. In addition, more than 4,700 km of irrigation canals, 3,400 km of drainage channels, over 9,000 hydraulic structures (sluice gates and regulators), 4,300 bridges and culverts and two barrages were built with a cost of US$ 5 billions (Gain, 1998). These embankments have proved to be fatal to the coastal environment today. These embankments have created permanent water logging of 110,000 ha land with 900,000 people in nine Thanas in Khulna, Jessore and Satkhira District (Gain, 1998).

Hasan (1990) reported that the adequate supply of shrimp post larvae is one of the major problems of shrimp industry in Bangladesh. However, he concluded the shrimp production could be raised from the present 253 kg/ha to 500 kg/ha through implementing proper pond preparation, maintaining good water exchange gates and with little or no supplementary feed.

Hossain, *et al,* (1989). Conducted studies on the growth and survival of juveniles of *Macrobrachium rosenbergii* in freshwater nursery ponds. The stocking densities in two nursery ponds were 27 and 15 post larvae/ m^2. The survival rate at the end of the study were 62% and 69% for stocking densities 27 and 15 post larvae/ m^2.

Hossain, *et al,* (1989) studied on *the* rearing of prawn larvae *Penaeus japonicus* Bate, under bioconversion system VI. Rearing of larvae with live planktonic feed. All types of plankton raised under bioconversion system were fed to larvae in live condition.

In another study (Alam *et al.*, 1989) reported that about 95% of 7500 ha mangrove forest in the Chakaria Sunderbans has been cleared for the construction of shrimp ponds. Rapid deforestation in the Matamuhuri catchments area has increased siltation, which is compounded by the building of embankments for shrimp ponds (Alam *et al.*, 1989b).

In respect of socio-economic impacts of shrimp cultivation Chowdhury (1989) reported that poverty is stark, naked and very deep; landlessness and land concentration have been proceeding at as alarming race. The existing land holding system in the area presents an extreme inequality in the ownership and control over land, which is characterized by small minority monopoly. Thousands of farm laborers have been rendered unemployment along with a large number of sharecroppers evicted from the land (Chowdhury 1986).

Islam *et al.* (1993) estimated that about 61.7 million, 6.7 million, 14.3 million 222.8 million, 13.8 million and 816.7 million Of bagda PL were harvested in Khulna, Satkhira, Bagerhat, Patuakhali, Noakhaki and Cox's Bazar coastal region respectively.

Jalal (1988) also reported the negative impacts of shrimp culture on the environment, such as -loss of grazing land, loss of sources of fresh water and a reduction in tree cover owing to the rise of salinity. Shrimp farming may not so far have affected the yield of rice. But over time, there will be an accumulation of salt lowering the yield and forcing landowner to sell land permanently to the shrimp farmer. He pointed out that there is a lack of integration of ecological/environmental considerations in making any multi-sartorial project design and implementation. Without such an approach, development efforts cannot be sustained over the long run. He recommends including an Environment Impact Assessment (EIS) for all coastal resource development projects.

Jalal (1988) previously reported that shrimp culture has spread out in an unplanned, uncoordinated and essentially uncontrolled manner. In some instances, that is suitable and unsuitable for shrimp have been inundated with saline water for shrimp culture.

Karim *et al.* (1990) reported the availability of tiger shrimp fry throughout the coastal areas of Bangladesh. He also mentioned that shrimp fry were available from September to May in the adjacent rivers of Sunderbans. December to March in the tidal rivers of Satkhira district and from April to August in Cox;s bazaar district.

Karim and Aftabuzzaman (1995) reported that farming technology followed by most farmers is rather primitive and inefficient. Production level is every low, possibly around 300 kg/ha. It is difficult to effectively early any improved culture technology in the existing farms because most of the ponds are unmanageably large in size, shallow in depth and irregular in shape. Water supply and drainage system is inadequate. They also reported that rotation of aquaculture with agriculture is most commonly practiced farming system in the brackish water belt of the Southwestern coastal region.

