Effect of Different Management Practices on the production Performance of Tiger Shrimp (*Penaeus monodon*)

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Effect of Different Management Practices on the production Performance of Tiger Shrimp (*Penaeus monodon*)

Approved as to style and content

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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 is it being concurrently submitted for any degree

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Dedicated to

My Beloved Parents
an unexpressed affection

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Abstract

Economic feasibility of shrimp culture practiced in the southern coastal districts of Bangladesh was studied on randomly selected 45 ponds between March 2006 and October 2006. The water quality parameter, growth performance and cost-benefit aspects were investigated and analyzed. In addition to economic feasibility, the technical aspect of shrimp farming was also investigated. In semi-intensive culture system, the highest temperature, alkalinity, salinity, DO and pH were found 34^0C, 190mg/L, 19ppt, 9ppm and 8.5 respectively and the lowest of those were found 24^0C, 110mg/L, 11ppt, 5ppm and 8.1 respectively. In improved traditional culture system, the highest temperature, alkalinity, salinity, DO and pH were found 34^0C, 190mg/L, 20ppt, 9ppm and 8.5 respectively and the lowest of those were found 24^0C, 110mg/L, 9ppt, 5ppm and 8 respectively. In traditional culture system, the highest temperature, alkalinity, salinity, DO and pH were found 34^0C, 140mg/L, 18ppt, 8ppm and 8.8 respectively and the lowest of those were found 24^0C, 90mg/L, 7ppt, 4ppm and 8 respectively. In semi-intensive culture system, the highest stocking density was 117647 PL/ha in S12 pond and the lowest stocking density was 69231 PL/ha in S15 pond where average stocking density was 85024 PL/ha for both first and second crop. In improved traditional culture system, the highest stocking density was 50000 PL/ha in M6 pond and the lowest stocking density was 10405 PL/ha in M14 pond where average stocking density was 20614 PL/ha for first crop and the highest stocking density was 47727 PL/ha in M6 pond and the lowest stocking density was 10405 PL/ha in M14 pond where average stocking density was 19713 PL/ha for second crop. In traditional culture system, the highest stocking density was 37502 PL/ha in T14 pond and the lowest stocking density was 833 PL/ha in T2 pond where average stocking density was 13698 PL/ha for first crop and the highest stocking density was 31877 PL/ha in T14 pond and the lowest stocking density was 667 PL/ha in T2 pond where average stocking density was 10230 PL/ha for second crop. The highest production rate was found 2638Kg/ha and 2638Kg/ha in S8, 902Kg/ha and 706Kg/ha in M6 and 212Kg/ha and 154Kg/ha in T14 where average production rate was found 1952Kg/ha and 1952Kg/ha in semi-intensive culture, 379.99Kg/ha and 343.96Kg/ha in improved traditional culture and 64.23Kg/ha and 90.73Kg/ha in traditional culture from first and second crop accordingly. Through cost-benefit analysis it was found that by investing Tk.1 profit come Tk.0.31, Tk.2.4 and Tk.0.93 from traditional, improved traditional and semi-intensive culture system respectively.

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CHAPTER – 1

INTRODUCTION

1.1. Background of the study

Bangladesh is fortunate enough having an extensive water resources scattered all over the country in the form of small ponds, beels, lakes, canals, rivers and estuaries covering an area of about 4.34 million hectare. Fisheries sectors provide fulltime employment about 1.2 million and part time employment facilities to about 10.8 million people (DoF, 2003). The fisheries resources contribute 63% of the national animal protein intake, about 5.24% of the total GDP (gross domestic product) and 4.76% of the total foreign earning majority of which comes from exporting of shrimp and prawn. Total annual fish production is 2.102 million mt. in 2003-04, where as only 1.781 million mt in 2000-2001 (DoF, 2005).

In the last three decades, shrimp farming has been transformed from a subsistence activity into a large-scale industry producing 30% of world shrimp supply and generating a retail trade of $US 6 billion per year (World Shrimp Farming 2003). Shrimp farming traces its origin to Southeast Asia where for centuries farmers raised incidental crops of wild shrimp in tidal fishponds. Modern shrimp farming was born in the 1930s when Motosaku Fujinaga, a graduate of Tokyo University, succeeded in spawning the kuruma shrimp *(Penaeus japonicus)*. Dr.Fujinaga cultured larvae through to market size in the laboratory and succeeded in mass producing them on a commercial scale. For more than 40 years, he generously shared his findings and published a number of papers on his works.

Shrimp cultivation has a long and largely quiet history in Bangladesh since its introduce in the early 1970's. Shrimp farming in Bangladesh began to expand rapidly during the mid 1980s (Alauddin and Hamid, 1996). The government of Bangladesh recognized shrimp farming as an industry under the Second Five-Year Plan (1980–85) and adopted measures necessary for increased shrimp production (Haque 1994). As a result in 1979–80, slightly more than 20,000 ha were under shrimp cultivation (Ahmed 19995). Shrimp farming area also has increased from 64000 ha in 1989-1990 to 170000 ha in 2003, with the number of shrimp farms increasing from 10300 in 1998 to 40000 in 2003 (DoF 2002); Nuruzzaman and Muniruzzaman, 2003). Bangladesh earned about US$ 322 million during 2000-2001 by exporting fish and shrimp, 80% of which was from the export of shrimp alone (DoF 2001).

The global shrimp industry has experienced phenomenal growth over the last twenty-two years generating more than 730,000 metric tons of farm cultured product annually. In

Bangladesh Shrimp farming already consumes more than 141352.54 hectares of land and is suffering from unprecedented environmental pressure to clean up its damaging methodology. Production increases in shrimp farming over the past ten years have been primarily due to tremendous increases in pond area rather than increased output per land area. Further expansion and productivity gains will most likely result from intensification brought about through improvements in nutrition and breeding programs. In light of the above subject matter, the present study was conducted to make comparison between traditional, improve-traditional and semi-intensive culture systems of giant tiger shrimp locally known as Bagda.

The giant tiger shrimp, cultured throughout Asia, has always represented more than fifty percent of world production of farmed shrimp, with the western white shrimp *(P. vannamei),* which represents close to 100% of production in the Western Hemisphere, coming in second. The black tiger shrimp, *P. monodon* locally known as "Bagda" is one of the largest penaeid shrimps reaching 260 mm in body length and 250 g in weight (Wyban, 1996). It is the most important shrimp in the world (Wyban, 1996). *P. monodon* is the most important cultivable species among the penaeids. It takes only 3-5 months to reach a body weight of 35g (Liao, 1981). *P. monodon* is omnivorous that needs only cheap food with a low production cost. Typical survival rates are 80-95%, with a survival rate of 95%, production cost are merely half those of similar species, with 50% survival (Liao, 1981). Relatively simple facilities such as low cost clay bottom ponds are suitable for grow out, and even give better results than cement bottom ponds (Liao, 1981). It is rather hardy and resistant to diseases with only a few cases reported for this prawn (Liao, 1977). Due to this unique feature, culture practice of this species has been increasing day by day in tropical and subtropical countries of the world (Liao, 1981).

The production of marine shrimp in impoundments, ponds, raceways and tanks, got started in the early 1970s, and, today, over fifty countries have shrimp culture activities. In the Eastern Hemisphere, Thailand, Vietnam, Indonesia, India and China are the leaders, and Malaysia, Taiwan, Bangladesh, Sri Lanka, The Philippines, Australia and Myanmar (Burma) have large industries. In the Western Hemisphere, Mexico, Belize, Ecuador and Brazil are the leading producers, and there are shrimp farms in Honduras, Panama, Colombia, Guatemala, Venezuela, Nicaragua and Peru. The shrimp importing nations as the United States, Western Europe and Japan—specialize in high-tech "intensive" shrimp farming, but, thus far, their total production has been insignificant. In the Middle East, Saudi Arabia and Iran produce the most farmed shrimp. At present about 150000 hectare of coastal land are under shrimp cultivation in the Bangladesh (Nuruzzaman, 1995). Bagherhat and Khulna districts are the most productive zone for Bagda (*P. monodon)* culture. . Most of the ghers are almost traditionally, collect the fry from the natural sources and rear them in the ghers. As a result, production is 250-273 kg/ha. Where as production rate exceeds 1500-3000 kg/ha in some country (FAO report'97).Total production of shrimp was 30209 metric tons in 2001-02. About 1447.8 corers taka was earned from frozen shrimp products in 2001-02 (DoF, 2003). Bangladesh seafood export earnings were US$ 356 million in 1999-2000. Of this, US$ 322.5 million came from frozen shrimp alone. This accounted for 6.28% of the total export earnings. The black tiger shrimp (*P. monodon)* has very high demand in domestic and international markets the important data from developing countries show that shrimp import expanded from 5 billion$ to 7 billion$ and in the next 5 years it will be 10 billion$.(Taskforce report'98). The main importers of frozen shrimp from Bangladesh are the United States, closely followed by Japan. The European Union as a group is the largest total importer of shrimp from Bangladesh. It has been estimated that the shrimp culture industry provides direct employment to some 350,000 persons, who are engaged in fry collection and transportation, nursery and grow-out operations, and handling and processing. Women have become involved in removing bottoms of shrimp enclosures, beheading shrimps in shrimp depots and collecting post larvae from the rivers and streams. Women are also engaged in repairing dikes and constructing the shrimp farm.

As a result of increases in demand and price, shrimp culture started to expand in the 1970s (Rahaman and Awal, 1993). Presently, land under shrimp culture has increased to about 141352.54 ha to 52,000 ha estimated at the year 2001-2002 (DoF, 2003). About 75% of this land is located in the Khulna, Bagerhat and Satkhira districts in the south and the rest in the Cox's Bazar district in the south-eastern region of the country. According to some estimates, the area suitable for shrimp culture in Bangladesh is around 0.2 million ha. In Khulna areas, shrimp is cultured in the dry season and paddy in the rainy season and in the Cox's Bazar area, shrimp and salt are produced alternately.

Population growth will widen the gap between demand and supply from wild fisheries. Ocean catches have stabilized at approximately 100 million tons per year and future supplies will have to come from aquaculture. Future production growth will most likely shift to intensification wherein output is a consequence of production efficiency per unit area rather than increases in area of production. Efficient use of capital, environmental pressure, and unit cost of administration will mandate earlier return on investment, higher utilization of existing facilities, and reduced exposure to crop failure from accidental loss or disease, and perhaps better food conversion efficiency as the primary rules of operation. Now a days it is proved that, to fulfill the world demand, improved culture technique with genetic improvement could be the only alternatives. The present study was conducted in the southern region to scrutinize the production performance of *P. monodon* in traditional, improve-trditional and semi-intensive culture systems. Black tiger shrimp (*P. monodon*) is the main candidate species of aquaculture in Southern region cultured mainly through traditional method. Management techniques are the main aspects in any culture system, which need experimental trials investigation of physico-chemical parameters and knowledge of their effects on the growth of the cultured shrimp for a particular region.

Prevailing shrimp culture practice includes: extensive (traditional); extensive (improved); semi-intensive; and intensive systems. Under the traditional system, tidal water carrying shrimp juveniles and finfish is allowed to enter during February to April through the sluice gates of the embankment. The trapped juveniles are allowed to grow for about four months before harvest. After the shrimp are harvested, the land is used for rice cultivation during July to December. Coastal embankments, constructed to increase rice production, adversely affected the natural life cycles of many fish and prawns inhabiting the seas and the estuaries. Extensive shrimp farming (low-density) is conducted in the tropics, in low-lying impoundments along bays and tidal rivers, often in conjunction with herbivorous fish. Impoundments range in size from a few hectares to over a hundred hectares. When local waters are known to have high densities of larval shrimp, the farmer opens the gates, impounds the wild larvae and then grows them to market size. Fishermen also capture wild post-larvae and sell them to extensive farmers for stocking. However, stocking densities are quite low, not over 25,000 post-larvae per hectare. The tides provide a water exchange rate from 0 to 5% per day. Shrimp feed on naturally occurring organisms, which may be encouraged with organic or chemical fertilizer. Construction and operating costs are low and so are the yields. Cast-nets and bamboo traps produce harvests of 50 to 500 kilograms (head-on) per hectare per year. Production costs range from $1.00 to $3.00 per kilogram of live shrimp. Since it is illegal in many countries to build new shrimp farms in tidal and mangrove areas, almost no new extensive shrimp farms are being constructed today.

Improved extensive is a superior form over extensive culture system. Where ponds are usually a few ha to 50 ha in size and are normally tidally fed with water. Smaller ponds at higher elevations are sometimes filled with a pump. Two to three juveniles are stocked /m^2. Lime and fertilizers are used and feeding is also done, but not systematically. About 50% of the pond water is exchanged during each spring tide cycle or 5–7 cm of water is exchanged every alternate day. Production is usually between 0.6–1.0 Mt/ha/year over two crops.

Semi-intensive is another improved form of aquaculture. In this system, 10–35 post-larvae /m^2 are stocked in smaller ponds, with sizes ranging from 0.4–5.0 ha. They are given mostly pelleted feed but they also partly subsist on natural foods. The ponds are generally aerated and 10–20% of water is exchanged daily by gravity drainage. Yields of 2–5 Mt/ha/yr are commonly obtained. The fourth one, intensive is the highly scientific culture system organized by a stocking density of 35 post-larvae/m^2, pond size ranging from 0.1 ha to 5 ha in size. Water is aerated and at least 30% of pond water is exchanged daily. Shrimp are fed entirely with artificial feed and production is about 5–10 Mt/ha/year.

Although almost all of the shrimp farms built in the last few years are semi-intensive and intensive in nature, much of the world's production still comes from extensive farms. India, Vietnam, Bangladesh, the Philippines and Indonesia are good examples of countries with vast areas of extensive farms. Ecuador and Honduras have extensive farms. China pursues its own brand of intensive farming. Japan, Taiwan and the United States concentrate on intensive shrimp farming—and intensive farms occur in all the major shrimp farming areas of the world. During the last twenty years, shrimp culture practices in Bangladesh have changed from traditional to improve traditional and there is increasing emphasis now on semi-intensive systems.

1.2. Problems identify

Presently most of the shrimp farms in southern region are following traditional type of culture methods which involves no or very little effort in pond preparation, acclimation, nursing of fries, supplementary feeding, predator control and regular water quality monitoring. As a result, the production rate rarely exceeds 150 kg/ha/year, which is far bellow the production rate achieved in other tiger shrimp producing countries in the world (Hoq et. al.,1994). Besides, shrimp farmers face many problems, such as, land use right, land use policy, legal supports, shortage of shrimp fry, infrastructure, industrial credit and marketing facilities. Very recently production of shrimp faced big setback due to viral out-breaks. It is estimated that viral infection causes a loss of world production of US Dollar 2 billion (Ahmed, 1995). New diseases are still being found (Annon, 1986) and man become suspicious minded to carry out culture practices of shrimp. It is evident that viral diseases are more suspective to marine and brackish water shrimps than fresh water prawns (Nash, 1990).

1.3. Hypothesis:

Effect of different management practices on production performance of tiger shrimp (*Penaeus monodon*).

1.4. Objectives:

The present study has been carried out to compare the production performance of Bagda (*P. monodon*) among traditional, improve-traditional and semi-intensive culture methods that widely practiced in southern region with the following objectives:

- To know the production performance in traditional, improve-traditional and semi-intensive culture systems.
- To know the economic feasibility of three culture methods
- To know the effect of stocking density on growth, survival and production in different culture methods.
- To know the effect of physcio-chemical parameters on growth and survival of cultured shrimp in three different management systems.

CHAPTER – 2

REVIEW OF LITERATURE

In the research world, concerning penaeid shrimp farming, significant effort has been so far paid to the intensification of monoculture of *P. monodon* in overseas countries (Verghese et al.,1975; Liao, 1977; Mokizuki, 1979; Apud et al.,1981,1983; Liu and Mancebo, 1983; Apud,1984; AQUACOP, 1985; Chiang and Liao, 1985; Chiu,1987; Wyban et al.,1987; Tacon,1988; Felix and Sukumaran,1988; Sandifer et al., 1988; Akiyama and Chwang, 1989; Chen et al.,1989; Boyd, 1990; Kongkeo, 1990; Boyd and Fast, 1992; Jackson and Wang, 1996; Linsuwan, 1996).

Effect of various environmental factors on growth and survival of larvae, post larvae, juvenile and adult of *P. monodon"* has also been studied in various countries (Zein-Eldin, 1963; Pantastico and Oliveros, 1980; Guady and Sloane, 1981; Motoh, 1981; Manik et al., 1979; Chakraborti et al., 1985; Chu and So, 1987; Lester and Pante, 1992).

Mirza *et al.* (1978) studied the physico-chemical characteristics of the river Old Brahmaputra at Mymensingh for a period of one year. The physical factor, temperature was found to play important role in aquatic medium and the value of dissolved oxygen was positively correlated with photosynthetic activities of the phytoplankton population.

Dewan (1973) investigated into the ecology in a Mymensingh lake (Bangladesh Agricultural University Campus). He observed higher oxygen concentration during winter and lower oxygen concentration during monsoon. He pointed out that the dissolved oxygen bears an inverse relationship with temperature and free carbon-di-oxide; a direct relationship with pH and total alkalinity.

George *(1961)* found that dissolved oxygen varied from 4.5 ppm to 9.9 ppm. He noted the highest value at 5.30 PM and lowest at 5.30 AM and stated that high 02 content were associated with high rate of photosynthesis.

Goolish and Adelman (1984) recorded maximum growth rate at 30 °C temperature of juvenile common carp. They also observed that the temperature of natural inland waters in the temperate regions generally varies between 0 °C and 30 °C, the maximum values occurring particularly in shallow waters in summer and the minimum exceptionally fall below zero in winter.

Islam *et al.* (1978) observed minimum values of dissolved oxygen during summer and maximum in winter. They observed water temperature was closely related with air temperature.

Lakshmmarayana (1965) in his study on the physico-chemical characteristics observed the higher values of dissolved oxygen throughout most of winter seasons. He stated that the low values of pH during rainy due to the changes in the levels of carbon-de-oxide and carbonates.

Lakshmanan *et al.* (1967) studied on survival and growth of cultivated fishes at the Government fish farms in five districts of Assam. They observed the highest temperature on all the ponds during the months July to August and the lowest during the months of December to January.

Martyshev (1983) stated from the study of the chemical parameters characterizing the suitability of water for carp and trout farms; he observed more than 4 ppm dissolved oxygen and pH 7.0 is optimum values for carps.

Michael (1969) reported that the pH ranging between 7.3 and 8.4 was the most suitable for fish culture. The amount of dissolved gases at any given time was found to be associated with biological activities in water. He further observed variations in total quantity of plankton affected the fish growth and production.

Oppenheimer *et al.* (1978) observed a declining trend of dissolved oxygen, pH, alkalinity and hardness during monsoon in three ponds in Dhaka city and pointed out that the horizontal bottoms of the ponds were richer in nutrients that the sloping sides.

Singh and Singh (1975) concluded that in organically manure ponds dissolved oxygen, pH and total alkalinity remained in the range of 3.0-8.5 mg/l, 6.0—7.8 and 30—125 mg/I which were they considered to be favorable for the growth and survival of major carps and related species of fish.

Shigueno (1975) described various culture techniques of shrimp in Japan. In a series of reports Deshimaru and Yone (1978 a-e) described the nutritional aspects of shrimp and effects of dietary supplements on the feeding behavior of shrimp.