Islam *et al.* (1993) reviewed the impact of destructive fishing methods on the coastal and marine fisheries resources. All over the coastal and marine waters, there has been a significant decline in fish availability since the 1970s although shrimp exports have increased. Introduction of engine and nylon twine prior to and after '70s made possible excessive exploitation of resources in the inshore and offshore fisheries. One such development is the small mesh drift gillnet for *Hilsa ilisha* which increased exploitation by at least 1, 00,000 MT over night. Over fishing by the trawl and estuarine set bagnet is well documented. Both male and female tiger shrimp (*Penaeus monodon*), *Upenaeus* *sulphureus*, *Lepturacanthus savala, Lutjanus johni* and *Ariomma indica* are being over fished by the trawl fishery with an exploitation rate (E) of 0.71, 0.62, 0.72, 0.65, 0.78 and 0.62 respectively. While 16 species of shrimps and are being severely over fished by the estuarine set bagnet in the shallow coastal region. The exploitation rates for different shrimp species are as follows: *Penaeus monodon*- 0.855, *P. indicus*- 0.74, *P. scuplitis*- 0.703, *P. styliferus*- 0.67, *Metapenaeus monoceros*- 0.758, *M. brevicornis*- 0.809, *M. spinulatus*-0.845, freshwater giant prawn *Macrobrachium rosenbergii*- 0.70. White fish species exploitation rates are - *Raconda. russeliana*- 0.657, *Setipinna tri*- 0.85, *Herpodon nehereus*- 0.805, *Lepturacanthus savala*- 0.819, *F. tetradactylum*- 0.866, *Polynemus paradiseus*- 0.787, *Sillago domina*- 0.759 and *S. sihama*- 0.751. It is evident that set bag net fishery (with a mesh size of 1.05 mm) is the most destructive to the natural resources as all the above species are caught before reaching maturity and hence not permitted to join the recruitment process through spawning (Islam *et al.*, 1993).

Khan *et al.* (1995), in their bio-socio-economic study has shown the negative impact of shrimp fry fishery (and also ESBN fishery) on coastal fish stocks in general, with particular reference to the *P.monodon* stock.

Mahmood (1990) reported that, in spite of tremendous potential of shrimp cultivation for the development of coastal Bangladesh and the economy of Bangladesh as a whole, it already resulted in severe destruction of natural vegetation including mangrove forest.

Mahmood (1986) indicated some socio-economic and environmental problems due to unplanned shrimp farming expansion. These are destruction of valuable mangrove forest, gradual reduction of areas under rice cultivation and crop failure, food shortage and scarcity of vegetable, scarcity of drinking water, reduction of cattle grazing land, fuel crises, violation of law and social unrest, expansion of shrimp farming on the bank of rivers and canal outside the water development. Board embankment results in siltation and reduction of nursery area of immigrating post larvae and emigrating juvenile of shrimp and fin fish, Increase of landless farmers, exploitation of laborers, destruction of country way and paths.

Mahmood *et al.* (1994), paid attention providing a first hand assessment on the quantum of damage caused to zooplankton while collecting of bagda PL during the period between June, 1982 and July, 1983 in Chakara, Satkhira and khepupara. He also reported that for fishing a single individual of *P.monodon* PL 1,631 zooplankton was destroyed.

Masud (1997) conducted studies on the effect of stocking density on the growth, survival, and production of black tiger shrimp (*Penaeus monodon*). PL $_{15\text{-}20}$ were reared in managed coastal ponds at 25,35 and 45 individuals/m^2 for 120 days in the Elite Aquaculture Ltd., Teknaf, Cox's Bazar. After 4 months of culture shrimp production averaged 4.94, 3.86 and 4.52 mt/ha under stocking density of 25, 35 and 45 individuals/m^2 respectively.

Shrimp culture also has some socio-economic impacts. Most important of them are employment and income. Employment has generated in the farm, in fry catching, in deheading center and in ice factories. Shrimp cultivation requires lower amount of labor. Some cases it may be even one forth of labor force employed in agriculture. Only 25 to 30 man-days of labor required for one acre of shrimp cultivation. Where as 93 to 108 man days required for cultivating Aus or Aman paddy (Chowdhury, 1989; Rahman and Chowdhury, 1986). If employments in fry catching and deheading are included, additional 32 man-days (26 for fry catching and 6 for deheading) required per acre (MPO. 1987).

Paul, *et al.* (1993) reported that shrimp PL has increased rapidly in the greater Khulna, Patualhali and Cox's Bazar region.

The overall salinity of water bodies in the Southwestern region has been increased in the last two decades. This has resulted in environmental degradation in the region. The impact of salinity increases has been studied by Bashirullah *et al.* (1989). Since the diversion of the Ganges water at Farakka from early 1975, salinity levels have increased dramatically in the western part of the coastal region. About 1.4 million ha already have saline soils or are subject to saltwater flooding (Mahtab, 1989). In the dry season, it affects agriculture, human freshwater resources and industry. Although of value in the short-term to the human population, this is causing ecological damage in terms of loss of coastal tidal plain habitat and damage to fish and shrimp nursery grounds (Bashirullah *et* *al.,* 1989). Embankments have a significant impact on fisheries, impeding the movement of newly hatched shrimp and fish from rivers and estuaries into the floodplain as the monsoon floods rise, and similarly preventing their return for breeding when the floods fall (Gain, 1998a).

CHAPTER- THREE

MATERIALS AND METHODS

3.0. Materials and Methods

3.1. Study Area

Earthen pond PL nursing is a new great profitable industry introduced in our country very recently and mainly practiced in Shatkhira district. The majority of the earthen pond PL nursing farms were situated in the South-Western coastal region of Bangladesh. The study site was very near to the bus stoppage of Munshigonj, Thana-Shamnagar, and District-Satkhira, Bangladesh. Mr. Abdul Rahim was the Nursery owner. It had a good communication system. Besides those, the nursery owners of that area were interested to have the result of the proposed research. Because of having nine suitable uniform ponds, that nursery was selected to carry out the research.

3.2. Nursery ponds construction and numbering

Nine experimental ponds were constructed having the length 6m, width 4.08m, and depth 1.2m. Each experimental pond had one inlet pipe connected with a common inlet channel and one outlet pipe ending to the common outlet channel. A common dike having width 1 m and height 1.2 m surrounded nine ponds. The nine experimental ponds were used for three treatments (T1, T_2 and T_3) with 3 replicates of each treatment.

The numbering of pond is necessary to facilitate the proper management like feeding, sampling and to show the result in printed form. The nine ponds were denoted as T_1P_1, T_1P_2 and T_1P_3 for treatment-1, T_2P_1, T_2P_2, and T_2P_3 for treatment -2, and T_3P_1, T_3P_2 andT_3P_3 for treatment-3.,

3.3. Fencing and Shading

The ponds were fenced on to the common dike with nylon nets and bamboo sticks having height 1.37 m to protect the ponds from invaders. Because of shallow ponds a canvas was used over the ponds as shade with the support of bamboo sticks which protects the

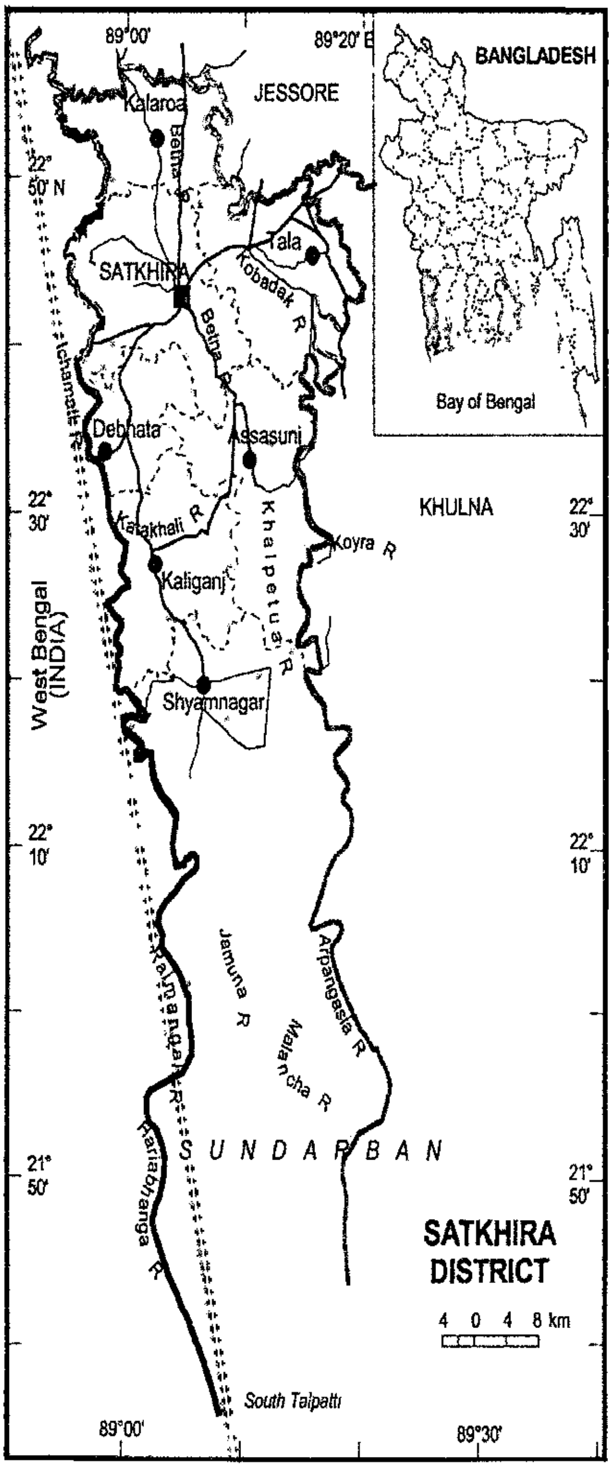

Fig. 1: Surveyed area, Satkhira District.

shrimp PL from excessive sunlight. When rain was started then an extra thin polyethylene used along with the canvas.

3.4. Construction of reserve ponds

A pond was constructed as a reservoir having length 10 m, width 8m and depth 1.5m. The pond was provided with one inlet and outlet canal. The pond was used to mix the freshwater from shallow pump with the saline water comes from river. The reservoir was connected with the common inlet channel through which saline water from river was introduced into the reserve pond.