Aure (1988) described in detail collection, handling and transportation of shrimp seed. Baldiverona (1988) described about construction of model ponds for shrimp culture. Chiu (1988a, 1988b) gave valuable suggestion for planning of shrimp farms and pointed out the criteria for intensive shrimp farms.

Chiu (1988c, 1988d) described nutritional aspect of *P. monodon* and water quality management for intensive shrimp culture. Corre (1988) described extensive and semi-intensive shrimp culture practiced in the Philippines.

Parado-Estepa (1988) pointed out important criteria for selecting healthy post larvae for stocking into ponds. Posadas (1988) gave an idea of economic evaluation of the extensive, modified extensive, semi-intensive and intensive systems of shrimp culture in the Philippines.

Tan and Cruz (1988) described the status and prospects of shrimp industry in the Philippines. Lio-po (1988) discussed shrimp health in aquaculture. Baticados (1988) described typical shrimp diseases, their causes, prevention and control measures. Apud (1989) discussed the various management techniques of *P. monodon* under extensive and semi-intensive system.

CHAPTER – 3

MATERIALS & METHODS

3. MATERIALS AND METHODS

3.1. Selection of the study area:

The survey was conducted in the Southern region (Bagerhat, Khulna and Satkhira) of Bangladesh. Fifteen traditional (T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{11}, T_{12}, T_{13}, T_{14}, and T_{15}), fifteen improved traditional (M_1, M_2, M_3, M_4, M_5, M_6, M_7, M_8, M_9, M_{10}, M_{11}, M_{12}, M_{13}, M_{14} and M_{15}) and fifteen semi-intensive (S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{13}, S_{14} and S_{15}) cultured ponds were used in the present study. The water surface areas of traditional ponds T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{11}, T_{12}, T_{13}, T_{14}, and T_{15} were 12.54,30,20.5,12,37.24,24,10,25,35,13,24,193.33,70.67,53.33 and 33 hector respectively, improved traditional M_1, M_2, M_3, M_4, M_5, M_6, M_7, M_8, M_9, M_{10}, M_{11}, M_{12}, M_{13}, M_{14} and M_{15} were 0.4, 0.2, 0.42, 0.42, 0.42, 0.44, 0.38, 0.6, 0.4, 0.4, 0.53, 0.3, 0.5, 1.73 and 0.8 hector respectively and semi-intensive ponds S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{13}, S_{14} and S_{15} were 0.06, 0.32, 0.55, 0.43, 0.38, 0.2, 0.36, 0.36, 0.73, 0.66, 0.53, 0.17, 0.46, 0.5 and 0.13 hector respectively.

3.2. Study period

The study was conducted from March 1, 2006 to 31 October, 2006.

3.3. Data collection

Various physical conditions of the ponds such as types of soil, gher dike, depth of water, color of the water, presence or absence of aquatic weed, etc. were collected at the beginning of the study for once. Physico-chemical parameters of the ghers such as pH, alkalinity (mg $CaCo_3$ / L) and DO (ppm) were measured using chemical kits [NASA chemical kit, CP Aquaculture (India) Pvt. Limited] whereas salinity (ppt) were determined by using refractometer (Model: ref 201) and temperature was measured by using thermometer at every seven days interval. All physic-chemical parameters were taken two times a day (Morning & Evening). At the same time the average body weight (gm) 2.5% shrimp were measured using a digital weight machine (Model: fej-200). Samples of shrimps were collected from 4 to 5 selected spots using a cast net and the samples were kept in a plastic bucket which was washed by potassium permanganate as an anti-septic. Data related too shrimp culture and productivity including pond preparation procedure, fry stocking and post stocking management including liming, fertilization, supplementary feeding and production were collected from farmer's record book.

3.4. Semi-intensive culture system

1. Inlet and pumping system

There was an inlet in the middle of the reservoir in front of the source of river water. There was also a pump machine for collecting water for reservoir from the river. Inlet was prepared to obtain the best quality of incoming water.

2. Reservoir

Every semi-intensive pond has reservoir which was prepared for the farm to supply necessary water in the culture ponds.

3. Aeration

Square shape ponds were aerated using electrical aerator. Each pond was aerated using two long-arm aerator installed at the opposite corner of the pond and powered by generator. It was operated about 12 hours/day.

4. Dikes

Dikes were 0.3m above the maximum water level which was high enough to prevent flooding. Polythene was used along the dike, which continued up to the 1 meter depth of the bottom. Slope of dike was 1: 3 m.

5. Inlet and outlet

All the ponds had inlet and outlet systems.

6. Buildings

Each pond had two houses which were made – one for storing necessary materials and another for the accommodation of workers.

7. Pond preparation

Water of the ponds was removed from the ponds by using pump machine and also black soil was removed from the bottom of the ponds. Then the bottom of the ponds was dried by the sunlight as long as the bottom soil had become cracked. Then ploughing was done by using tractor for two times about one week interval. Entrance of unwanted and fouling organisms was restricted by fencing round the pond. Water was reserved into reservoir from river. After settlement, water was bleached by using bleaching powder into water. After three days dolomite was given at 65kg/hec. After one week water was shifted from reservoir to the ponds.

3.5. Improved traditional culture system

Farm design and pond preparation:

Basic difference between traditional and improved traditional culture systems was pond preparation and nursing system. For improved culture there was no specific pond design.

Just bleaching and liming was done before stocking. An internal nursery was prepared for each pond. Size of internal nursery was depending on stocking size. Pl was released into internal nursery for the first time for about 15 days. With in 15 days feeding was done according to body weight. After 15 days Pl was relieved from the internal nursery. Then it was reared as well as traditional system.

3.6. Traditional culture system

Farm design and pond preparation:

No specific design was followed by the farmer for traditional culture system. At the very beginning of pond preparation the bottom mud was removed by the farmer. The bottom mud was dug with a spade until the undesirable bottom black soil was partially removed. Then dike was repaired to avoid the loss of culturable species. The farmer carried out the repairment of the dikes. The farmer pulled out manually aquatic weeds present in the ghers. The netting controlled the aquatic weeds. In order to control predator, rotenone was used. The main source of water was the tide of the nearby river. In some cases pump water was used. The liming rate varied from 112-750 kg/Ha. which were spread over the gher bottom including the dike walls. Liming was done during fair weather.

3.7. Stocking management

(1) Source of fry

The sources of fry was hatchery which was PCR tested by SSOQ for improved traditional and semi-intensive culture. For traditional culture, sources of fry included both wild source fry and hatchery-produced fry.

(2) Acclimatization

The fry were carried to the gher in an earthen container called hari. The farmer acclimatized the fry through gradual exchange of transported water with the gher water. This was done by slowly adding pond water to the container.

(3) Stocking time

The farmer stocked shrimp fry in the month of March. Stocking was done in the morning because shrimp fry were highly sensitive to abrupt changes of water temperature and exposure to sunlight.

(4) Stocking rate

Treatment	No. of PL	Stocking Density	Treatment	No. of PL	Stocking Density
S_1	9000	7.50	S_9	120000	8.22
S_2	48000	15	S_{10}	51000	7.73
S_3	44500	8.09	S_{11}	44000	4.15
S_4	55000	6.40	S_{12}	40000	4.00
S_5	53000	6.97	S_{13}	51000	5.54
S_6	35000	8.75	S_{14}	80000	8.00
S_7	80000	11.11	S_{15}	9000	6.92
S_8	80000	11.11			

Treatment	No. of PL	Stocking Density	Treatment	No. of PL	Stocking Density
M_1	12700	1.59	M_9	25000	3.13
M_2	5000	1.25	M_{10}	16000	2.00
M_3	13500	1.61	M_{11}	14000	1.32
M_4	18000	2.14	M_{12}	9000	1.50
M_5	15000	1.79	M_{13}	29000	2.90
M_6	43000	4.89	M_{14}	36000	1.04
M_7	12000	1.58	M_{15}	23000	1.44
M_8	25000	2.08			

Treatment	No. of PL	Stocking Density	Treatment	No. of PL	Stocking Density
T_1	65000	0.518341	T_9	1015000	2.9
T_2	450000	1.5	T_{10}	355000	2.730769
T_3	200000	0.97561	T_{11}	1070000	4.458333
T_4	224000	1.866667	T_{12}	4000000	2.069001
T_5	167000	0.448443	T_{13}	3508100	4.964058
T_6	250000	1.041667	T_{14}	3700000	6.937934
T_7	175000	1.75	T_{15}	1056000	3.2
T_8	470000	1.88			

(5) Stocking of other species

In semi-intensive ghers there was no other species and in traditional ghers and modified traditional technology stocking of other species were galda, rui, katla, silver carp, mrigal, vetki, khorsholla.

(6)Feed and feeding

The farmer used CP feed (manufactured and marketed by CP Aquaculture Private Ltd., India) for semi-intensive culture. Farmer mixed 1 egg + 5 g C-Vita + 20 g flour with 1 kg CP feed and feeding frequency was four (6 AM, 11 AM, 5 PM, 10 PM) with a feeding rate prescribed by the feed manufacturer. In case of MTT farmer used CP feed for the first 15 days as well as semi-intensive. After then feeding was used irregularly. However, for traditional ghers the farmer didn't use supplementary feed.

3.8. Post stocking management

(1)Sampling

Sampling was done in weekly interval for measuring body weight of the species and checking water quality parameters in semi-intensive culture ghers. In contrast, no sampling was done in traditional culture ghers.

(2) Fertilization

All semi-intensive, modified traditional and traditional culture ghers were fertilized by inorganic fertilizer through out the culture period. Organic fertilizer was used only for traditional culture ghers.

(3) Liming

During culture period the farmer used dolomite just before the moulting period in his semi-intensive and modified traditional ghers. Liming was often done to prevent algal bloom.

(4) Harvesting

Harvesting was done at a time in semi-intensive ghers. For this, farmer opened the outlet to remove water of the ghers and set a set-bag-net at the mouth of the outlet. He also used khepla jal.

In modified traditional ghers harvesting was done from 90 days after stocking and then continuously it was done by using trap.

In traditional ghers partial harvesting was done from June to August by using net. At the end of the culture period, farmer carried out complete harvest by draining out the pond and then hand picking the fishes.

3.9. Data analysis:

(1)Growth rate:

Growth rate was determined in terms of weight (g). The growth rate of the shrimp was calculated following Mahmud et al., (1993):

$$\text{Growth rate (g/day)} = \frac{W_2 - W_1}{T_2 - T_1}$$

Where, W_2 = Weight (g) at time T_2
W_1 = Weight (g) at time T_1
T_2 = Date of last sampling
T_1 = Date of previous sampling
Here, $T_2 - T_1 = 7$ days

(2)Survival rate:

The survival rate was calculated by using the following formula:

$$\text{Survival rate} = \frac{\text{No. of total live shrimp}}{\text{Total no. of shrimp stocked}} \times 100$$

(3)FCR (Food Conversion Ratio):

The food conversion ratio for the semi-intensive ponds was calculated following New (1990) as follows

$$\text{FCR} = \frac{\text{Dry weight of food presented (kg)}}{\text{Wet weight of animal produced (kg)}}$$

(4)Specific growth rate:

$$\text{SGR (\%day)} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1} \text{ X } 100$$

Where, W_1 = the initial live body weight (g) at time T_1 (day)
W_2 = the final live body weight (g) at time T_2 (day)

4. RESULTS

4.1. Water Quality Parameters

4.1.1. Water Temperature:

Semi-intensive (S_1 to S_{15}) Ponds: The water temperature values varied between 24 ^{0}C and 34 ^{0}C in all the ponds. The water temperature values found to fluctuate in all the ponds during the culture period (Fig. 1.1, 1.2, 1.3).

Improved traditional (M_1 to M_{15}) Ponds: The water temperature values varied between 24 ^{0}C and 34 ^{0}C in all the ponds. The water temperature values found to fluctuate in all the ponds during the culture period (Fig. 2.1, 2.2, 2.3).

Traditional (T_1 toT_{15}) Ponds: The water temperature values varied between 24 ^{0}C and 34 ^{0}C in all the ponds. The water temperature values found to fluctuate in all the ponds during the culture period (Fig.3.1, 3.2, 3.3).

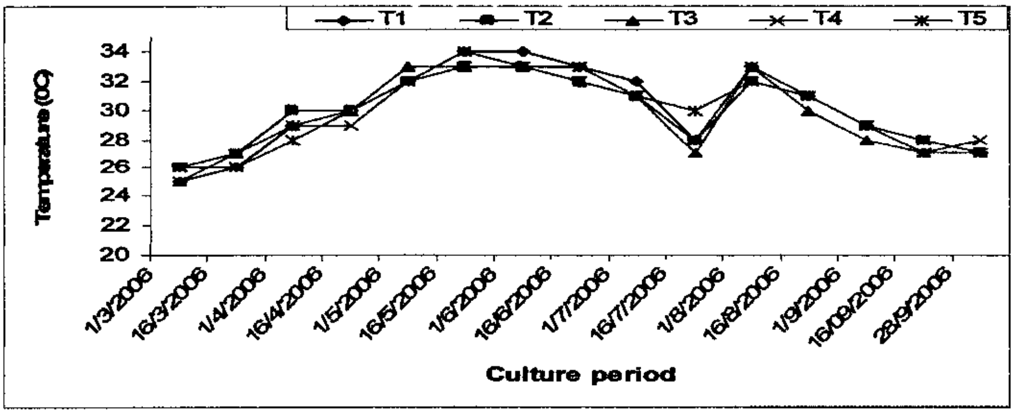

Fig 1.1: Fortnightly water temperature of 5 semi-intensive ponds of Bagerhat

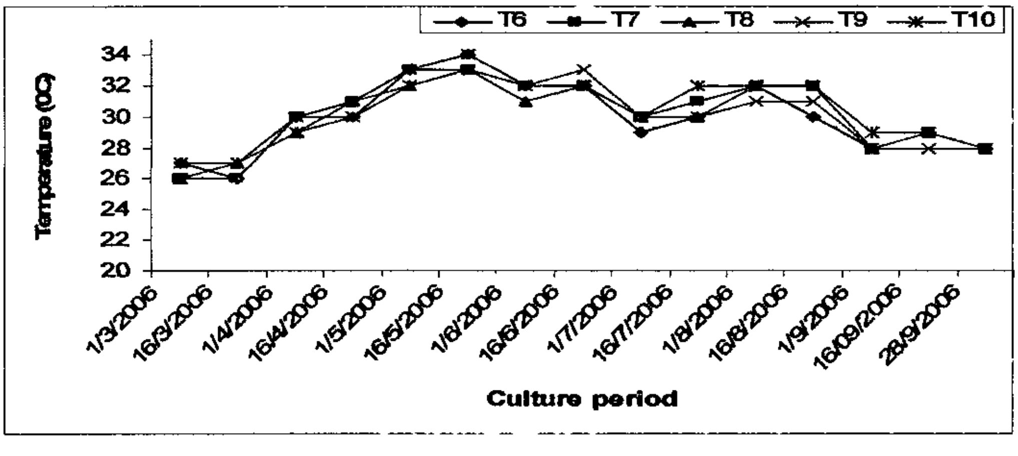

Fig 1.2: Fortnightly water temperature of 5 semi-intensive ponds of Khulna

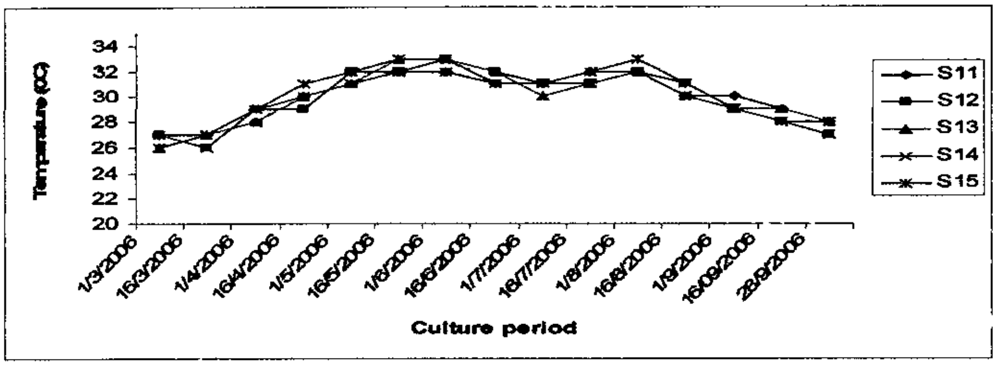

Fig 1.3: Fortnightly water temperature of 5 semi-intensive ponds of Satkhira

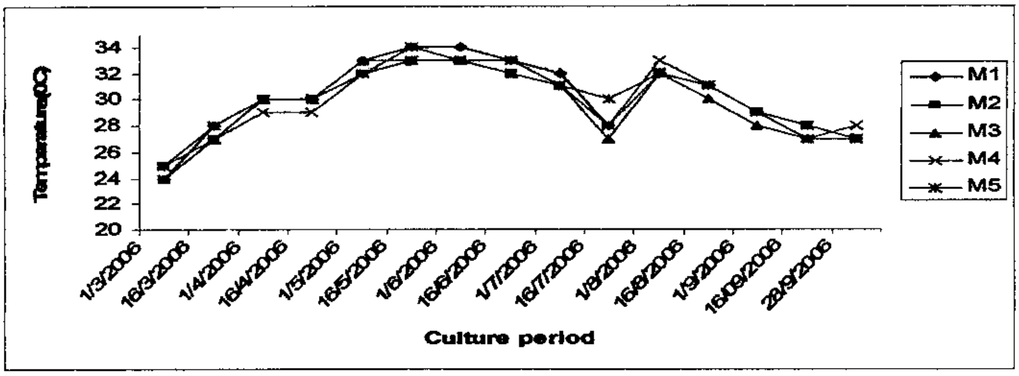

Fig 2.1: Fortnightly water temperature of 5 modified traditional ponds of Bagerhat

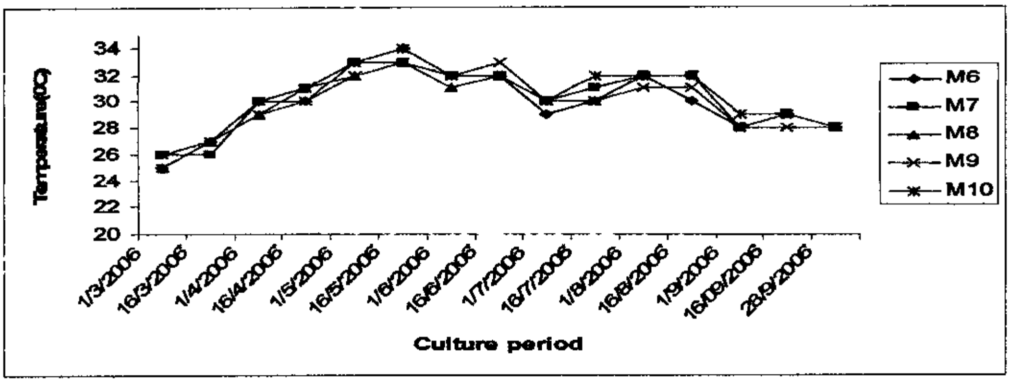

Fig 2.2: Fortnightly water temperature of 5 modified traditional ponds of Khulna

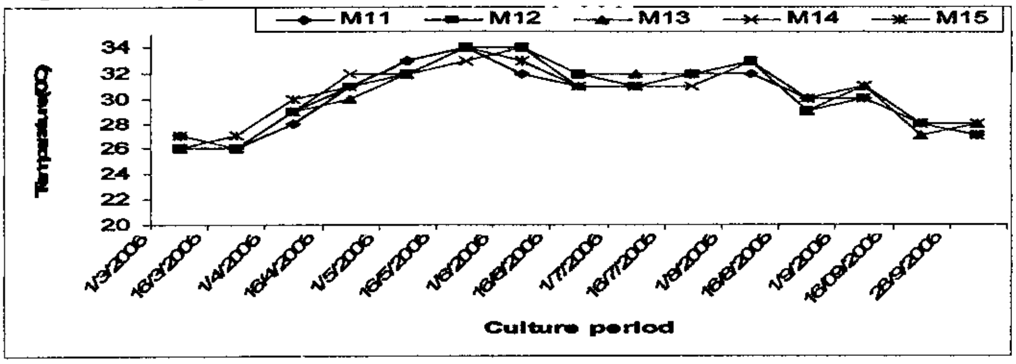

Fig 2.3: Fortnightly water temperature of 5 modified traditional ponds of Satkhira

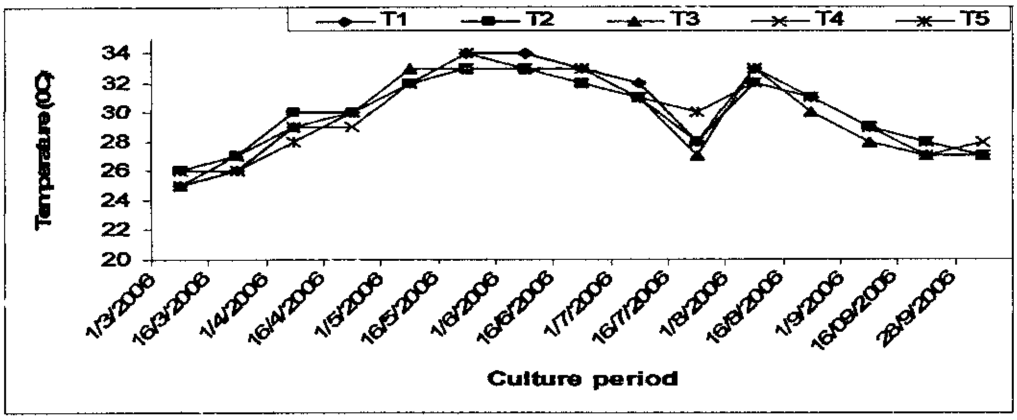

Fig 3.1: Fortnightly water temperature of 5 traditional ponds of Bagerhat

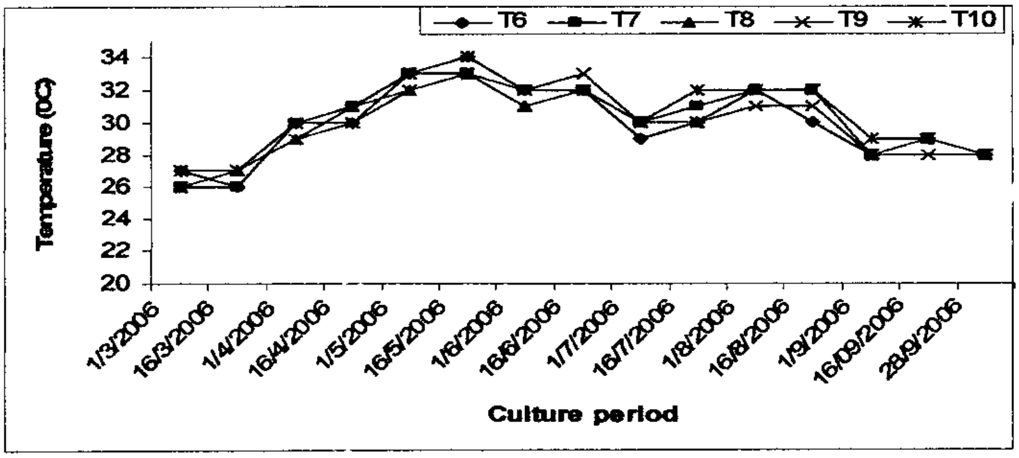

Fig 3.2: Fortnightly water temperature of 5 traditional ponds of Khulna

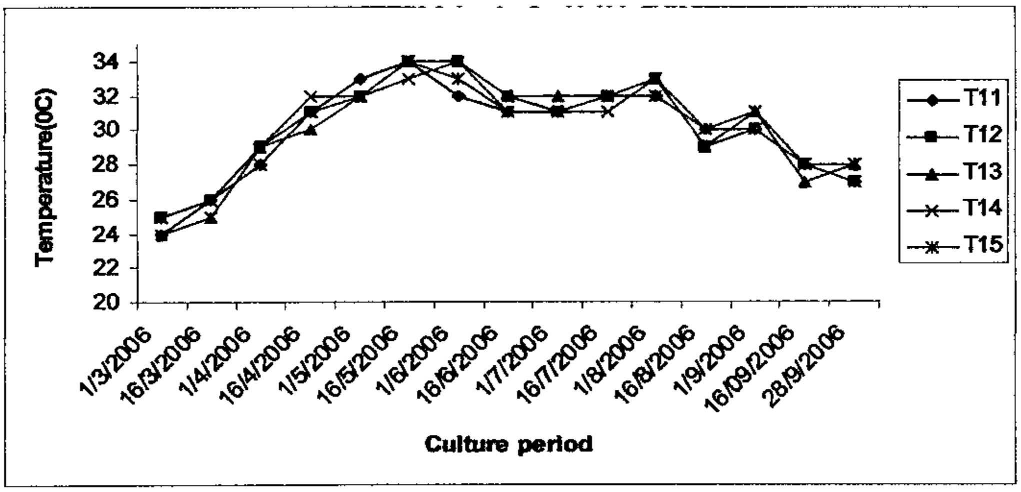

Fig 3.3: Fortnightly water temperature of 5 traditional ponds of Satkhira

4.1.2. Water Alkalinity:

Semi-intensive (S_1 to S_{15}) Ponds: The water alkalinity values varied between 90mg/L and 190 mg/L in all the ponds. The water alkalinity values found to fluctuate in all the ponds during the culture period (Fig. 4.1, 4.2, 4.3).

Improved traditional (M_1 to M_{15}) Ponds: The water alkalinity values varied between 110mg/L and 190 mg/L in all the ponds. The water alkalinity values found to fluctuate in all the ponds during the culture period (Fig. 5.1, 5.2, 5.3).

Traditional (T_1 toT_{15}) Ponds: The water alkalinity values varied between 90mg/L and 140 mg/L in all the ponds. The water alkalinity values found to fluctuate in all the ponds during the culture period (Fig. 6.1, 6.2, 6.3).

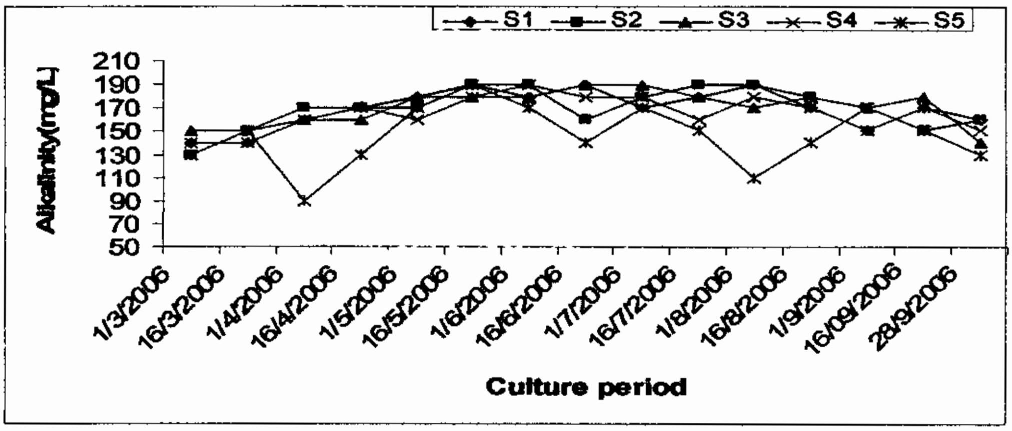

Fig 4.1: Fortnightly alkalinity of 5 semi-intensive ponds of Bagerhat

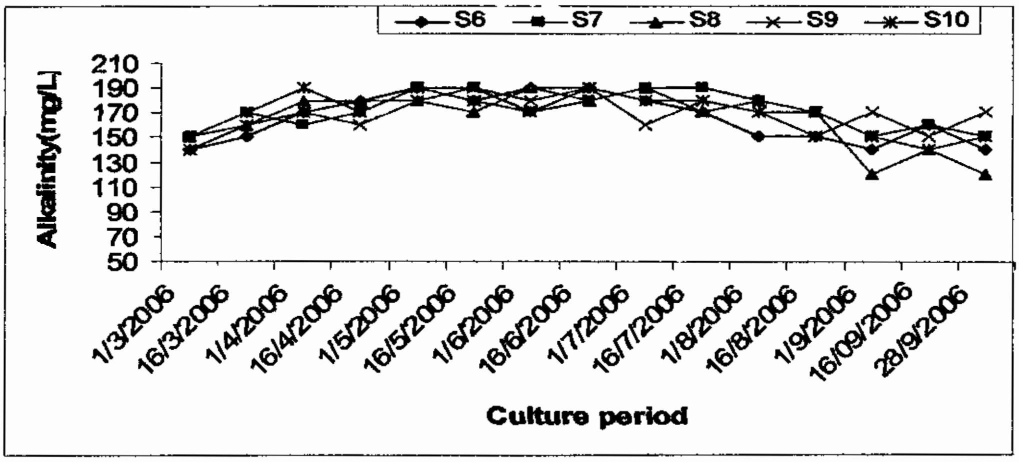

Fig 4.2: Fortnightly alkalinity of 5 semi-intensive ponds of Khulna

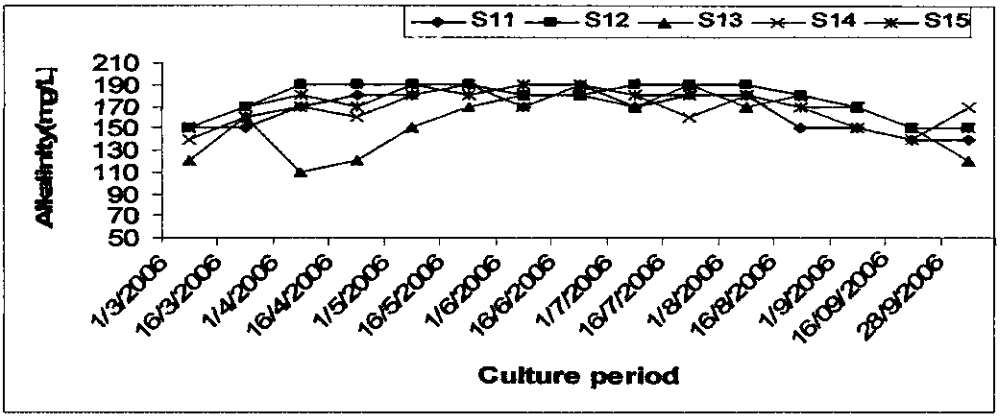

Fig 4.3: Fortnightly alkalinity of 5 semi-intensive ponds of Satkhira

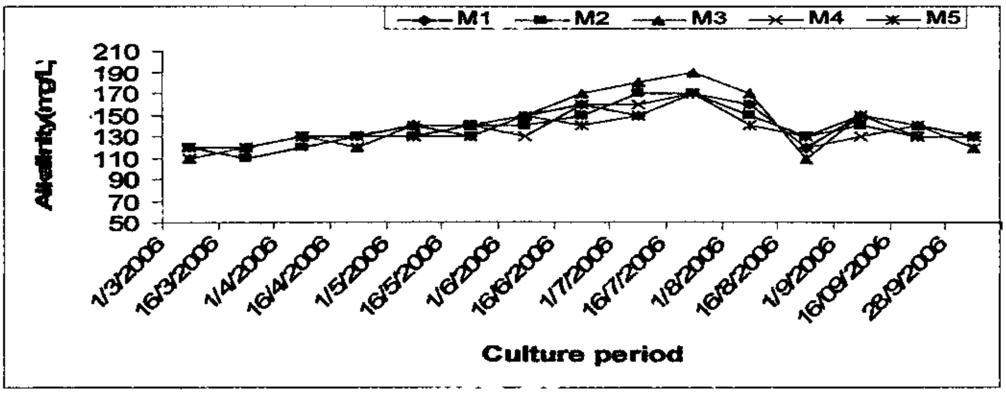

Fig 5.1: Fortnightly alkalinity of 5 modified traditional ponds of Bagerhat

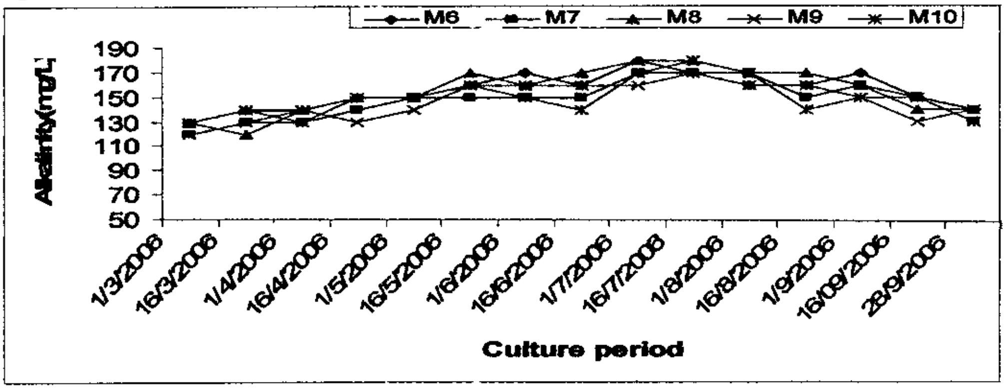

Fig 5.2: Fortnightly alkalinity of 5 modified traditional ponds of Khulna

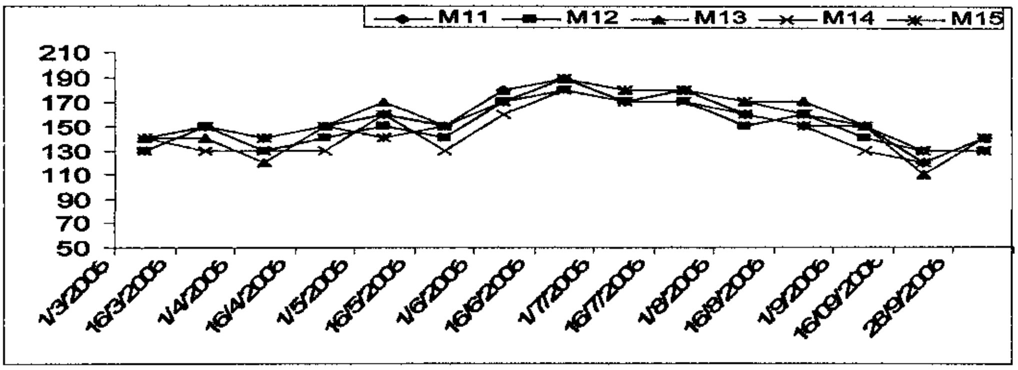

Fig 5.3: Fortnightly alkalinity of 5 modified traditional ponds of Satkhira

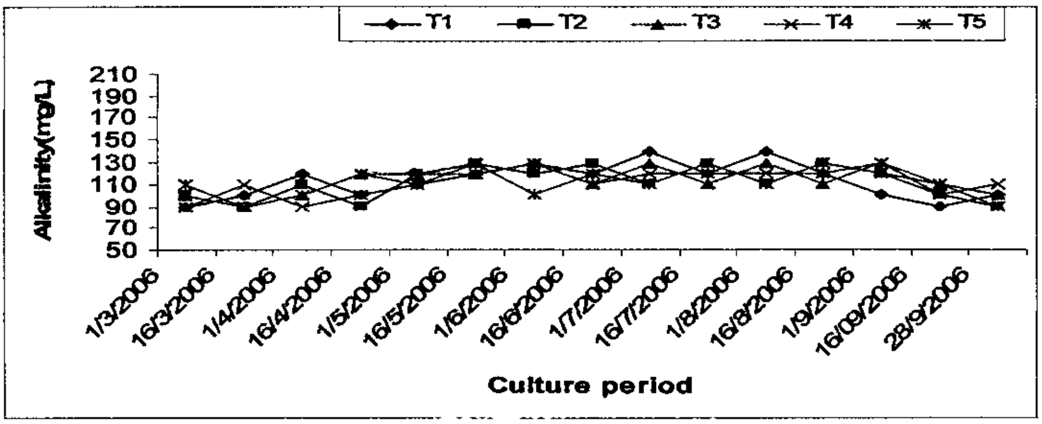

Fig 6.1: Fortnightly alkalinity of 5 traditional ponds of Bagerhat

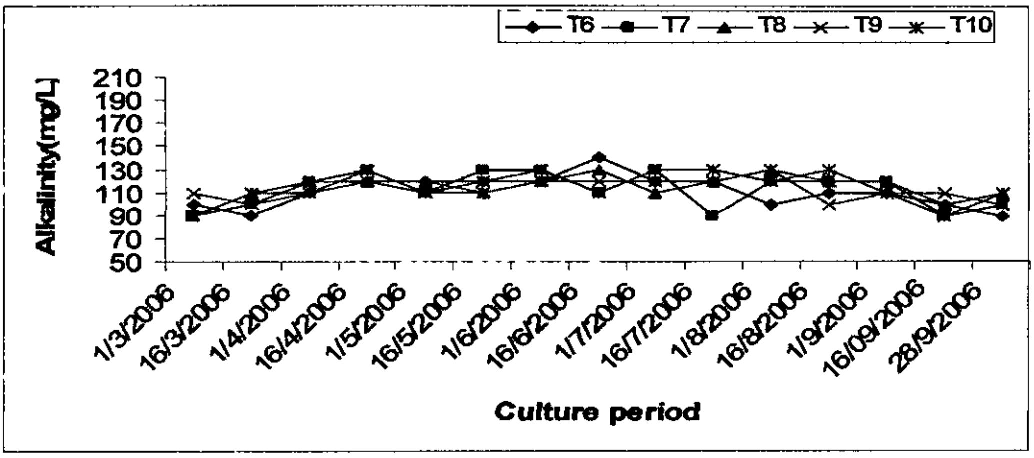

Fig 6.2: Fortnightly alkalinity of 5 traditional ponds of Khulna

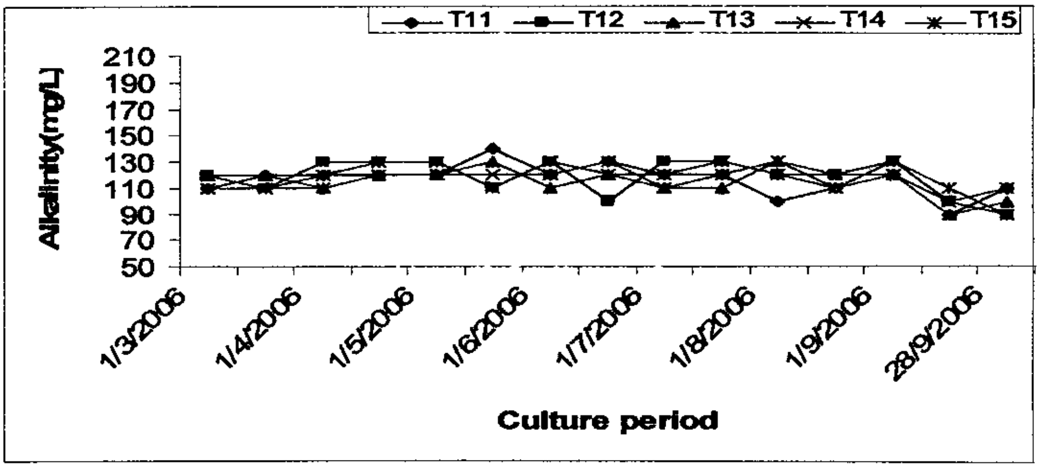

Fig 6.3: Fortnightly alkalinity of 5 traditional ponds of Satkhira

4.1.3. Salinity:

Semi-intensive (S_1 to S_{15}) Ponds: The water salinity varied between 11 ppt and 19 ppt in all the ponds. The salinity gradually increased from March to June, 2007 in all the ponds (Fig. 7.1, 7.2, 7.3). There after it started to decline. The fluctuation of salinity values showed different patterns in all the ponds through out the culture period.