3.5. Pond preparation

Prior to stocking the pond bottom mud was removed well. The pond bottom and pond slope was beaten with the bamboo slots to increase the compactness of the soil and inhibit the seepage. The ponds were limed with dolomite at the rate of 10g/ m^2 to disinfect the pond and to increase the soil pH. Water from the reservoir was introduced in to the experimental ponds maintaining water depth 1.5 m.

3.6. Collection of PL

The shrimp PL were collected from Rupali hatchery. The price of the PL was 250 Tk/ 1,000 PL. the PL was transported by Pickup and van. During transportation water salinity was 25 ppt.

3.7. Stocking date and rearing period

First stocking was done 22nd September' 04 and the experiment were stayed only for five days to acclimatize the PL and harvesting was done after completing the experiment.

3.8. Stocking of PL

The PL packets were counted before stocking and the weak and injured PL were identified and were rejected. After opening the upper lids the PL packets (cartoons) were left floating on the concern stocking ponds for about half an hour to acclimatize the PL. Three different stocking densities were maintained in the three treatments with three replicates each. The stocking densities were 800 PL/m^2 (T_1), 1200 PL /m^2 (T_2) and 1600 PL/m^2 (T_3) (Table 2). The experimented PL were collected in the morning (9.00 AM) to reduce the mortality due to transportation and after counting and acclimatization stocked in the experimental ponds at afternoon (5.00 PM.).

Table 2:.Experimental design showing stocking densities in different treatments.

Treatments	Stocking rate (PL/m^2)	Pond area (m^2)	Pond ID	No. of PL stocked
T_1	800	24.5	T_1P_1	19600
			T_1P_2	19600
			T_1P_3	19600
T_2	1200	24.5	T_2P_1	29400
			T_2P_2	29400
			T_2P_3	29400
T_3	1600	24.5	T_3P_1	39200
			T_3P_2	39200
			T_3P_3	39200

3.9. Water quality monitoring

The hydrological parameters were observed twice (morning & evening) in a day. Among the hydrological parameters DO using HACH test Kit through titration, pH using HACH test Kit through titration, Salinity using Hand Refractometer and Temperature were measured using Celsius Thermometer.

3.10. Water Exchange

50% water of the experimental ponds was changed daily. Water was drained through the out let pipe using fine meshed net so that the shrimp PL can't go out with water. The water was discharged through the common out let canal. Water was introduced from the reservoir using water pump and plastic pipe.

3.11. Harvesting date and its procedure

Complete harvesting of each pond was done at 26th September, separately at the end of the experiment. During the harvesting the water of the experimental ponds was let to discharge through the out let pipe in to the common out let channel. A fine meshed net was set under the out let pipe to collect the shrimp PL. After the first drying the ponds were flashed with water for complete harvesting.

3.12. Counting & Survival rate determination

After harvesting the experimental shrimp PL were counted separately for each experimental pond and kept records. The survival rate was determined by using the following formula:

$$\textbf{Survival rate (\%)} = \frac{\text{Total number of PL survived}}{\text{Total number of PL stocked}} \times 100$$

3.12. Data Analysis

Data were collected, sorted, categorized and analyzed using different statistical packages, Microsoft Excel, SPSS. The survival rate of PL, cost-benefit analysis of the operation was also analyzed. The results were presented in the form of table and figures.

3.13. Cost-benefit analysis:

Cost benefit ratio was evaluated by the following formula given by (Loudon and Loundon, 2000).

- Total cost (Tk) = Fertilizer (Tk) + liming (Tk) + feed (Tk) + fry (Tk) +miscellaneous (Tk).
- Miscellaneous (Tk) = Labour + night guard cost.
- Total yield (Kg/ha) = Gross production.
- Total income (Tk) = Commodity selling price per unit × Total yield.
- Total net income (Tk) = Total income (Tk)- Total cost (Tk)

CHAPTER- FOUR

RESULTS & DISCUSSION

4.0. Results and Discussion

4.1. Hydrological parameters

Water is the key point to increase the mortality of the shrimp PL. To protect the PL from the attack of different types of diseases especially from white spot disease good water quality should be ensured. The water quality parameters such as temperature, pH, dissolve oxygen, salinity and water depth in different ponds were monitored in alternative day during the study period.

4.1.1. Water depth

The experimental ponds were very small having the area of 24.5 m^2 of each pond. Thus water exchange was very easy. In every morning and evening water depth was checked and if it was reduced from 75 cm the water was introduced through pump to the experimental ponds.

4.1.2. Temperature

During the study period the value of temperature were varied between 27^0 C and 29^0 C (Table 3). In case of T_2 always water temperature was highest rather than other two treatments. Among the five days of the experiment 25th April was hottest day, when water temperature of all the ponds were higher. During the study period water temperature in the morning for all treatments were lower than the water temperature in the evening. There was no highly noticeable temperature differences were observed among the treatments during the study period. Water temperature of the experimental ponds was within the culturable range. Though water depth of all the ponds were lower compared to the normal culturable ponds, but water temperature was not increased so high, because all the ponds were shaded with the canvas. Such practices were accustomed to the local shrimp PL nursery practitioners.