Improved traditional (M_1 to M_{15}) Ponds: The water salinity varied between 9 ppt and 20 ppt in all the ponds. The salinity gradually increased from March to June, 2007 in all the ponds (Fig. 8.1, 8.2, 8.3). There after it started to decline. The fluctuation of salinity values showed different patterns in all the ponds through out the culture period

Traditional (T_1 toT_{15}) Ponds: The water salinity varied between 7 ppt and 18 ppt in all the ponds. The salinity gradually increased from March to June, 2007 in all the ponds (Fig. 9.1, 9.2, 9.3). There after it started to decline. The fluctuation of salinity values showed different patterns in all the ponds through out the culture period.

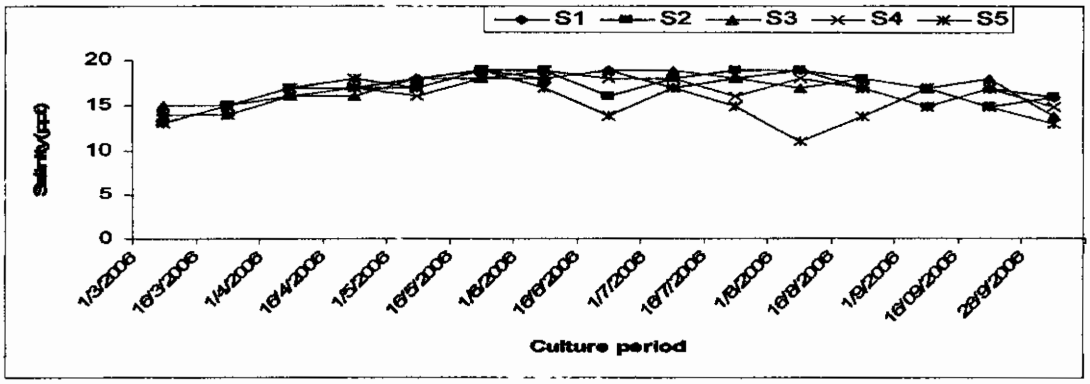

Fig 7.1: Fortnightly water salinity of 5 semi-intensive ponds of Bagerhat

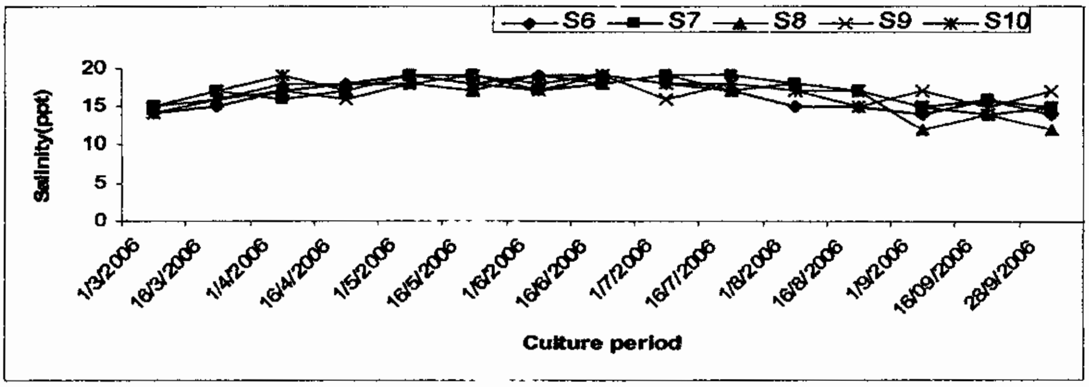

Fig 7.2: Fortnightly water salinity of 5 semi-intensive ponds of Khulna

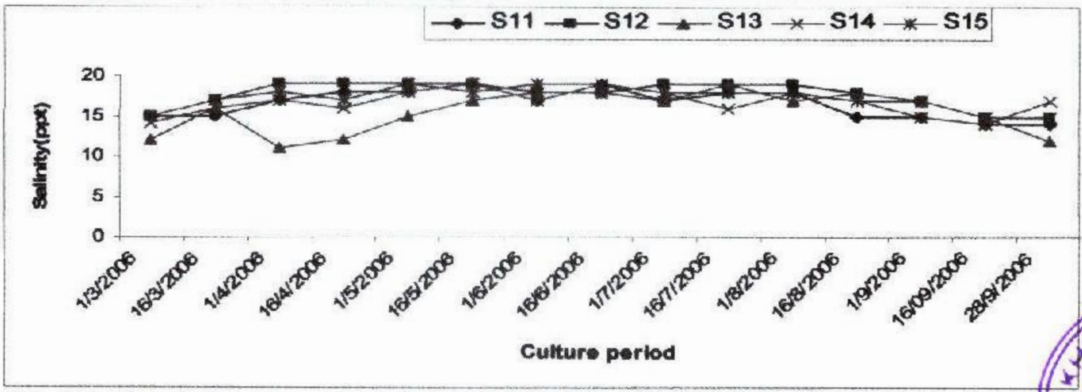

Fig 7.3: Fortnightly water salinity of 5 semi-intensive ponds of Satkhira

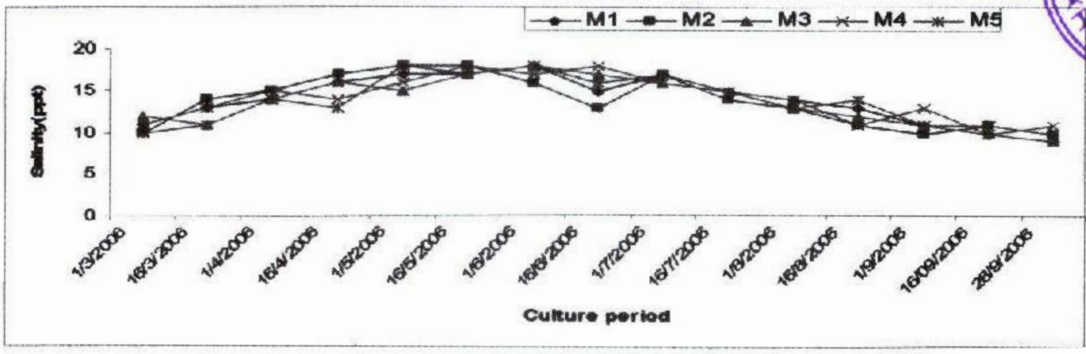

Fig 8.1: Fortnightly water salinity of 5 modified traditional ponds of Bagerhat

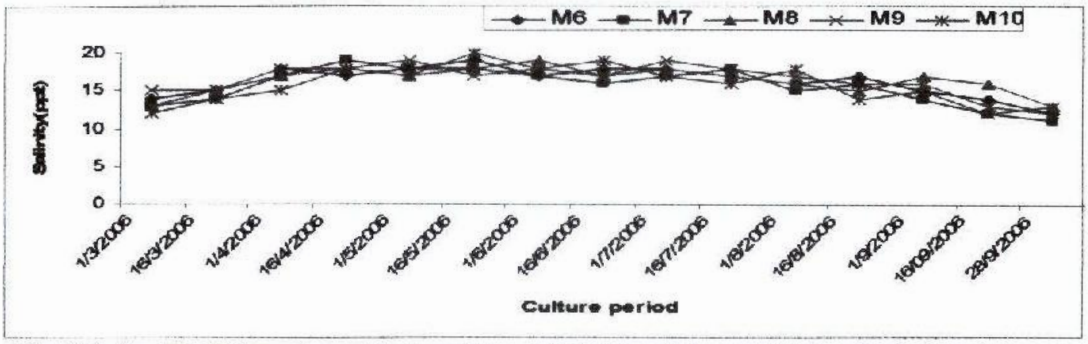

Fig 8.2: Fortnightly water salinity of 5 modified traditional ponds of Khulna

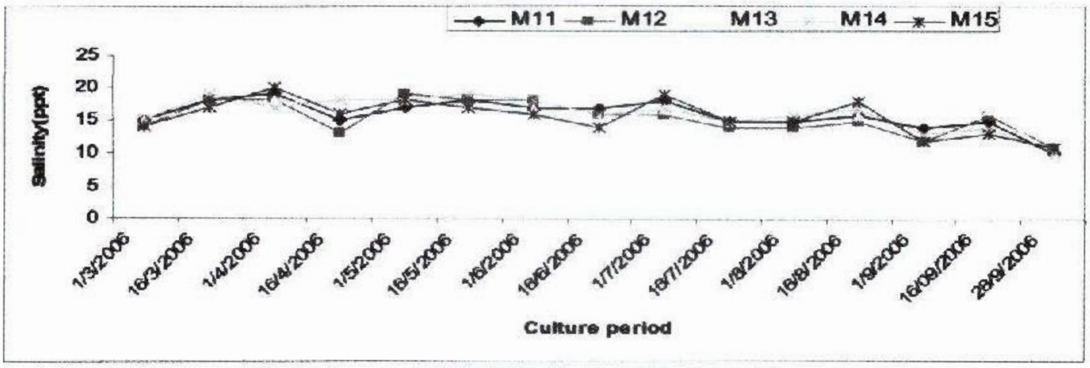

Fig 8.3: Fortnightly water salinity of 5 modified traditional ponds of Satkhira

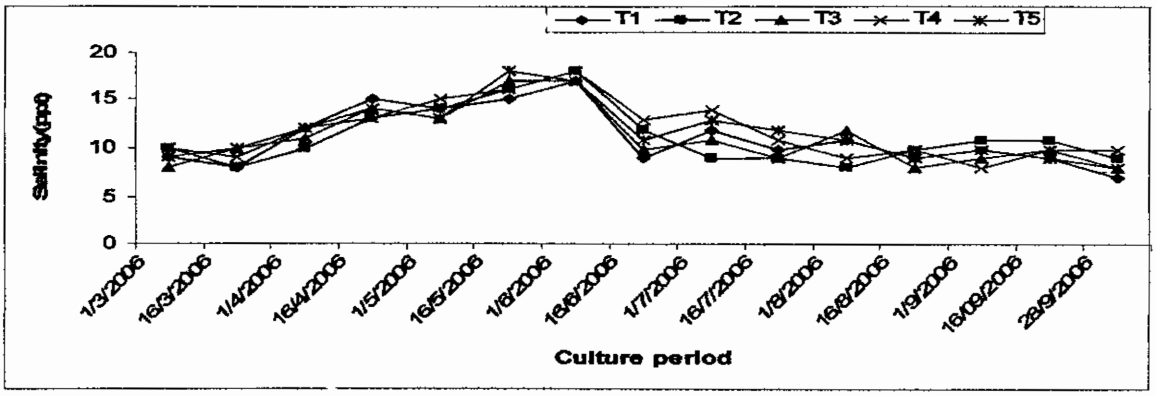

Fig 9.1: Fortnightly water salinity of 5 traditional ponds of Bagerhat

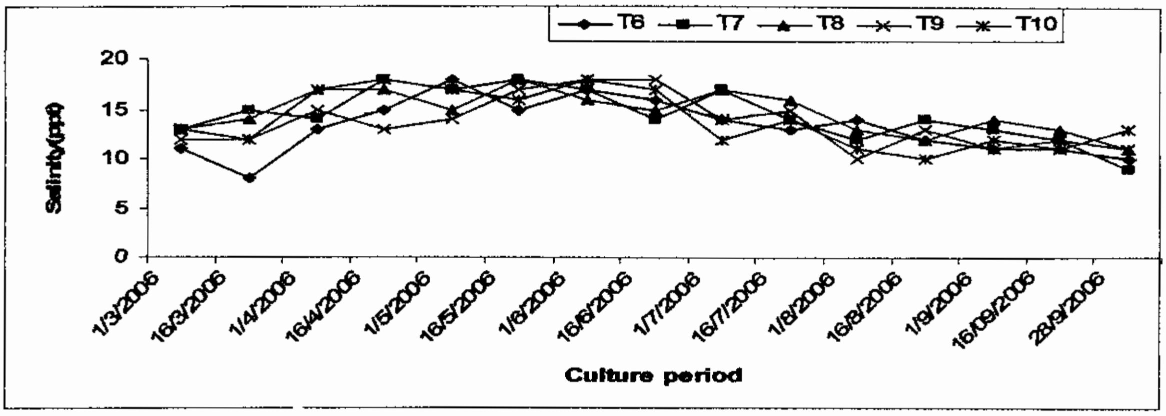

Fig 9.2: Fortnightly water salinity of 5 traditional ponds of Khulna

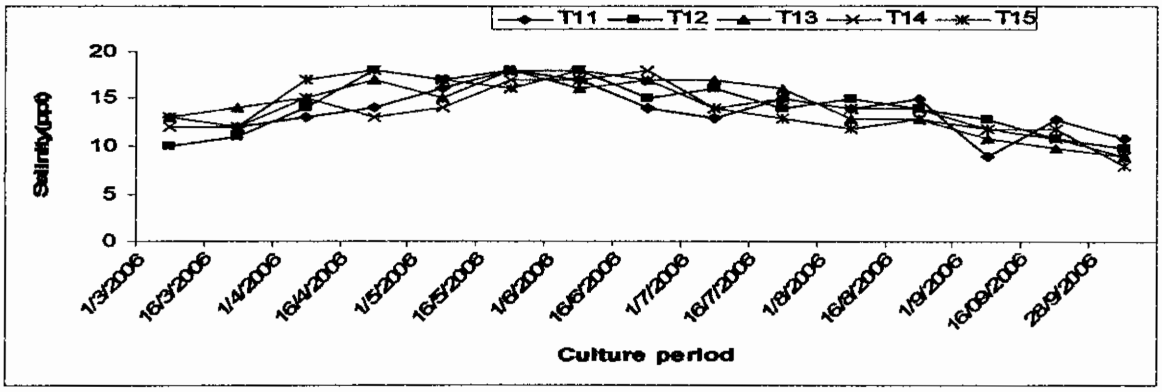

Fig 9.3: Fortnightly water salinity of 5 traditional ponds of Satkhira

4.1.4. pH

Semi-intensive (S_1 to S_{15}) Ponds: The pH values varied between 8.1 and 8.5 in all the ponds. The fluctuation of pH values showed different patterns in all the ponds through out the culture period (Fig.10.1, 10.2, 10.3).

Improved traditional (M_1 to M_{15}) Ponds: The pH values varied between 8 and 8.5 in all the ponds. The fluctuation of pH values showed different patterns in all the ponds through out the culture period (Fig.11.1, 11.2, 11.3).

Traditional (T_1 to T_{15}) Ponds: The pH values varied between 8 and 8.8 in all the ponds. The fluctuation of pH values showed different patterns in all the ponds through out the culture period (Fig.12.1, 12.2, 12.3).

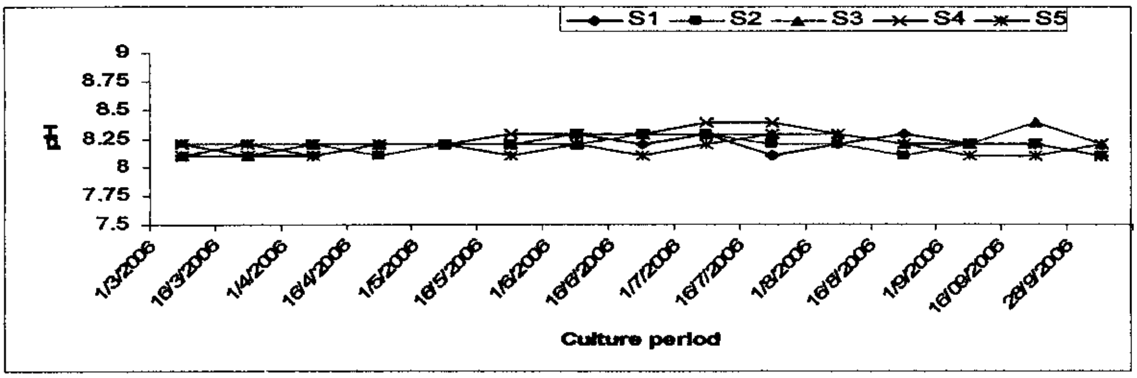

Fig 10.1: Fortnightly water pH of 5 semi-intensive ponds of Bagerhat

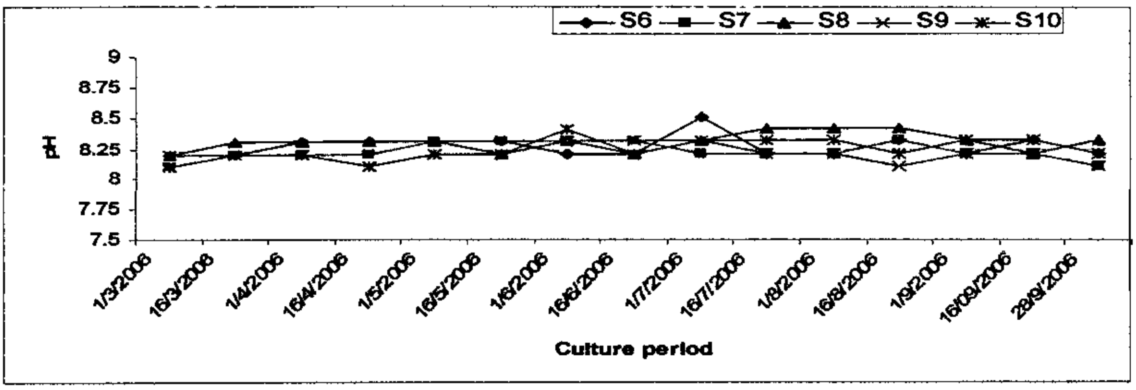

Fig 10.2: Fortnightly water pH of 5 semi-intensive ponds of Khulna

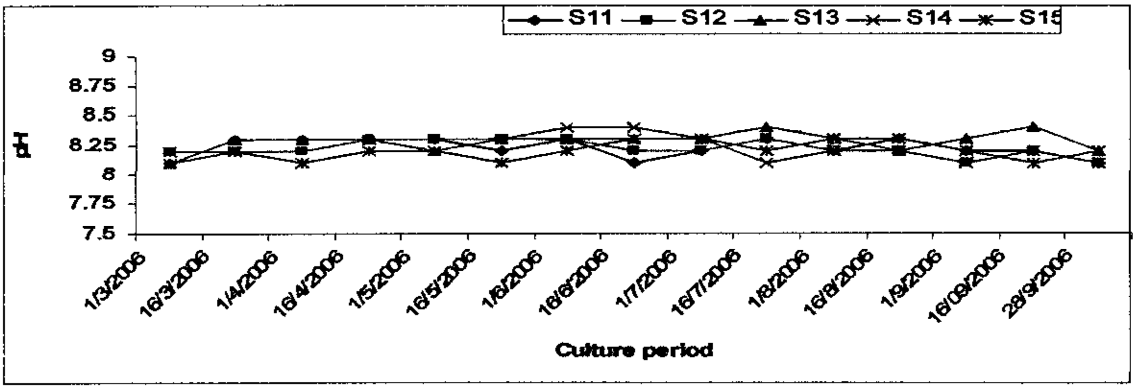

Fig 10.3: Fortnightly water pH of 5 semi-intensive ponds of Satkhira

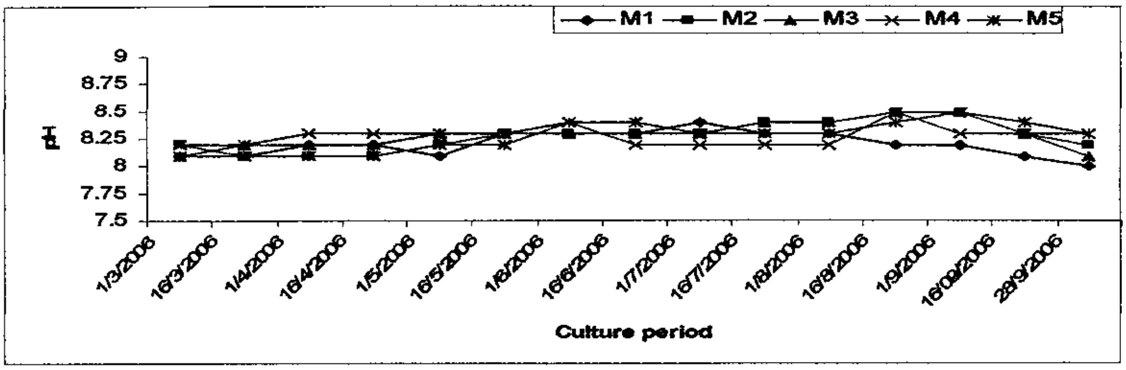

Fig 11.1: Fortnightly water pH of 5 modified traditional ponds of Bagerhat

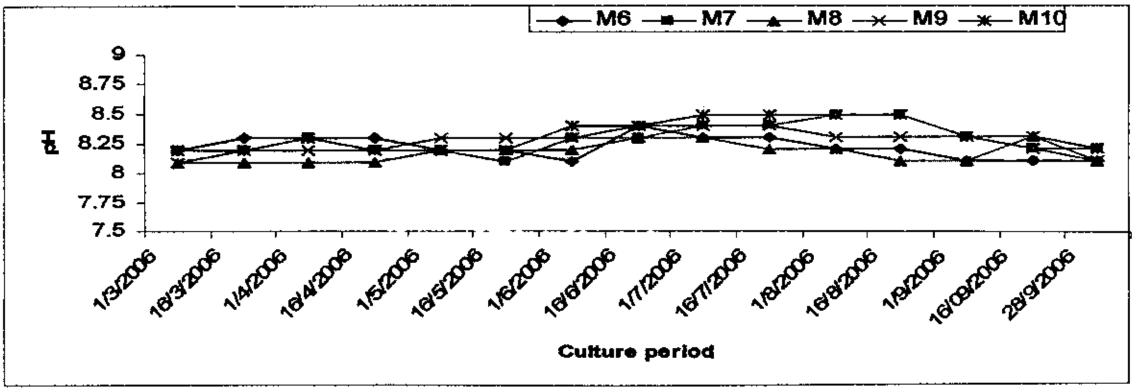

Fig 11.2: Fortnightly water pH of 5 modified traditional ponds of Khulna

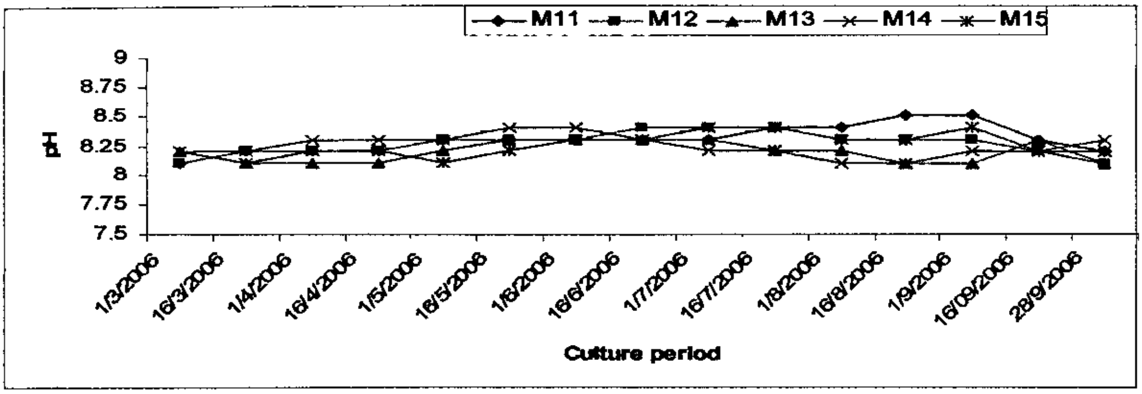

Fig 11.3: Fortnightly water pH of 5 modified traditional ponds of Satkhira

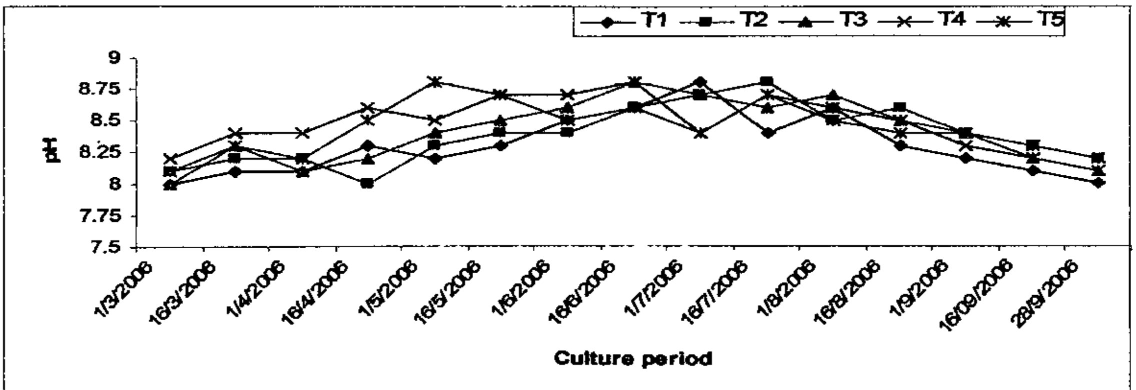

Fig 12.1: Fortnightly water pH of 5 traditional ponds of Bagerhat

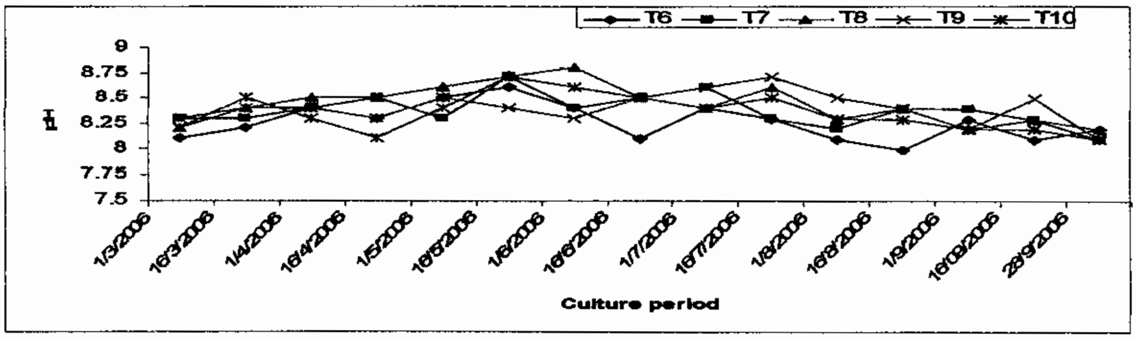

Fig 12.2: Fortnightly water pH of 5 traditional ponds of Khulna

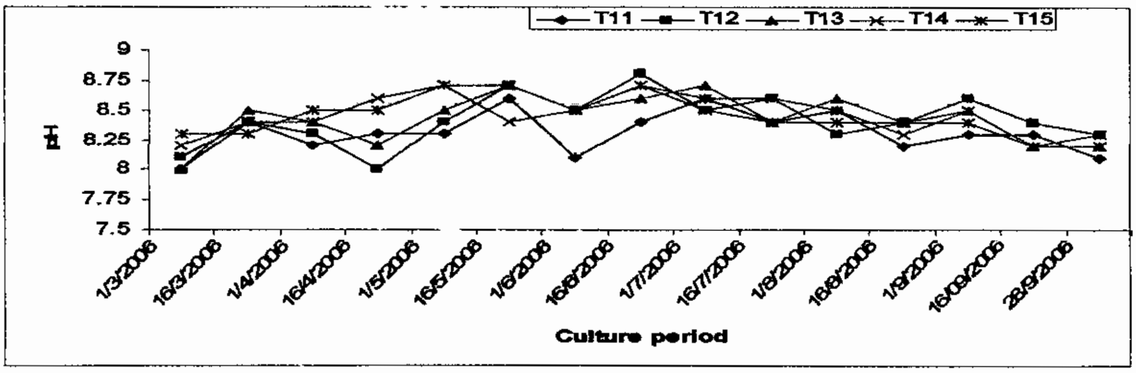

Fig 12.3: Fortnightly water pH of 5 traditional ponds of Satkhira

4.1.5. DO

Semi-intensive (S_1 to S_{15}) Ponds: The DO values varied between 5 ppm and 9 ppm in all the ponds. The fluctuation of DO values showed different patterns in all the ponds through out the culture period (Fig.13.1, 13.2, 13.3).

Improved traditional (M_1 to M_{15}) Ponds: The DO values varied between 5 ppm and 9 ppm in all the ponds. The fluctuation of DO values showed different patterns in all the ponds through out the culture period (Fig.14.1, 14.2, 14.3).

Traditional (T_1 toT_{15}) Ponds: The DO values varied between 4 ppm and 8 ppm in all the ponds. The fluctuation of DO values showed different patterns in all the ponds through out the culture period (Fig.15.1, 15.2, 15.3).