Shofiquzzoha *et al.*, 2001 conducted an experiment on Optimization of stocking rates of shrimp where water temperature during the period was ranging between 32.75^0C to 29.35^0 C. It is important to rear larvae within the optimal culture range in similar salinities and temperatures to those in which they were spawned. When spawned at 28^0C, the most suitable larval rearing temperature for maximum survival, growth and developmental uniformity of *P. esculentus* was found at 26^0C (Crocos *et al.*, 2000).

Roy *et al.* (1992) recorded pond water temperature in the winter season 20-30^0C and in the summer season 25-32.5^0C in his experiment, conducted at Aquaculture Farm Ltd., Cox's Bazar. Naskar and Chakraborty (1984) stated that optimum range for black tiger shrimp (*P. monodon*) was between 28 -32^0C. Chiu (1988) also opined out the temperature range of 25-32^0C was the optimum for *P. monodon* farming.

Apud *et al.* (1985) said that individual weight of *P. monodon* might be affected by the lowering temperature bellow the optimum level.

4.1.3. Dissolved oxygen (DO)

During the study period the value of dissolve oxygen were varied between 4.70 to 7.88 mg/l for all treatments (Table 4). In all ponds dissolve oxygen value was lower during the morning time and higher was during the after noon time. Average dissolve oxygen value was lower for T_2 in all the experimental days rather than other two treatments, due to higher water temperature that was found for the treatment T_2 in all the experimental days. But all the values were within the culturable ranges. The highest value of dissolved oxygen was probably due to low temperature.

Mckee and wolf (1963) stated that DO for worm water fish habitat should not be less than 5ppm at least 16 hour of any day. Bhuiyan (1970) reported that dissolved oxygen content from 5.0mg/l to 7 mg/l is required for high production. In the experimental time dissolve oxygen remained within the culturable range so that there was no stress on the nursing PL due to dissolve oxygen problem.

Table 3: Temperature variation found in the experimental treatments.

April'04	T_1 (^0C)				T_2 (^0C)				T_3 (^0C)			
Date	Morning	After noon	Range	Av.	Morning	After noon	Range	Av.	Morning	After noon	Range	Av.
22	27.50	28.33	27-28.5	27.92	27.17	28.00	27-28	27.58	27.33	28.50	27-28.5	27.92
23	27.33	28.83	27-29	28.08	28.17	29.00	28-29	28.58	27.33	28.17	27-28.5	27.75
24	27.00	27.00	27-27	27.00	27.83	28.17	27-29	28.00	28.17	28.33	28-28.5	28.25
25	28.00	28.00	28-28	28.00	28.83	29.00	28.5-29	28.92	28.00	28.83	27.5-29	28.42
26	27.50	28.33	27-28.5	27.92	27.50	29.00	27-29	28.25	27.50	27.50	27-28	27.50

Table 4: Dissolve Oxygen variation found in the experimental treatments.

April'04	T_1 (mg/l)				T_2 (mg/l)				T_3 (mg/l)			
Date	Morning	After noon	Range	Av.	Morning	After noon	Range	Av.	Morning	After noon	Range	Av.
22	4.80	6.17	4.78-6.30	5.48	4.80	6.20	4.78-4.89	4.50	4.79	6.17	4.79-6.20	5.48
23	4.79	6.33	4.78-6.40	5.56	4.79	6.33	4.78-6.40	5.56	4.78	6.37	4.78-6.40	5.57
24	4.79	5.89	4.78-7.88	5.34	4.79	4.89	4.79-6.30	4.84	4.78	4.89	4.78-4.89	4.84
25	4.78	4.85	4.70-4.86	4.82	4.79	4.85	4.78-4.45	4.82	4.77	4.86	4.47-4.86	4.82
26	4.76	4.84	4.75-4.84	4.80	4.75	4.84	4.75-4.84	4.80	4.75	4.82	4.75-4.82	4.79

Rahaman *et al.* (1995) stated that oxygen concentration is higher in winter season and lower in summer in the summer season due to inverse relation of dissolved oxygen with temperature or due to cold temperature of water as the cold water has the greater oxygen holding capacity. Dewan (1973) and Islam *et al.* (1978) found almost same results. In general, an acceptable environment for aquatic life must contain not less than 5 ppm of oxygen. Various observations have been made on critical as well as optimum level of DO in pond water. Boyd and Clay (1998) stated that minimum concentration of DO tolerated by fish is obviously functioning of exposure time. Ellis (1937) indicated that 3.0 ppm DO or less should be regarded as hazardous for fish and suitable DO level should be 5.00 ppm or more.