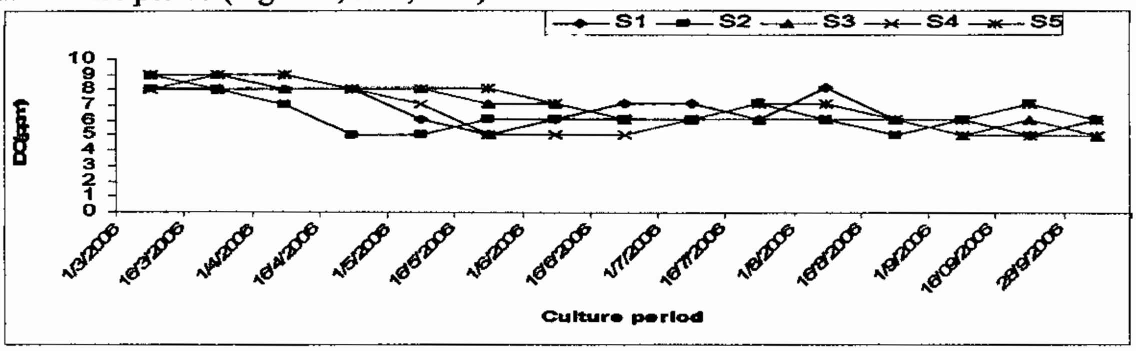

Fig 13.1: Fortnightly water DO of 5 semi-intensive ponds of Bagerhat

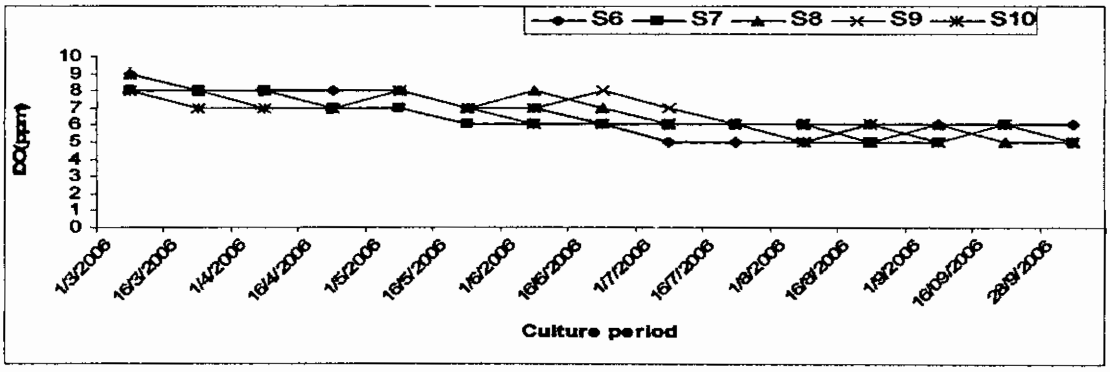

Fig 13.2: Fortnightly water DO of 5 semi-intensive ponds of Khulna

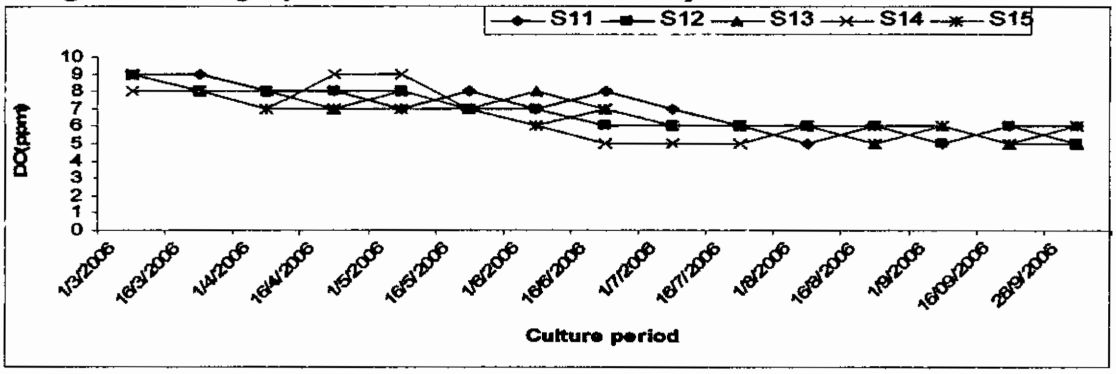

Fig 13.3: Fortnightly water DO of 5 semi-intensive ponds of Satkhira

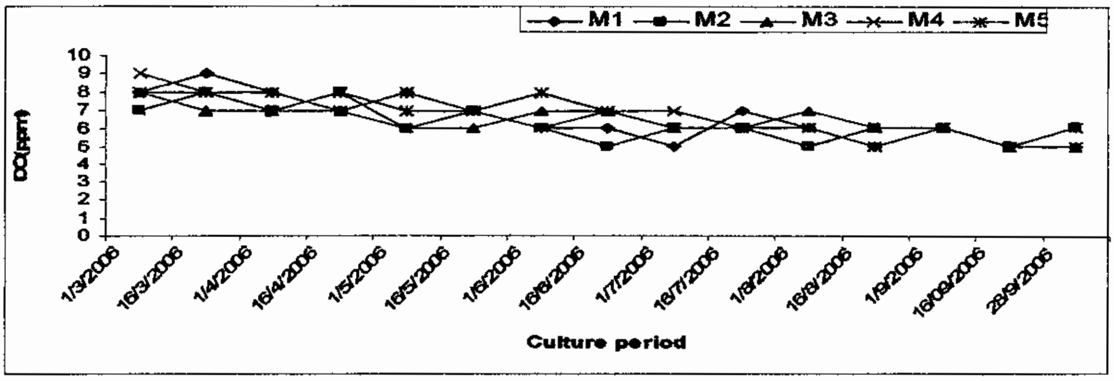

Fig 14.1: Fortnightly water DO of 5 modified traditional ponds of Bagerhat

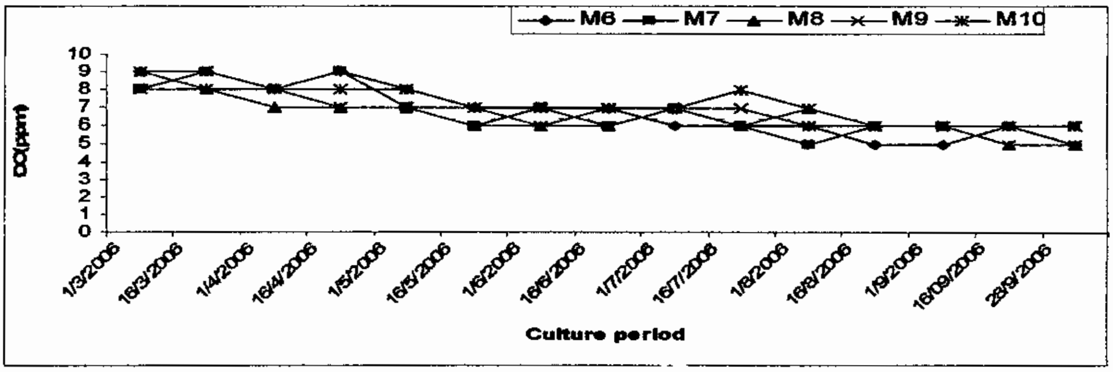

Fig 14.2: Fortnightly water DO of 5 modified traditional ponds of Khulna

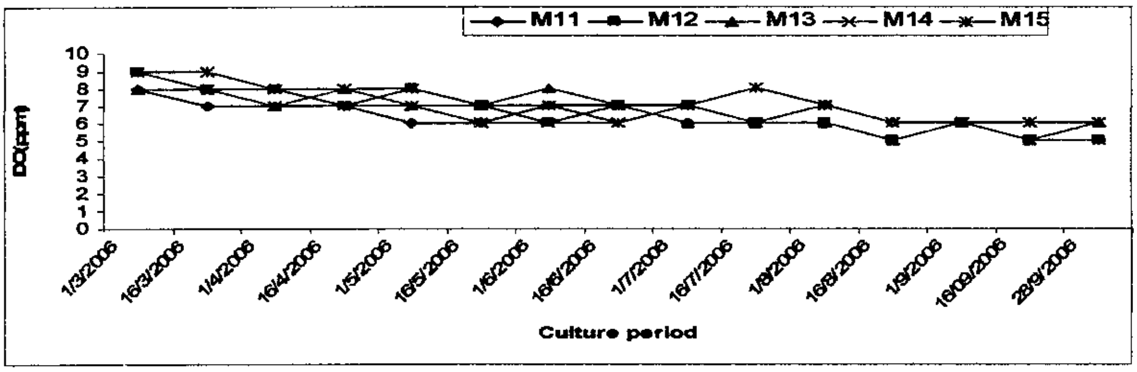

Fig 14.3: Fortnightly water DO of 5 modified traditional ponds of Satkhira

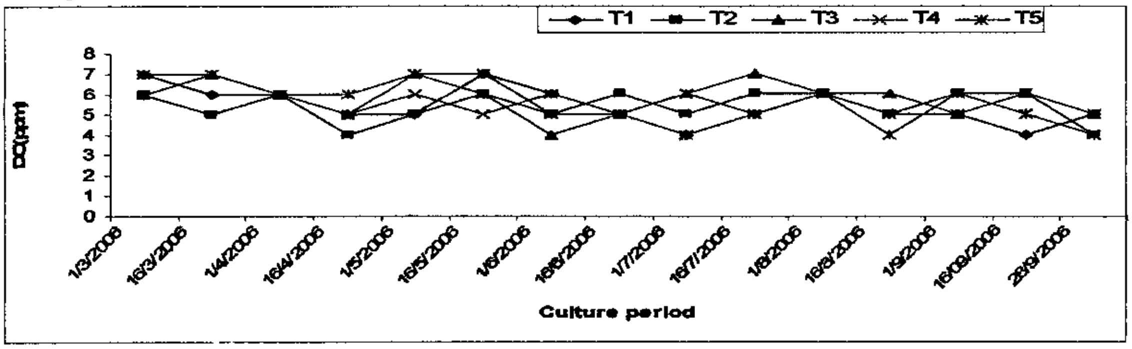

Fig 15.1: Fortnightly water DO of 5 traditional ponds of Bagerhat

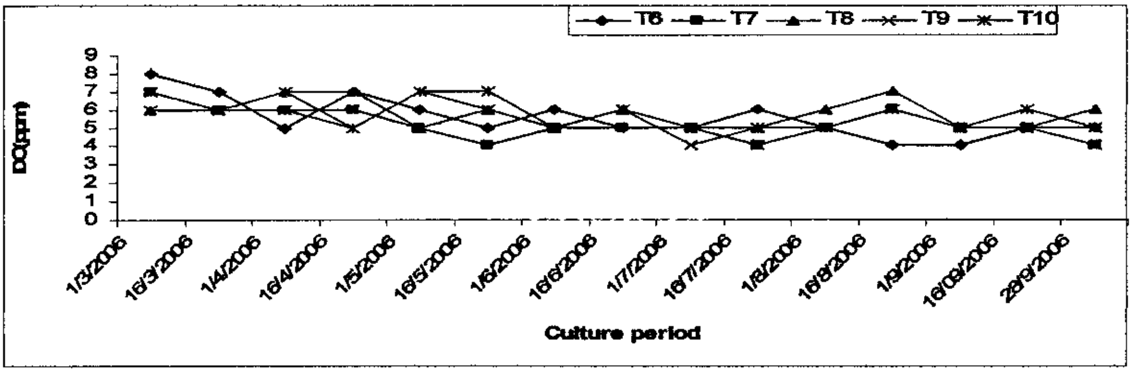

Fig 15.2: Fortnightly water DO of 5 traditional ponds of Khulna

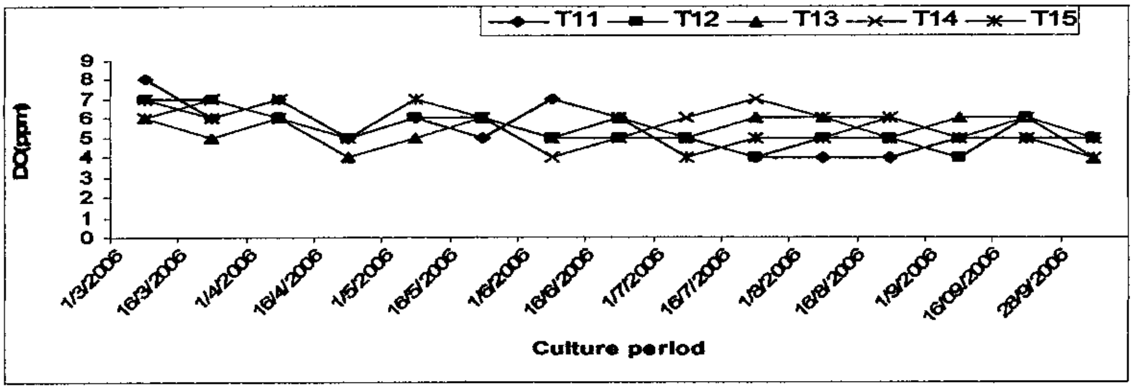

Fig 15.3: Fortnightly water DO of 5 traditional ponds of Satkhira

Table 1: Water quality parameters of semi-intensive ponds

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}	S_{15}
Highest salinity (ppt)	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Lowest salinity (ppt)	14	13	14	14	11	14	15	12	14	14	14	15	11	14	15
Average salinity (ppt)	16.93	17.00	17.07	16.53	15.47	16.53	17.13	16.53	16.80	17.00	16.60	17.73	15.60	16.73	17.33
Highest alkalinity (mg/l)	190	190	190	190	190	190	190	190	190	190	190	190	190	190	190
Lowest alkalinity (mg/l)	140	130	140	140	90	140	150	120	140	140	140	150	110	140	150
Average alkalinity (mg/l)	169.3	170.0	170.7	165.3	146.0	165.3	171.3	165.3	168.0	170.0	166.0	177.3	156.0	167.3	173.3
Highest DO (ppm)	9	8	9	9	9	9	8	9	8	8	9	9	9	9	9
Lowest DO (ppm)	5	5	5	5	6	5	5	5	5	5	5	5	5	5	5
Average DO (ppm)	6.80	6.27	6.73	6.47	7.27	6.67	6.33	6.73	6.73	6.27	7.00	6.73	6.73	6.53	6.53
Highest pH	8.3	8.3	8.4	8.4	8.3	8.5	8.3	8.4	8.3	8.4	8.3	8.3	8.4	8.4	8.3
Lowest pH	8.1	8.1	8.1	8.1	8.1	8.2	8.1	8.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Average pH	8.19	8.20	8.23	8.24	8.17	8.26	8.22	8.29	8.20	8.23	8.23	8.22	8.28	8.21	8.21
Highest temperature(^{0}C)	34	34	33	34	34	34	33	34	33	33	32	33	33	32	33
Lowest temperature(^{0}C)	25	25	25	24	25	25	26	26	25	26	27	26	26	26	26
Average temperature(^{0}C)	29.93	30.00	30.07	30.00	30.27	29.53	29.80	29.80	29.47	29.93	30.00	29.93	29.93	29.73	30.27

Table 2: Water quality parameters of improved traditional ponds

	M_1	M_2	M_3	M_4	M_5	M_6	M_7	M_8	M_9	M_{10}	M_{11}	M_{12}	M_{13}	M_{14}	M_{15}
Highest salinity (ppt)	18	18	18	18	18	19	19	19	19	20	19	19	18	19	20
Lowest salinity (ppt)	9	10	9	10	10	12	11	13	12	12	10	11	10	10	11
Average salinity (ppt)	14.00	13.80	13.73	14.13	13.87	16.33	15.67	16.40	16.53	15.87	15.93	15.47	16.13	16.13	15.67
Highest alkalinity (mg/l)	170	170	190	170	170	180	170	180	170	180	190	180	190	180	190
Lowest alkalinity (mg/l)	120	110	110	120	110	130	120	120	120	130	120	120	110	120	130
Average alkalinity (mg/l)	140.0	137.3	142.7	137.3	136.0	155.3	148.0	155.3	147.3	149.3	155.3	149.3	156.0	146.7	154.7
Highest DO (ppm)	9	8	8	9	8	9	9	9	8	9	8	9	8	9	9
Lowest DO (ppm)	5	5	5	5	5	5	5	5	5	6	5	5	5	5	6
Average DO (ppm)	6.53	6.27	6.40	6.67	6.67	6.87	6.80	6.53	6.67	7.20	6.40	6.67	6.67	6.53	7.20
Highest pH	8.4	8.5	8.5	8.5	8.5	8.4	8.5	8.3	8.4	8.5	8.5	8.4	8.3	8.4	8.4
Lowest pH	8	8.1	8.1	8.2	8.1	8.1	8.1	8.1	8.1	8.2	8.1	8.1	8.1	8.1	8.1
Average pH	8.21	8.28	8.29	8.28	8.27	8.22	8.29	8.17	8.27	8.33	8.30	8.27	8.19	8.25	8.25
Highest temperature(^{0}C)	34	33	33	34	33	34	33	33	33	34	34	34	34	34	34
Lowest temperature(^{0}C)	24	25	24	24	25	25	26	25	25	26	26	26	26	26	26
Average temperature(^{0}C)	30.13	29.87	29.60	29.80	30.13	29.93	30.20	29.93	29.80	30.40	30.13	30.27	30.33	30.27	30.47

Table 3: Water quality parameters of traditional ponds

	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}	T_{14}	T_{15}
Highest salinity (ppt)	17	18	17	18	18	18	18	18	18	18	18	18	18	18	18
Lowest salinity (ppt)	7	8	8	8	8	8	9	11	10	10	9	10	9	9	8
Average salinity (ppt)	11.13	11.20	11.13	11.87	11.73	13.20	14.47	14.73	13.67	14.07	13.80	14.27	14.27	13.80	14.13
Highest alkalinity (mg/l)	140	130	130	130	130	140	130	130	130	130	140	130	130	130	130
Lowest alkalinity (mg/l)	90	90	90	90	90	90	90	90	100	90	90	90	90	100	90
Average alkalinity (mg/l)	113.3	112.0	114.0	112.0	112.0	111.3	112.7	115.3	112.7	115.3	116.7	118.7	115.3	116.0	118.0
Highest DO (ppm)	7	6	7	7	7	8	7	7	7	7	8	7	6	7	7
Lowest DO (ppm)	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4
Average DO (ppm)	5.40	5.40	5.80	5.53	5.67	5.53	5.20	5.80	5.53	5.60	5.47	5.40	5.40	5.80	5.53
Highest pH	8.8	8.8	8.8	8.8	8.8	8.6	8.7	8.8	8.7	8.7	8.6	8.8	8.7	8.7	8.7
Lowest pH	8	8	8	8.1	8.1	8	8.1	8.2	8.1	8.1	8	8	8	8.2	8.2
Average pH	8.30	8.38	8.41	8.47	8.44	8.27	8.38	8.44	8.41	8.35	8.31	8.42	8.43	8.45	8.45
Highest temperature(^{0}C)	34	33	33	34	33	34	33	33	33	34	34	34	34	34	34
Lowest temperature(^{0}C)	25	26	25	25	26	26	26	26	27	26	24	25	24	24	25
Average temperature(^{0}C)	30.00	29.93	29.67	29.87	29.93	30.00	30.20	30.00	29.93	30.40	29.93	30.20	30.13	30.00	30.13

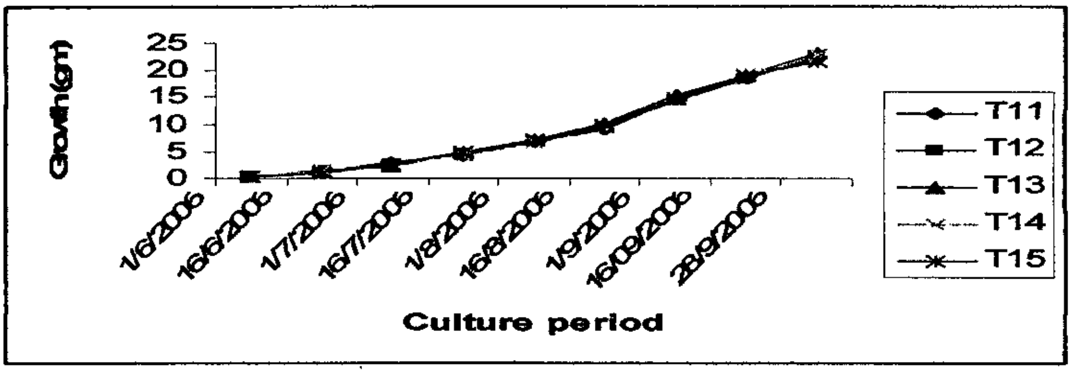

Fig.16.3.2. Fortnightly growth performance of 5 traditional ponds of Satkhira

Improved Traditional (M_1 to M_{15}) Ponds:

The growth of *P. monodon* by weight in all the ponds are presented in Figs.17.1.1, 17.1.2, 17.2.1, 17.2.2, 17.3.1, 17.3.2. The growth of *P. monodon* by weight in all the Improved Traditional ponds increased throughout the culture period. In first crop the initial average body weight of shrimps in the pond M_1, M_2, M_3, M_4, M_5, M_6, M_7, M_8, M_9, M_{10}, M_{11}, M_{12}, M_{13}, M_{14} and M_{15} were 0.32g, 0.32gm, 0.31gm, 0.31gm, 0.31gm, 0.32gm, 0.32gm, 0.31gm, 0.32gm, 0.31gm, 0.3gm, 0.32gm, 0.31gm, 0.32gm and 0.31g respectively. After 120 days of culture period the final weight in the pond M_1, M_2, M_3, M_4, M_5, M_6, M_7, M_8, M_9, M_{10}, M_{11}, M_{12}, M_{13}, M_{14} and M_{15} were 27.22gm, 28.51gm, 28.65gm, 27.32gm, 28.11gm, 28.65gm, 29.08gm, 29.45gm, 27.85gm, 29.52gm, 28.65gm, 29.08gm, 28.45gm, 28.66gm and 28.95gm respectively. The initial overall average body weight was 0.314gm and the final overall average body weight was 28.54gm. Therefore, the overall average absolute growth (Final weight – Initial weight) of the shrimp in improved traditional ponds was found to be 28.23gm.

In second crop the initial average body weight of shrimps in the pond M_1, M_2, M_3, M_4, M_5, M_6, M_7, M_8, M_9, M_{10}, M_{11}, M_{12}, M_{13}, M_{14} and M_{15} were 0.31g, 0.31gm, 0.31gm, 0.32gm, 0.32gm, 0.33gm, 0.31gm, 0.31gm, 0.3gm, 0.32gm, 0.31gm, 0.31gm, 0.32gm, 0.31gm and 0.31g respectively. After 120 days of culture period the final weight in the pond M_1, M_2, M_3, M_4, M_5, M_6, M_7, M_8, M_9, M_{10}, M_{11}, M_{12}, M_{13}, M_{14} and M_{15} were 28.45gm, 29.45gm, 28.65gm, 28.66gm, 27.22gm, 28.46gm, 29.62gm, 29.8gm, 27.95gm, 27.35gm, 28.25gm, 27.85gm, 28.01gm, 28.44gm and 29.85gm respectively. The initial overall average body weight was 0.313gm and the final overall average body weight was 28.53gm. Therefore, the overall average absolute growth (Final weight – Initial weight) of the shrimp in improved traditional ponds was found to be 28.22gm.

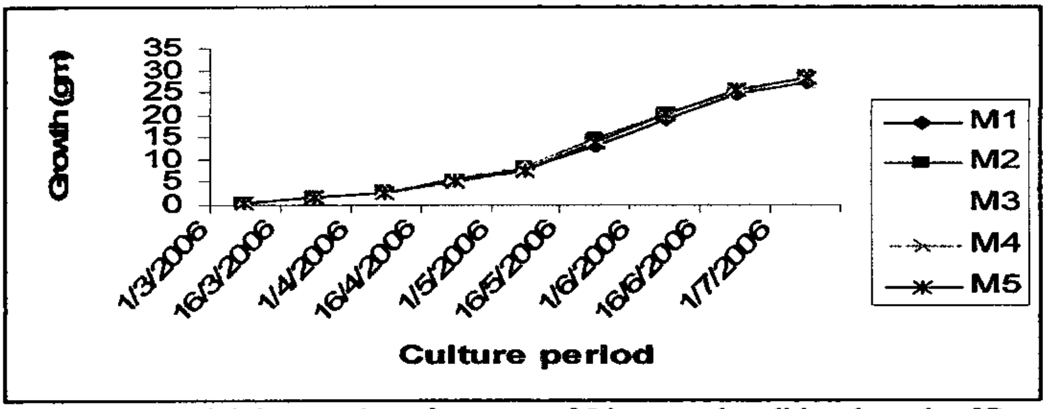

Fig.17.1.1. Fortnightly growth performance of 5 improved traditional ponds of Bagerhat

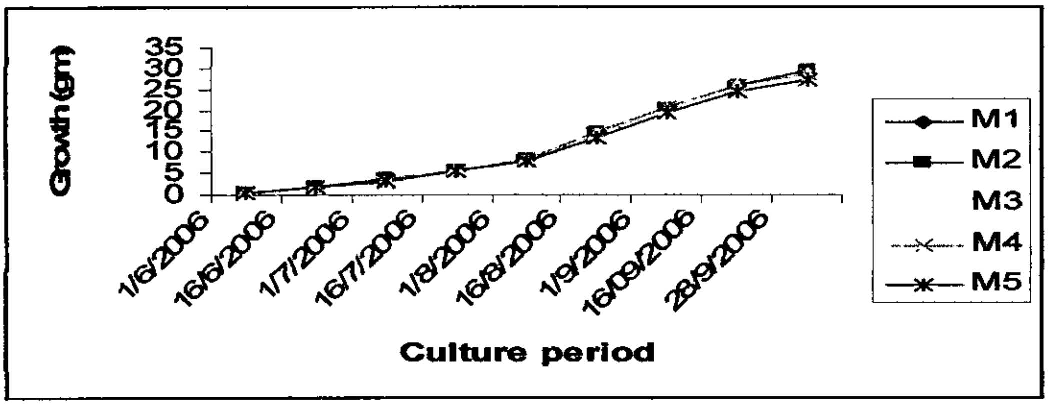

Fig.17.1.2. Fortnightly growth performance of 5 improved traditional ponds of Bagerhat

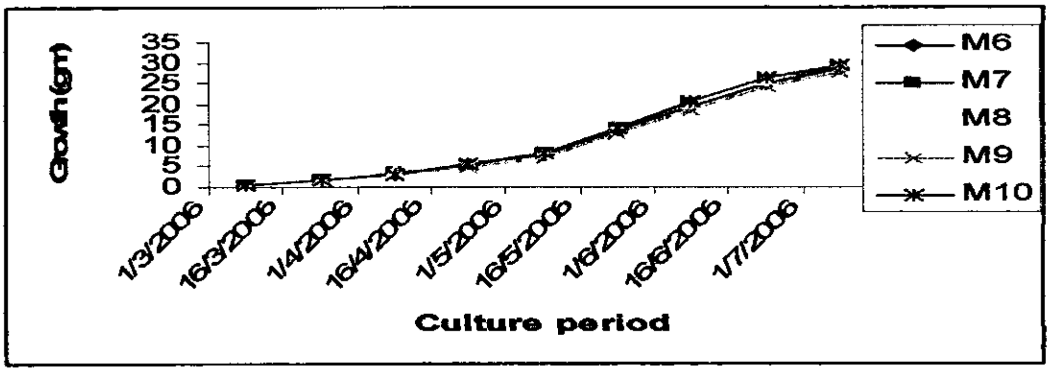

Fig.17.2.1. Fortnightly growth performance of 5 improved traditional ponds of Khulna

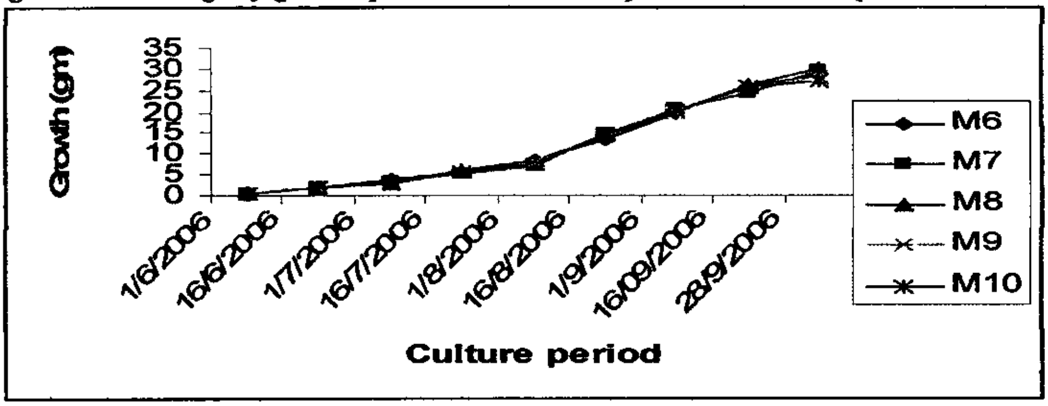

Fig.17.2.2. Fortnightly growth performance of 5 improved traditional ponds of Khulna

In second crop the initial average body weight of shrimps in the pond $S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{13}, S_{14}$ and S_{15} were 0.31g, 0.31gm, 0.32gm, 0.31gm, 0.3gm, 0.33gm, 0.31gm, 0.31gm, 0.3gm, 0.32gm, 0.31gm, 0.31gm, 0.32gm, 0.31gm and 0.31g respectively. After 120 days of culture period the final weight in the pond $S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}, S_{11}, S_{12}, S_{13}, S_{14}$ and S_{15} were 30.52gm, 30.15gm, 31.1gm, 30.05gm, 29.85gm, 28.85gm, 28.25gm, 30.15gm,28.03gm, 31.52gm, 30.52gm, 30.06gm, 30.88gm, 29.88gm and 28.15gm respectively. The initial overall average body weight was measured 0.312gm and the final overall average body weight was measured 29.86gm. Therefore, the overall average absolute growth (Final weight – Initial weight) of the shrimp in semi-intensive ponds was found to be 29.55gm.