4.1.4. pH

Another important factor for fish culture is pH. In the experiment, the range of pH values were 7.5-8.5, 7.5-8.5 and 7.5-8 for treatments T_1, T_2 and T_3, respectively (Table 5). All the values of all the experimental ponds were within the culturable range.

Verma (1969) stated the highest value of pH during summer and the lowest of the same during winter. The low pH value during winter probably due to low water temperature, less alkalinity, high dissolved oxygen and low rainfall. Banerjea (1967), while correlating productivity of large numbers of ponds with various soil and water properties, observed neutral to slightly alkaline pH range to be most favorable for fish pond.

Sarker (2000) noted that the range of pH value 7-8.5 is suitable for fish culture but fish died when pH reached more than 11. Andrews *et al.* (1972) stated that waters having a pH range from 6.7 to 8.6 are generally support a good fish population. Only few species, however, can tolerate pH values lower than 5 or grater than 9.

The present investigation showed the pH values were in alkaline range in all the ponds that were in productive range in fish culture. Alikunhi (1956) stated that water on acid soil is usually less productive than those on alkaline soil. Michael (1968) reported the pH ranging between 7.3 and 8.4 are the most suitable for fish culture.

4.1.5. Salinity

In the experiment the range of salinity values were 23-24.5, 23.5-24 and 23-24.5 ppt for treatments T_1, T_2 and T_3, respectively (Table 6). All the values of all the experimental ponds were within the culturable range. Little salinity up rise was done due to introduction of river water, mixture of ground freshwater and temperature up rise.

Shivananda and Murthy (1997) recommended salinity requirement for shrimp culture is 25-30 ppt. Keys *et al.* 2000 stated that larval survival is dependent on water temperature and salinity conditions. Most *P. esculentus* larvae are found in waters less than 50 m deep with temperature and salinity ranges of 21.5–30.6^{0}C and 30.1–34.2‰, respectively (Rothlisberg and Jackson, 1987).

These natural ranges are thought to encompass the optimal culture ranges for the larvae of this species (Rothlisberg and Jackson, 1987). This has been supported by the successful rearing of larval *P. esculentus* at temperatures ranging from 24 to 30^{0}C at 30–34‰ laboratories and hatcheries (Crocos *et al.*, 2000; Jackson *et al.*, 1992).

Post-larvae are typically purchased from commercial hatcheries and shipped in water with near oceanic salinity (28 to 35 ppt) because they cannot tolerate low salinity. The PL must be acclimated to ambient salinities (and ionic profiles) before moving them into grow-out facilities. Acclimation procedures in brackish water or seawater are well established and can be found in the scientific literature or requested from an aquaculture extension agent or specialist. However, because ionic profiles of inland, low-salinity well water often vary considerably from that of marine brackish water, acclimation is more stressful. Specific protocols for low-salinity acclimation vary with salinity, culture methods and resources. In general, a 10-day-old PL can be acclimated only down to 4 ppt with good survival. However, shrimp older than 15 days may be acclimated to a lower salinity. There is a clear interaction between PL size and health and other stress factors (shipping stress, temperature, dissolved oxygen) that influence acclimation. Each situation must be evaluated independently. If the hatchery has the capacity and the shrimp are at least 8 days old, they can be pre-acclimated from the typical 28 to 35 ppt of the hatchery to as low as 15 ppt (Keys *et al.* 2000). The salinity should not be reduced below 15 ppt because PL do not transport well at lower salinities.

Salinity in the range of 15 tot 25 ppt were usually considered more suitable for *Penaeus monodon* grow-out (Boyd and Clay 1989). Chiu (1988) also reported that the optimum range of salinity for *P. monodon* farming should within 20 to 25 ppt. the salinity in this experiment, was found within this limit which indicates a favorable condition for growth and survival of *P. monodon*.

Table 5: pH variation found in the experimental treatments.

April'04	T_1				T_2				T_3			
Date	Morning	After noon	Range	Av.	Morning	After noon	Range	Av.	Morning	After noon	Range	Av.
22	8.33	8.17	8-8.5	8.25	8.17	8.00	8-8.5	8.08	7.83	7.83	7.5-8	7.83
23	8.17	8.17	8-8.5	8.17	7.83	8.00	7.5-8	7.92	7.67	7.67	7.5-8	7.67
24	7.67	7.67	7.5-8	7.67	7.83	7.83	7.5-8	7.83	7.83	7.83	7.5-8	7.83
25	7.50	7.50	7.5-7.5	7.50	7.67	7.50	7.5-8	7.58	7.50	7.50	7.5-7.5	7.50
26	7.17	7.33	7-7.5	7.25	7.33	7.33	7-7.5	7.33	7.50	7.50	7-7.5	7.50

Table 6: Salinity variation found in the experimental treatments.