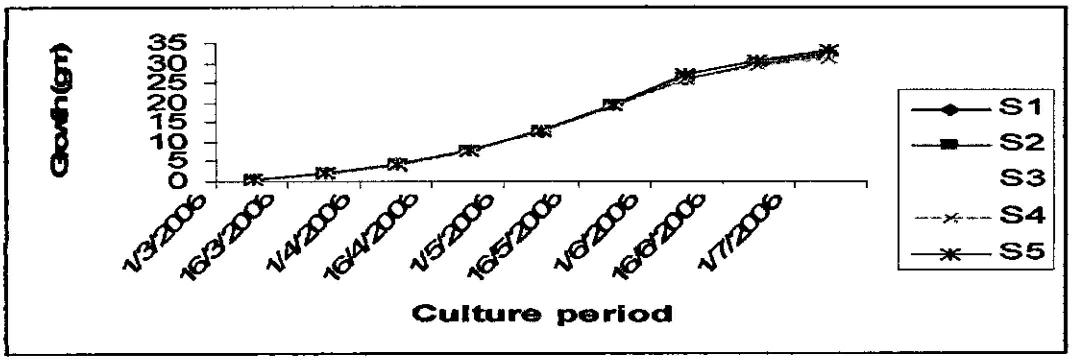

Fig.18.1.1. Fortnightly growth performance of 5 semi-intensive ponds of Bagerhat

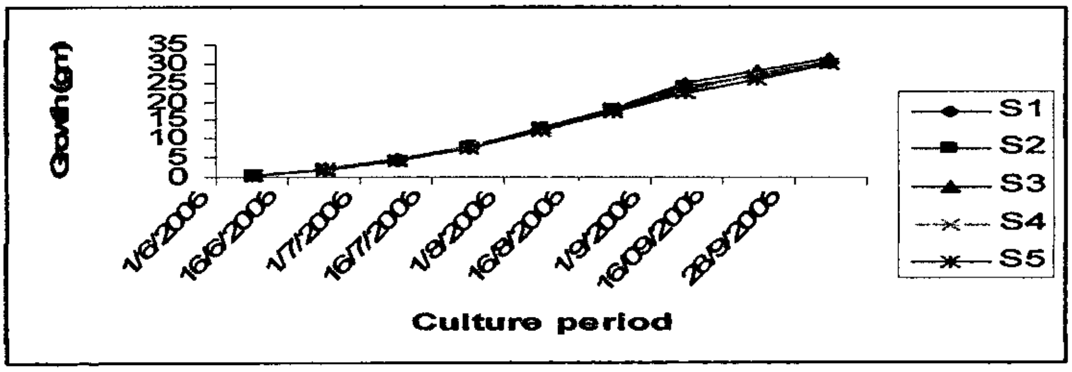

Fig.18.1.2. Fortnightly growth performance of 5 semi-intensive ponds of Bagerhat

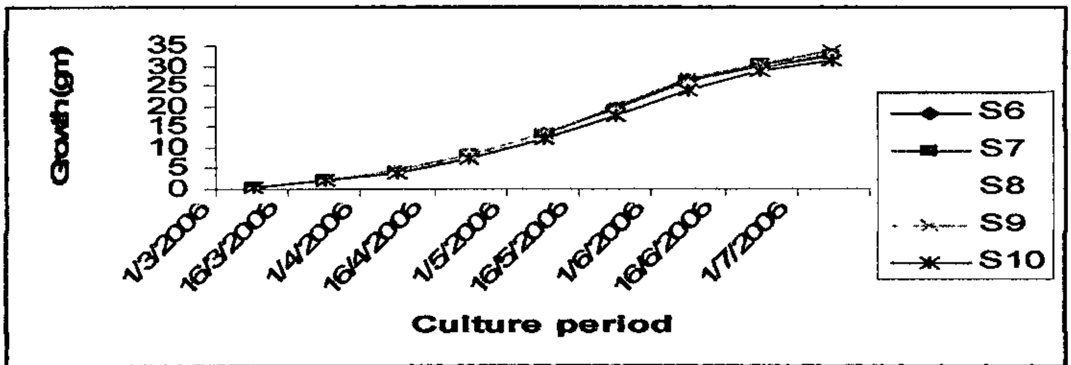

Fig.18.2.1. Fortnightly growth performance of 5 semi-intensive ponds of Khulna

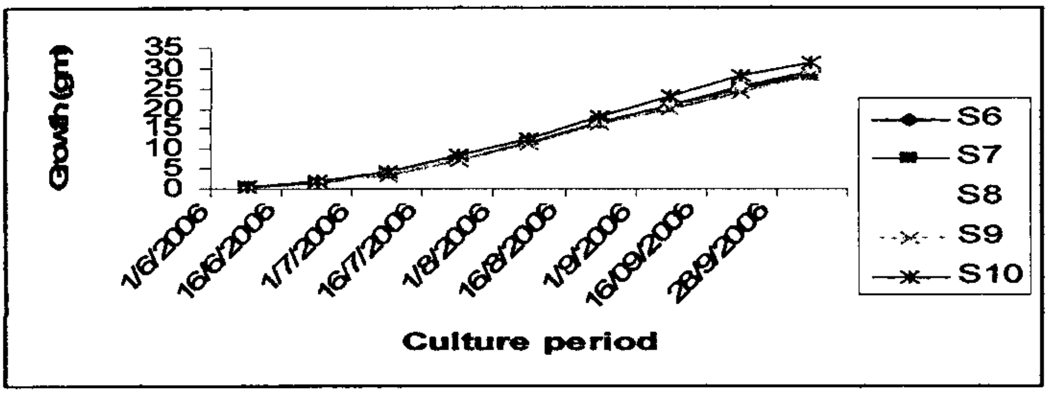

Fig.18.2.2. Fortnightly growth performance of 5 semi-intensive ponds of Khulna

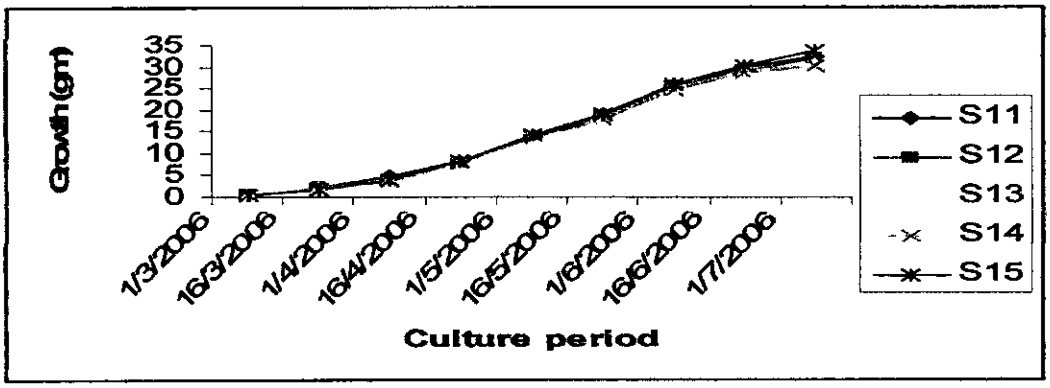

Fig.18.3.1. Fortnightly growth performance of 5 semi-intensive ponds of Satkhira

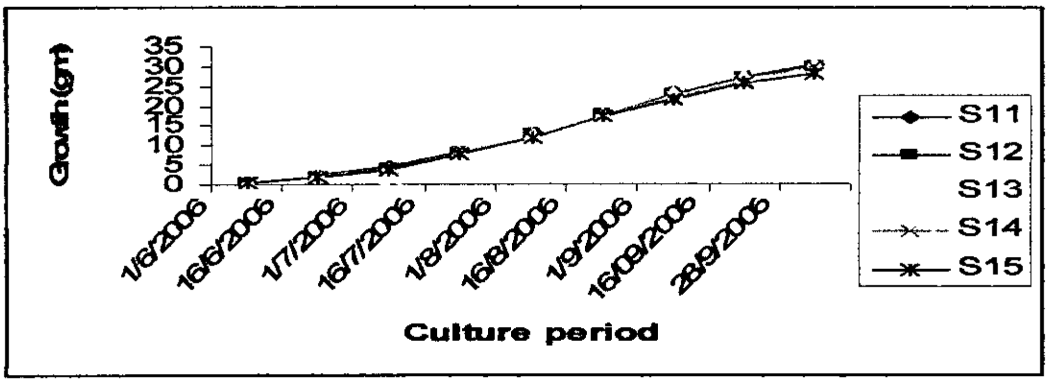

Fig.18.3.2. Fortnightly growth performance of 5 semi-intensive ponds of Satkhira

Table 4: **Pond wise total and average production, production rate, growth rate, SGR, survival rate and FCR of *P. monodon* in fifteen traditional (T_1 to T_{15}) ponds for first crop**

	Treatment															
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	Average
Pond size(Ha)	12.54	30	20.5	12	37.24	24	10	25	35	13	24	193.33	70.67	53.33	33	39.574
Stocking density (PL/ha)	2791	833	5854	10333	2417	5833	10000	10000	17571	15000	27917	12931	28301	37502	18182	13698
Mean initial weight (gm)	0.31	0.32	0.31	0.33	0.31	0.31	0.32	0.31	0.32	0.33	0.32	0.31	0.31	0.32	0.31	0.316
Mean final weight (gm)	21.22	22.5	21.05	22.45	21.56	21.65	22.44	19.95	22.23	22.65	22.35	21.98	22.55	23.65	23.88	22.14
Mean weight gain (gm)	20.91	22.18	20.74	22.12	21.25	21.34	22.12	19.64	21.91	22.32	22.03	21.67	22.24	23.33	23.57	21.82
Total initial weight (gm)	10850	8000	37200	40920	27900	43400	32000	77500	196800	64350	214400	775000	620000	640000	186000	198288
Total final weight (gm)	185675	157500	505200	501084	388080	575890	493680	947625	2734290	795015	2695410	9341500	9471000	11352000	3582000	2915063
Production rate (Kg/Ha)	14.81	5.25	24.64	41.76	10.42	24.00	49.37	37.91	78.12	61.16	112.31	48.32	134.02	212.86	108.55	64.23
Total weight gain (gm)	182963	155260	497760	493718	382500	567644	486640	932900	2694930	783432	2656818	9209750	9340800	11198400	3535500	2874601
SGR (% day)	1.53	1.54	1.53	1.53	1.54	1.54	1.54	1.51	1.53	1.53	1.54	1.54	1.55	1.56	1.57	1.54
Survival rate (%)	25	28	20	18	20	19	22	19	20	18	18	17	21	24	25	21
Mortality rate (%)	75	72	80	82	80	81	78	81	80	82	82	83	79	76	75	79
FCR																
Growth rate (gm/day)	0.17	0.18	0.17	0.18	0.18	0.18	0.18	0.16	0.18	0.19	0.18	0.18	0.19	0.19	0.20	0.18

Table 5: Pond wise total and average production, production rate, growth rate, SGR, survival rate and FCR of *P. monodon* in fifteen traditional (T_1 to T_{15}) ponds for second crop

	Treatment															
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	Average
Pond size(Ha)	12.54	30	20.5	12	37.24	24	10	25	35	13	24	193.33	70.67	53.33	33	39.574
Stocking density (PL/ha)	2392	667	3902	8333	2068	4583	7500	8800	11429	12308	16667	7759	21340	31877	13818	10230
Mean initial weight (gm)	0.32	0.29	0.35	0.31	0.3	0.33	0.31	0.32	0.3	0.32	0.33	0.32	0.32	0.31	0.31	0.316
Mean final weight (gm)	21.45	21.55	22.25	19.9	21.6	21.95	22.25	21.05	20.88	21.8	22.42	22.85	23.5	23.01	21.56	21.87
Mean weight gain (gm)	21.13	21.26	21.9	19.59	21.3	21.62	21.94	20.73	20.58	21.48	22.09	22.53	23.18	22.7	21.25	21.55
Total initial weight (gm)	9600	5800	28000	31000	23100	36300	23250	70400	120000	51200	132000	480000	482592	527000	141360	144106
Total final weight (gm)	160875	103440	391600	417900	365904	579480	417187	1157750	1753920	767360	1972960	8226000	8151281	8214570	2162899	2322875
Production rate (Kg/Ha)	12.83	3.45	19.10	34.83	9.83	24.15	41.72	46.31	50.11	59.03	82.21	42.55	115.34	154.03	65.54	50.73
Total weight gain (gm)	158475	102048	385440	411390	360822	570768	411375	1140150	1728720	756096	1943920	8110800	8040284	8103900	2131800	2290399
SGR (% day)	1.52	1.56	1.50	1.51	1.55	1.52	1.55	1.52	1.54	1.53	1.53	1.54	1.55	1.56	1.54	1.53
Survival rate (%)	25	24	22	21	22	24	25	25	21	22	22	24	23	21	22	23
Mortality rate (%)	75	76	78	79	78	76	75	75	79	78	78	76	77	79	78	77
FCR																
Growth rate (gm/day)	0.18	0.18	0.18	0.16	0.18	0.18	0.18	0.17	0.17	0.18	0.18	0.19	0.19	0.19	0.18	0.18

Table 6: **Pond wise total and average production, production rate, growth rate, SGR, survival rate and FCR of *P. monodon* in fifteen improved traditional (M_1 to M_{15}) ponds for first crop**

	Treatment															
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	Average
Pond size(Ha)	0.4	0.2	0.42	0.42	0.42	0.44	0.38	0.6	0.4	0.4	0.53	0.3	0.5	1.73	0.8	0.53
Stocking density (PL/ha)	16000	12500	16667	21429	19048	50000	15789	21667	32500	20000	13208	15000	30000	10405	15000	20614
Mean initial weight (gm)	0.32	0.32	0.31	0.31	0.31	0.32	0.32	0.31	0.32	0.31	0.3	0.32	0.31	0.32	0.31	0.314
Mean final weight (gm)	27.22	28.51	28.65	27.32	28.11	28.65	29.08	29.45	27.85	29.52	28.65	29.08	28.45	28.66	28.95	28.54
Mean weight gain (gm)	26.9	28.19	28.34	27.01	27.8	28.33	28.76	29.14	27.53	29.21	28.35	28.76	28.14	28.34	28.64	28.23
Total initial weight (gm)	2048	800	2170	2790	2480	7040	1919	4030	4160	2480	2100	1440	4650	5760	3720	3172
Total final weight (gm)	108009	46329	136377	142613	146175	397089	111664	260342	249815	153504	124345	83750	277388	325016	232758	186345
Production rate (Kg/Ha)	270.02	231.64	324.71	339.56	348.04	902.48	293.85	433.90	624.54	383.76	234.61	279.17	554.78	187.87	290.95	379.99
Total weight gain (gm)	106739	45809	134901	140995	144563	392654	110435	257602	246944	151892	123043	82829	274365	321387	230266	184295
SGR (% day)	1.61	1.62	1.64	1.62	1.63	1.63	1.63	1.65	1.62	1.65	1.65	1.63	1.64	1.63	1.64	1.63
Survival rate (%)	62	65	68	58	65	63	64	68	69	65	62	64	65	63	67	65
Mortality rate (%)	38	35	32	42	35	37	36	32	31	35	38	36	35	37	33	35
FCR																
Growth rate (gm/day)	0.22	0.23	0.24	0.23	0.23	0.24	0.24	0.24	0.23	0.24	0.24	0.24	0.23	0.24	0.24	0.24

Table 7: **Pond wise total and average production, production rate, growth rate, SGR, survival rate and FCR of *P. monodon* in fifteen improved traditional (M_1 to M_{15}) ponds for second crop**

	Treatment															
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	Average
Pond size(Ha)	0.4	0.2	0.42	0.42	0.42	0.44	0.38	0.6	0.4	0.4	0.53	0.3	0.5	1.73	0.8	0.53
Stocking density (PL/ha)	15750	12500	15476	21429	16667	47727	15789	20000	30000	20000	13208	15000	28000	10405	13750	19713.40
Mean initial weight (gm)	0.31	0.31	0.31	0.32	0.32	0.33	0.31	0.31	0.3	0.32	0.31	0.31	0.32	0.31	0.31	0.313
Mean final weight (gm)	28.45	29.45	28.65	28.66	27.22	28.46	29.62	29.8	27.95	27.35	28.25	27.85	28.01	28.44	29.85	28.53
Mean weight gain (gm)	28.14	29.14	28.34	28.34	26.9	28.13	29.31	29.49	27.65	27.03	27.94	27.54	27.69	28.13	29.54	28.22
Total initial weight (gm)	1953	775	2015	2880	2240	6930	1860	3720	3600	2560	2170	1395	4480	5580	3410	3038
Total final weight (gm)	118295	45648	113596	136711	123853	310781	120846	236016	218010	140032	122609	77702	247048	312282	213428	169124
Production rate (Kg/Ha)	295.74	228.24	270.47	325.50	294.89	706.32	318.02	393.36	545.03	350.08	231.34	259.01	494.10	180.51	266.78	343.96
Total weight gain (gm)	117006	45167	112367	135185	122397	307178	119581	233561	215670	138394	121264	76837	244226	308879	211211	167261
SGR (% day)	1.64	1.65	1.64	1.63	1.61	1.61	1.65	1.65	1.64	1.61	1.63	1.63	1.62	1.64	1.65	1.63
Survival rate (%)	66	62	61	53	65	52	68	66	65	64	62	62	63	61	65	62.33
Mortality rate (%)	34	38	39	47	35	48	32	34	35	36	38	38	37	39	35	37.67
FCR																
Growth rate (gm/day)	0.23	0.24	0.24	0.24	0.22	0.23	0.24	0.25	0.23	0.23	0.23	0.23	0.23	0.23	0.25	0.24

Table 8: **Pond wise total and average production, production rate, growth rate, SGR, survival rate and FCR of *P. monodon* in fifteen semi-intensive (S_1 to S_{15}) ponds for first crop**

	Treatment															
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	Average
Pond size(Ha)	0.06	0.32	0.55	0.43	0.38	0.2	0.36	0.36	0.73	0.66	0.53	0.17	0.46	0.5	0.13	0.39
Stocking density (PL/ha)	75000	75000	80000	69767	78947	90000	111111	111111	82192	77273	75472	117647	82609	80000	69231	85024
Mean initial weight (gm)	0.32	0.32	0.31	0.31	0.31	0.32	0.32	0.31	0.32	0.31	0.3	0.32	0.31	0.32	0.31	0.314
Mean final weight (gm)	32.58	32.18	31.85	31.05	33.22	32.35	32.24	33.44	33.65	31.12	32.28	31.88	30.55	30.4	33.85	32.18
Mean weight gain (gm)	32.26	31.86	31.54	30.74	32.91	32.03	31.92	33.13	33.33	30.81	31.98	31.56	30.24	30.08	33.54	31.86
Total initial weight (gm)	1440	7680	13640	9300	9300	5760	12800	12400	19200	15810	12000	6400	11780	12800	2790	10207
Total final weight (gm)	105559	579240	966966	633416	717549	413433	902719	949695	1433494	1142730	955492	420816	870678	851200	234581	745171
Production rate (Kg/Ha)	1759	1810	1758	1473	1888	2067	2508	2638	1964	1731	1803	2475	1893	1702	1804	1952
Total weight gain (gm)	104522	573480	957554	627092	710853	409343	893759	940891	1419862	1131347	946612	416592	861843	842240	232433	737895
SGR (% day)	1.67	1.67	1.68	1.67	1.69	1.67	1.67	1.69	1.68	1.67	1.69	1.67	1.66	1.65	1.70	1.68
Survival rate (%)	72	75	69	68	72	71	70	71	71	72	74	66	75	70	77	72
Mortality rate (%)	28	25	31	32	28	29	30	29	29	28	26	34	25	30	23	28
FCR	1.2	1.3	1.20	1.2	1.3	1.4	1.2	1.2	1.3	1.3	1.4	1.2	1.2	1.3	1.2	1.26
Growth rate (gm/day)	0.27	0.27	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.26	0.27	0.26	0.25	0.25	0.28	0.27

Table 9: **Pond wise total and average production, production rate, growth rate, SGR, survival rate and FCR of *P. monodon* in fifteen semi-intensive (S_1 to S_{15}) ponds for second crop**

	Treatment															
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	Average
Pond size(Ha)	0.06	0.32	0.55	0.43	0.38	0.2	0.36	0.36	0.73	0.66	0.53	0.17	0.46	0.5	0.13	0.39
Stocking density (PL/ha)	75000	75000	80000	69767	78947	90000	111111	111111	82192	77273	75472	117647	82609	80000	69231	85024
Mean initial weight (gm)	0.32	0.32	0.31	0.31	0.31	0.32	0.32	0.31	0.32	0.31	0.3	0.32	0.31	0.32	0.31	0.314
Mean final weight (gm)	32.58	32.18	31.85	31.05	33.22	32.35	32.24	33.44	33.65	31.12	32.28	31.88	30.55	30.4	33.85	32.18
Mean weight gain (gm)	32.26	31.86	31.54	30.74	32.91	32.03	31.92	33.13	33.33	30.81	31.98	31.56	30.24	30.08	33.54	31.86
Total initial weight (gm)	1440	7680	13640	9300	9300	5760	12800	12400	19200	15810	12000	6400	11780	12800	2790	10207
Total final weight (gm)	105559	579240	966966	633416	717549	413433	902719	949695	1433494	1142730	955492	420816	870678	851200	234581	745171
Production rate (Kg/Ha)	1759	1810	1758	1473	1888	2067	2508	2638	1964	1731	1803	2475	1893	1702	1804	1952
Total weight gain (gm)	104522	573480	957554	627092	710853	409343	893759	940891	1419862	1131347	946612	416592	861843	842240	232433	737895
SGR (% day)	1.67	1.67	1.68	1.67	1.69	1.67	1.67	1.69	1.68	1.67	1.69	1.67	1.66	1.65	1.70	1.68
Survival rate (%)	72	75	69	68	72	71	70	71	71	72	74	66	75	70	77	72
Mortality rate (%)	28	25	31	32	28	29	30	29	29	28	26	34	25	30	23	28
FCR	1.2	1.3	1.20	1.2	1.3	1.4	1.2	1.2	1.3	1.3	1.4	1.2	1.2	1.3	1.2	1.26
Growth rate (gm/day)	0.27	0.27	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.26	0.27	0.26	0.25	0.25	0.28	0.27

4.3. Production

Traditional (T_1 to T_{15}) Ponds:

The production rate of *P. monodon* in all the traditional ponds is shown in table 4 and 5. The average production rate of traditional ponds was found to be 64.23kg/ha in first crop and 50.73kg/ha in second crop.

Improved traditional (M_1 to M_{15}) Ponds:

The production rate of *P. monodon* in all the improved traditional ponds is shown in table 6 and 7. The average production rate of improved traditional ponds was found to be 379.99kg/ha in first crop and 343.96kg/ha in second crop.

Semi-intensive (S_1 and S_2) Ponds:

The production rate of *P. monodon* in all the semi-intensive ponds is shown in table 8 and 9. The average production rate of semi-intensive ponds was found to be 1952kg/ha in first crop and 1664.43kg/ha in second crop.

4.4. Cost-benefit analysis

Table- 10: Average estimated per hector cost-benefit analysis for traditional ponds

Line item	Average cost (Tk) for traditional pond in first crop	Average cost (Tk) for traditional pond in second crop	Total cost
Direct production cost			
Urea	350.00	210.00	
TSP	160.00	—	
Cow dung	500.00	500.00	
Dolomite	—	—	
Stone lime	600.00	600.00	
PL	3350.00	2864.00	**9134.00**
Indirect production cost			
Pond repairing	2000.00	—	
Predator control (Rotenone)	600.00	—	
Land rent	11250.00		**13850.00**
Administrative expense			
Staff salary	—		
Transportation cost	1000.00	1000.00	**2000.00**
Computation of sells revenue:			
Line item	**T_1 (Amount/hector)**	**T_2 (Amount/hector)**	**Total sells**
Total production	64.23 kg	50.73 kg	**32188.00**

- **Total operating cost = Direct cost + Indirect cost = 22984.00 Tk.**
- **Gross profit = Total sells revenue – Total operating cost =9204.00 Tk.**
- **Net profit = Gross profit – Administrative cost = 7204.00 Tk.**

Table- 11: Average estimated per hector cost-benefit analysis for improved traditional ponds

Line item	Average cost (Tk) for improved traditional pond in first crop	Average cost (Tk) for improved traditional pond in second crop	Total cost
Direct production cost			
Urea	2100.00	2100.00	
TSP	2400.00	2400.00	
Cow dung	1000.00	1000.00	
Dolomite	600.00	480.00	
Stone lime	3600.00	3000.00	
PL	8245.00	7845.00	
CP feed	375.00	337.00	
Other feed	8550.00	7740.00	**51772.00**
Indirect production cost			
Pond repairing	3000.00	------	
Predator control (Rotenone)	600.00	------	
Blue net	350.00	-----	
Labor	1500.00	1500.00	
Land rent	11250.00		**18200.00**
Administrative expense			
Staff salary	12000	-----	
Transportation cost	2000.00	2000.00	**000.00**
Computation of sells revenue:			
Line item	**T_1 (Amount/hector)**	**T_2 (Amount/hector)**	**Total sells**
Total production	379.99 kg	343.96kg	**253382.50**

- **Total operating cost = Direct cost + Indirect cost = 69972.00 Tk.**
- **Gross profit = Total sells revenue – Total operating cost =183410.50 Tk.**
- **Net profit = Gross profit – Administrative cost = 167410.50 Tk.**

Table-12: Estimated per hector cost-benefit analysis for semi-intensive ponds

Line item	Average cost (Tk) for semi-intensive pond in first crop	Average cost (Tk) for semi-intensive pond in second crop	Total cost
Direct production cost			
Inlet + outlet PVC pipe	7200.00	7200.00	
Fertilizer before stocking			
Urea	1400.00	1400.00	
TSP	1600.00	1600.00	
Cow dung	---	---	
Fertilizer after stocking			
Urea	1400.00	1400.00	
TSP	1600.00	1600.00	
Molamix (molasses + rice bran)	3000.00	3000.00	
Liming before stocking			
Dolomite	800.00	800.00	
Stone lime	3500.00	3500.00	
Liming after stocking			
Dolomite	3488.00	5040.00	
Stone lime	3731.00	4865.00	
Seed	34009.00	32424.00	
Feed			
CP feed	184464.00	157288.00	
Egg	7379.00	6291.50	**479979.50**
Indirect production cost			
Pond preparation	10000.00	---	
Long arm aerator	28000.00	-----	
Pump mechine	6000.00	-----	
Net	4000.00	-----	
Digel	26880.00	24000.00	
Labour	10000.00	8000.00	
Land rent	11250.00	---	**128130.00**
Administrative expense			

Staff salary	72000.00	---	
Transportation cost	30000.00	25000.00	**127000.00**

Computation of sells revenue:			
Line item	**S_1 (Amount/hector)**	**S_2 (Amount/hector)**	**Total sells**
Total production	1952 kg	1664.43 kg	**1301915.00**

- **Total operating cost = Direct cost + Indirect cost = 608109.50Tk.**
- **Gross profit = Total sells revenue – Total operating cost =693805.50 Tk.**
- **Net profit = Gross profit – Administrative cost = 566805.50 Tk.**

CHAPTER – 5

DISCUSSION

5. DISCUSSION

5.1. Water Quality Parameters

5.1.1. Water temperature:

Temperature is one of the most important physico-chemical parameters (others are salinity, pH, water transparency and water depth) that have direct effect on the growth of marine shrimp (Lester and Pante, 1992). Chiu (1988d) reported that the optimum temperature for *P. monodon* culture is 25 ^{0}C to 32 ^{0}C. Apud (1989) mentioned a range of water temperature from 25 ^{0}C to 30 ^{0}C would be favorable for *P. monodon* culture. For penaeid species, recommended range of temperature is about 25 ^{0}C to 30 ^{0}C (Annon, 1986). In the present study water temperature was found to fluctuate between 24^{0}C and 34 ^{0}C in traditional ponds, 24^{0}C and 34 ^{0}C in improved traditional ponds, 24 ^{0}C and 34 ^{0}C to 34 ^{0}C in semi-intensive ponds (Table-1, 2, 3).

5.1.2. Salinity:

Fluctuations in salinity below 8 ppt or above 18 ppt have been reported to be retard for growth of penaeid shrimp (Boyd and Fast, 1992). The different trends were found for all the culture systems in the present study. The salinity varied from 7 ppt to 18 ppt in traditional, 9ppt to 20ppt in modified traditional and 11ppt to 19 ppt in semi-intensive ponds, which were favorable for the growth of shrimp (Table-1, 2, 3). Chiu (1988b) and Apud (1989) mentioned that the optimum range of salinity for *P. monodon* farming would be 10 ppt to 25 ppt. Subrahmanyam (1973), Verghese et. al., (1975) and Liao (1977) have observed a direct influence of salinity on the growth of *P. monodon.* Although low and high salinities below 10 ppt and above 25 ppt were reported to retard growth of *P. monodon* (Chiu, 1988b; Apud, 1989).

5.1.3 pH:

The best range of water pH for shrimp culture is 7-9 (Boyd and Fast, 1992). The pH values in all traditional, modified traditional and semi-intensive ponds in the present study were within this range. Chiu (1988b) noted that optimum range of pH is 6.8-8.7 for shrimp culture. The pH range in all the traditional, modified traditional and semi-intensive ponds indicated that the water was alkaline with pH ranging from 8.0-8.8, 8.0-8.5 and 8.1-8.5(Table-1, 2, 3). Low pH reduces ammonia toxicity (Whitfield, 1974) but mobilizes metals, including iron and aluminum, which can reduce yields in aquaculture ponds (Simpson et. al., 1983). Low pH can also reduce natural pond productivity presumably by reducing the availability of nutrients (Alabaster and Lloyd, 1980) including phosphorus (Boyd, 1982) and carbon sources for photosynthesis, e.g. bicarbonates and hence alkalinity. If the pH is reduced, problem may be encountered with soft shrimp exoskeletons and this could affect marketability (Simpson et.al., 1983). Nagarajaiah and Gupta (1983) reported that lower and higher pH values occurred due to high rainfall and high abundance of algae respectively. To maintain pH level at optimum range, lime was applied regularly in the improved traditional and semi-intensive ponds. However, no significant difference in pH values in semi-intensive ponds was noticed with traditional ponds.

5.1.4. Alkalinity:

For successful culture of *P. monodon* alkalinity is recommended to be >80 mg/L (John Hansell, 1993). Alkalinity is the buffering capacity of the pond water. The higher the alkalinity, the better the stabilization of the pond system. The CP Aquaculture Pvt. Ltd. recommended the range of alkalinity from 80 mg/L to120 mg/L for shrimp culture. In the present study alkalinity was founding fluctuate between 90-190 mg/L in semi-intensive ponds, 110-190 mg/L in improved traditional ponds and 90-140 mg/L in traditional ponds.

5.1.5. DO

In the present study DO level varied between 5-9 ppm in semi-intensive ponds, 5-9 ppm in traditional ponds and 4-8 ppm in traditional ponds whereas Pakrasi (1978) and Banaerjee (1978) considered 4-8 ppm of DO as favorable range for shrimp culture. Shing (1984) considered 4-8 ppm or more to desirable range. Law (1988) suggested that there are long term effects of DO level on the growth of shrimp.

5.2. Growth:

In first crop, among the traditional ponds, comparatively higher growth by weight was found in pond T_{15}, among the improved traditional ponds, it was found in pond M_{10} where among the semi-intensive ponds, higher growth by weight was found in pond S_{15}. In second crop, among the traditional ponds, comparatively higher growth by weight was found in pond T_{14}, among the improved traditional ponds, it was found in pond M_{15} where among the semi-intensive ponds, higher growth by weight was found in pond S_3. In first crop the final average growth by weight of *P. monodon* in the present study after 120 days was 22.14 gm in traditional pond, 28.54g in improved traditional pond and 32.18g in semi-intensive pond. In second crop the final average growth by weight of *P. monodon* in the present study after 120 days was 21.87 gm in traditional pond, 28.53g in improved traditional pond and 29.86g in semi-intensive pond. In first crop the stocking density of

PL was 13698 PL/ha in traditional ponds, 20614 PL/ha in improved traditional ponds and 85024 PL/ha in semi-intensive ponds. In second crop the stocking density of PL was 10230 PL/ha in traditional ponds, 19713 PL/ha in improved traditional ponds and 81061 PL/ha in semi-intensive ponds. Comparatively a higher growth by weight was found in the semi-intensive ponds (Table-8, 9). Hossain et. al., (1992), for example, found 21.65 ± 0.81g in 120 days with the stocking density of $5PL/m^2$. In another experiment in brackish water, Hoq et. al., (1994) reported a weight gain of 27.99 ± 2.07g in 105 days with a stocking density of $4PL/m^2$. While Felix and Sukumaran (1988) found a final harvesting weight at 19.0g in 105 days with a stocking density of 5 PL/m^2 in fresh water ponds. In another experiment in brackish water, Rahman (1990) reported a weight gain of 32g in 126 days with stocking density of $18PL/m^2$ and 26g in 112 days with stocking density of $17PL/m^2$. Liao (1981) reported a weight gain of 31.5g and 31.3g in 106 days with a stocking density of 16 PL/m^2.

5.3. Growth rate:

In both crops, the overall growth rate 0.27g/day, 0.24g/day and 0.18g/day in semi-intensive, improved traditional and traditional ponds respectively (Table-4, 5,6,7,8 and 9). 0.18g/day reported by Hossain et. al., (1992); 0.28g/day by Hoq et. al., (1994); 0.15g/day by Felix and Sukumaran (1988); 0.05g/day by Biswas (1996). The comparatively higher growth rate of shrimp in semi-intensive ponds may be due to better feeding and better management than the traditional ponds.

5.4. Production, FCR and Cost Benefit Analysis

5.4.1. Production:

The average production rate of *P. monodon* in traditional ponds was 64.23 kg/ha., in improved traditional pond was 379.99 kg/ha and 1952 kg kg/ha in semi-intensive ponds respectively in first crop and 50.73 kg/ha in traditional pond, 343.96kg/ha in improved traditional pond and 1664.43 kg/ha in semi-intensive ponds in second crop. The present production rate in traditional ponds seems to be lower than the findings of 767.50 kg /hector reported by Felix and Sukumaran (1988); 980.50 kg/hector reported by Hossain et. al., (1992); 420.20 kg/hector by Hoq et. al., (1994) and 554.34 kg/hector by Biswas, 1996. the present production rate in semi-intensive ponds seems to be satisfactory with the findings of 4008 kg/hector reported by Liao, 1981; 3581 kg/hector by Rahman (1990).

5.4.2. FCR:

The overall average FCR of *P. monodon* in the present study after 120 days was 1:1.26 in semi-intensive ponds in both crops and 1:1.5 in modified traditional ponds in both crops (table-6, 7, 8 and 9). It is highly satisfactory when compared with the findings of 1:1.69 and 1:1.78 by Liao, (1981) in semi-intensive method for the same species.

5.5. Cost-Benefit Analysis:

In the present study, it was found less benefit from the traditional ponds and a higher benefit was gained from the semi-intensive ponds.

Table-13

Culture system	Total investment(operational cost+ administrative cost)Tk	Total sell Tk	Net profit Tk/hector	Net profit ratio per One taka investment
Traditional	24984.00	32188.00	7204.00	1: 0.28
Improved Traditional	85972.00	253382.50	167410.50	1: 1.94
Semi-intensive	735109.50	1301915.00	566805.50	1: 0.77

From the table-13 it is clear that modified traditional culture system is economically more feasible than that of traditional and semi-intensive culture systems. The main point is that in modified traditional culture system less investment than semi-intensive is required and then risk also minimum and net profit ratio per one taka investment is 1: 1.94 which is about to double profit where as it is 1: 0.28 and 1: 0.77 in traditional and semi-intensive culture system respectively. Modified traditional culture system can be easily adopted by the small and middle scale shrimp farmers of the southern region of Bangladesh (Khulna, Bagerhat and Satkhira district) so it is more feasible culture and management practice for shrimp culture.

CHAPTER – 6

CONCLUSION

6. Conclusion

In this study it was observed that modified traditional culture system is better in aspects of economic condition of shrimp farmers of southern region of Bangladesh (Khulna,Bagherhat and Satkhira District) than the semi-intensive and traditional culture systems. Production cost in semi-intensive culture system is higher than the modified traditional and traditional culture system as well as risk also higher. The reason for the higher production rate in the semi-intensive culture system is due to higher stocking rate of PL, use of feed, regular use of lime, fertilizers, chemicals and better pond management practice and for all of this higher investment is required. But in modified traditional culture system a few more investment than traditional culture system is required but risk is minimal and production is much better than traditional culture system. From the table-13 it is clear that modified traditional culture system is economically more feasible than that of traditional and semi-intensive culture systems. The main point is that in modified traditional culture system net profit ratio per one taka investment is 1: 1.94 which is about to double profit where as it is 1: 0.28 and 1: 0.77 in traditional and semi-intensive culture system respectively. Modified traditional culture system can be easily adopted by the small and middle scale shrimp farmers of the southern region of Bangladesh (Khulna, Bagerhat and Satkhira district) so it is more feasible culture and management practice for shrimp culture.

The major setbacks of expanding semi-intensive culture system among with the farmers are-

- Lack of extensive service from Government and Non-Government organization
- Insufficient credits to the farmers.
- A huge fear about outbreak of viral disease with comparatively higher stocking rate of the shrimp PL.

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