April'04	T_1 (ppt)				T_2 (ppt)				T_3 (ppt)			
Date	Morning	After noon	Range	Av.	Morning	After noon	Range	Av.	Morning	After noon	Range	Av.
22	24.17	24.00	24-24.5	24.08	24.00	24.00	24-24	24.00	23.83	24.50	23.5-24.5	24.17
23	24.50	24.50	24.5-24	24.50	24.00	24.00	24-24	24.00	24.33	24.33	24-25	24.33
24	24.00	24.00	24-24	24.00	23.50	23.67	23.5-24	23.58	23.67	24.00	23-24	23.83
25	23.67	24.17	23.5-25	23.92	23.50	23.67	23.5-24	23.58	23.50	24.17	23.5-25	23.83
26	23.17	23.00	23-23.5	23.08	23.83	24.00	23.5-24	23.92	23.67	23.00	23-24	23.33

4.2. Estimation of survival rate

In the treatments three different stocking densities were maintained. The stocking densities were 800; 1200 and 1600 PL/ m^2. The pond size, stocking density, pond wise survival rate and average survival rate (Table 7). The maximum survival rate (85%) was found in T_1P_1 pond while the minimum (57%) was found in T_3P_3. pond. The maximum average survival rate 84%, was found in the T_1 while the minimum average survival rate 58%, was found in the T_3. From the experiment it was depicted that survival rate had inverse relation with the stocking density. Where the stocking density was higher (39200/pond) (57.78±1.95) and then the survival rate was lower in T_3 and vise versa.

Table 7: Treatment and pond wise stocking density, no of harvested and survival rate

Treatments	Pond ID	No. of PL stocked	No. of PL harvested	Pond wise survival rate (%)	Average survival rate (%)
T_1	T_1P_1	19600	16463	84	82.64±1.28
	T_1P_2	19600	16162	82.46	
	T_1P_3	19600	15967	81.46	
	Average	19600	16197		
T_2	T_2P_1	29400	22345	76	72.73±4.82
	T_2P_2	29400	22052	75	
	T_2P_3	29400	19756	67.2	
	Average	29400	21384		
T_3	T_3P_1	39200	22036	56.34	57.78±1.95
	T_3P_2	39200	23520	60	
	T_3P_3	39200	22392	57	
	Average	39200	22649		

The survival rate of shrimp PL was satisfactory in respect of other experiments. Hossain *et al.* (1989) found survival rate 62% and 69% of *Macrobrachium rosenbergii* PL in freshwater nursery ponds for stocking densities 27 and 15 post larvae/ m^2.

Davis *et al.* (2004) stated that there is little published information about the growth and survival of this species in well water or inland surface water. Some of the first reports were from West Texas, where Pacific white shrimp was successfully produced in earthen ponds (86.7%). The shrimp grew from 1.2 g to about 20 g in 120 days at a stocking density of 25 shrimp/ m^2. There are also reports of super-intensive culture (109 shrimp/m^2) in earthen ponds (0.1 ha) in the Sonora Desert of Arizona, with production as high as 12,000 kg/ha in low-salinity groundwater of 2.0 ppt.

Davis *et al.* (2004) also stated that researchers have been working to identify reasons for differences in survival and growth among farms, and to develop strategies for acclimating and producing shrimp under various conditions. The first thing a farmer must determine is whether or not his water is suitable for shrimp culture. If it is suitable, he must know how to acclimate shrimp to the new water body. Once the PL or juvenile shrimp are acclimated to local conditions, the farmer must deal with typical production issues such as feeding, maintaining water quality (including ionic profiles), and managing blooms of undesirable algae.

Alam *et al*., 1997. conducted an experiment was conducted in two phases for 45 days each to study the effects of six stocking densities (Phase-1: 100, 200 and 300 PL m^2 and Phase-2: 250, 500 and 750 PL $m\text{-}^2$) on growth and survival of *Macrobrachium rosenbergii* post larvae (PL) in nylon hapa-nets (1.8 m X 1.8 m X 1.4m) installed in a pond. Stocking densities of 100, 200 and 300 PL_{10}/m^2 resulted in similar ($p < 0.05$) body length (47-48 mm) and survival rate (84-88%), while body weight (0.62 g) in PL with 300/ m^2 was significantly lower.

Two companies SAFICO and GAPP, grew out the PL in small ponds before stocking them in the grow-out ponds. Both companies prefer to grow out the PL from PL_8 to PL_{20} before stocking. Those toke a couple of weeks. The expected weight at the end of the nursing phase was around 1.5 g.

Sadek, 1993 found survival rate of shrimp (*Penaeus monodon*) 64 and 75% where stocking density were 7 and 15 PL/m^2 in water source salinity were 41 and 42 (ppt), respectively.

4.3. Cost-benefits analysis:

In the cost-return analysis total experiment cost is divided into two different sections viz; fixed cost and operational cost. Fixed cost is required during first time installment of the project and the cost is shown in table 8. The main items of expenditure were land rental value, pond and reservoir construction, fencing, shading, pump installment etc. Those costs were needed for the first time of the business. In the first month and or even sometimes in the second month that investment would not be returned. In the present study the fixed cost or installment cost were estimated 43,900 Tk (Table 8).

Table 8: Total fixed cost in the nursing farm.

Item	Unit	Unit price (Tk)	Cost (Tk)
Land rent	20 dec	100	2,000
Pond construction	1 (0.6 dec)	600	600
Reservoir construction	1 (3 dec)	6,000	6,000
Fencing	0.6 dec	300	300
Shading			5,000
Pump installation			25,000
Staff shade			5,000
Total			43,900

All other expenditures were selected as operational cost that was shown in the table 9 The main items of the operational cost were PL, liming to the reservoir, labour, transport etc. The total operational cost from three different treatments was calculated 4,653; 7,107 and 9,361 Tk for T_1, T_2, T_3 respectively.

Table 9: Total operation cost for one pond per cycle nursing in the experimental farm.

Item	Treatment cost								
	T_1			T_2			T_3		
	Unit	Unit price (Tk)	Cost (Tk)	Unit	Unit price (Tk)	Cost (Tk)	Unit	Unit price (Tk)	Cost (Tk)
PL	19600	0.23	4,508	29400	0.23	6,762	39200	0.23	9,016
Liming	0.2kg	8	2	0.2kg	8	2	0.2kg	8	2
Staff cum labor	2	60	120	2	60	120	2	60	120
Transport cost			200			200			200
Fuel			23			23			23
Total			4,653			7,107			9,361

Table 10 shows the total return from three different treatments T_1, T_2 and T_3. After the one cycle experiment total PL were sold to the consumer at the price of 0.38 Tk/PL. in the experiment the calculated return for T_1, T_2 and T_3 were 6154.86, 8125.92 and 8606.62 Tk respectively from one cycle (Table 10).

Table 10: Treatment wise total return per cycle in the experimental period.

Item	Treatment returns								
	T_1			T_2			T_3		
	Unit	Unit price (Tk)	Income (Tk/ pond)	Unit	Unit price (Tk)	Income (Tk/ pond)	Unit	Unit price (Tk)	Income (Tk/ pond)
PL sell	16197	0.38	6154.86	21384	0.38	8125.92	22649	0.38	8606.62

The table 11 shows the cost-benefit analysis of the experiment. Sometimes benefit was not obtained from one season, if the fixed installment was higher. It was observed that benefit was observed after two to four or five cycle. In the experiment cost-benfit analysis was calculated by seventy two times multiplying the return and operation cost that is shown in the Table 11. But always fixed cost was unchanged. Moreover, negative grand return was observed in the treatment three (T_3). The grand total returns were found 64233.92, 29462.24 and -158215.36 Tk from T_1, T_2 and T_3 respectively. Finally in the experiment it was observed return on investment percentage was highest (16.95%) for the treatment of T_1 and negative (-20.34%) for the treatment of T_3.

Table 11: Cost-benefit analysis of the experiment.

Item	Treatment		
	T_1	T_2	T_3
PL sell /pond/cycle	6154.86	8125.92	8606.62
PL sell /9 ponds/8cycles (2 month)	443149.92	585066.24	619676.64
Total operation cost/ pond/cycle	4653.00	7107.00	9361.00
Total operation cost/9 ponds/8cycles (2 month)	335016.00	511704.00	673992.00
Total fixed cost	43900.00	43900.00	43900.00
Grand total of invest cost	378916.00	555604.00	777892.00
Grand return	64233.92	29462.24	-158215.36
Return on investment %	16.95	5.30	-20.34

The variation was occurred due to price investment during the PL buying. Other operational costs were almost same for all the treatments. In the treatment three greater amount of PL cost (9016) had to invest due to highest stocking density of PL (39200). But return from selling of PL was not obtained higher from the treatment three because its survival rate was lower (82.64±1.28) than other two treatments. Thus in the context of return on investment treatment one (T_1) was observed suitable over the treatment two (T_2) while treatment three was found very unsuitable (T_3).

CHAPTER FIVE

CONCLUSION

5.0. Conclusion

Shrimp PL acclimatization is the new industry practicing in the Satkhira District. The PL are getting nursing from the earthen pond has great demand in the farmers level. From the present study it was found that low stocking density of PL showed higher survival rate. But it was found that in the earthen pond nursing system less management strategies were followed where as in case of cemented tank nursing system the operators gave more attention. If some advanced management strategies like feed, aerators, water quality etc could be followed in the earthen pond nursing system then higher survival rate will be found from high stocking density pond and thus the nursery operators would be benefited.

CHAPTER- SIX

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6.0. References

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