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# Investigation of semi-intensive culture system of shrimp with special reference to soil-water characteristics of Bangladesh

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**Abstract**
The study was carried out to investigate the soil-water quality and production parameters of 9 selected semi-intensive shrimp ghers in Bagerhat and Khulna districts of Bangladesh over a growing cycle. Physico-chemical parameters of soil-water were measured and analyzed by standard methods. Gross yield (14998.05 kg /ha/cycle) of shrimp was also calculated from the stocking and harvesting data. Most of the parameters of soil and water correlated significantly with each other suggesting a high degree of interactions between different parameters in the system. A pattern of qualitative and qantative difference of zooplankton over phytoplankton was recorded in the semi-intensive farms Therefore, a high degree of salinity fluctuation and iron deposition in waters was also documented. However, significantly lower concentrations of phosphorus in the soil indicated a net retention and trapping of phosphatic nutrients in the environment. After that cropping pattern was two cycles per year, Feeding frequencies was four times in a day and *Penaeus monodon* production ranged from 4275 to 9645.66 kg /ha/ cycle in semi-intensive farms. The present findings indicate that semi-intensive systems served as less health risk in shrimp production and heavy usage of the surrounding water.

**Keywords:** Water and Soil quality, Semi-intensive, Shrimp, Ghers, Bangladesh

## 1. Introduction
Shrimp aquaculture is one of the fastest growing economic activities in coastal areas of Bangladesh. Bangladesh is the 5th largest shrimp producer in the world [11]. In Bangladesh annual shrimp production is 223582 metric ton and 2nd largest of total inland aquaculture [10]. The two main Region of shrimp production are located in the Southwestern part composed of Khulna, Satkhira and Bagerhat districts; and the other one is located in the Southeastern part of the country composed of Chittagong and Cox's bazaar districts and 0.276 million hectares of land are currently under brackishwater shrimp cultivation [16]. About 75% of the total shrimp farms are located in Khulna, Bagerhat and Satkhira districts. *Penaeus monodon* and *Macrobrachium rosenbergii* are the two major species cultured in Bangladesh [24]. Shrimp farming in Bangladesh has been expanding since the early seventies and reached an industrial scale followed by increasing demand for shrimp in the export market. It alone contributes more than 70% of the total export earnings from all the agro-based products. More than two millions of people directly and indirectly are engaged in shrimp aquaculture activities (Harvesting, Culture, Processing, and Experting) [3]. Rapid expansion of shrimp farming in Bangladesh for the last two decades is likely to lead both short and long-term negative environmental impacts leading ecological imbalance, environmental pollution, acceleration of land degradation, low salinity deforestation of mangrove, sedimentation and disease outbreak [22]. Mangrove is unique ecosystem and suitable habitat for shrimp culture [15]. However, mangrove wetlands are still being converted to gher for shrimp aquaculture [25]. Shrimp culture in Bangladesh relies on the supply of artificially formulated feed application of agrochemicals, antibiotics and disinfectants [22]. Shrimp farmers apply different types of chemicals and drugs for remediation of shrimp death in their farms (locally called *gher* in Bengali) from various diseases.

The farmers are not aware of the impacts of the use of those chemicals on farms' environment. 21% farmers used potassium permanganate, 18% used aqua-nourish, 17% used capsule and 14% agro-fish and almost all chemicals were used mainly for improving water quality and preventing diseases. Indiscriminate and overuse of the chemicals and drugs might be the cause of death of many living organisms [24]. Shrimp gher water and sediments are important sinks for various pollutants like pesticides and heavy metals [12] The long-term use of different chemicals and drugs in the shrimp and prawn farming has negative impacts on the environment as well as the human being. Therefore, this sector has been highly criticized by the seafood importing countries in terms of negative social and environmental issues. In 2009, EU which is the largest importer got nitro furan in prawn/shrimp and Bangladesh had to adopt self-imposed ban on seafood export. As a result, this shrimp and prawn farming and trade became vulnerable in the export market. Therefore, it is now a critical issue to identify the major sources of the contaminants in the shrimp and prawn farms. The present study was conducted to assess the impacts of shrimp and prawn farming on water and soil quality parameters of *gher* in the south western region of Bangladesh particularly in Khulna, Bagerhat district which is expected to contribute to knowledge generation for sustainable seafood farming and trade in Bangladesh. The specific objective of the present study was to assess the effects of shrimp and prawn farming on water and soil quality parameters as well as to assess the relationships between the different physico-chemical parameters. Physical and chemical properties of water in shrimp farms are useful indicators of the farm environment [8]. Environmental manipulation to boost aquaculture production requires a basic understanding of the physical, chemical and biological processes occurring in the systems. Little is known about the relative proportions or properties of the soil and its components [14]. Physico-chemical, biological prameter of water and soil qualities of semi-intensively managed commercial shrimp Ghers in Bangladesh have not yet been documented. The present study reports the physical and chemical qualities of water and soil, phytoplankton density and gross yield of semi-intensive shrimp production systems in Bangladesh.

## 2. Materials and methods

### 2.1 The study area

The study was conducted in Mongla, Sadar Upazilla of Bagerhat district and Dakop Upazilla of Khulna district throughout a production cycle from July 2014 to June 2015.Three semi-intensive farms S & M Fish Farm, bajlu Fish Farm and Gazi Fish Farm were randomly selected in each upazilla, which were categorized in three ($T_1$, $T_2$, $T_3$) treatment. In each category (treatment) of farms, three ghers were considered as replicates. The Ghers ranged in size between 0.26 and 0.53 ha (mean 0.39 ha) and a mean depth of 1.7 m throughout the growing cycle. All the Ghers were similar in configuration, basin and contour type, well-exposed to sunlight and natural air flow.

### 2.2 Shrimp farming techniques and farm management

The Farm owners were interviewed for detailed information on husbandry and management practices using FGD tools. Farm records were used to quantify the manure and fertilizers, supplemental feeds, shrimp harvests and to have information on the management practices applied and inputs used. Per hectare shrimp yield was calculated from the final biomass obtained in each individual Gher. Gher preparation began from mid-February to mid March with ploughing the enclosed land and encircling it with fence, which was left for about a week for drying under the sunshine. after one week of drying water was introduced by allowing the high tide of new moon or full moon to enter into the Ghers. Then Bleaching Powder (CaOCl) Cl was applied at the rate of 250 kg/ ha. After lime application the ghers were aerated by electric aerator and pulled horra up to 7 days. Then Molases, wheat bran or rice bran and yeast were mixed and heated and kept for two days then these mixture was applied at the rate of 80–100 kg/ha for plankton production. PCR tesed Shrimp fry (15–20 days old post larvae) were collected from hatchery and transfered into the rearing ghers. Stocking in the rearing ghers was done after plankton production. Then feeding starts and feeding frequencies was 4 times in a day. Aeration started after 2-3 hours of administered feed in the Gher. Bio-security and hygiene practices were maintained properly. The tiger shrimp, *Penaeus monodon* is the main target species for semi-intensive farming. The amount of feed supplied was calculated based on shrimp biomass. The other forms of post-stocking management included only periodic liming of the ponds as a measure of disease prevention.

### 2.3 Water quality parameters

Water samples were collected twice in every month from the selected farms using 500 ml plastic bottles between 09:00 AM to 10:00 AM. After collection of the samples dissolved oxygen (mg /l) was measured immediately in the sampling site. Other parameters of the water samples such as pH, Alkalinity (mg/l), nitrite nitrogen (NO2–N) Ammonia (mg/l) and Iron (mg/l) were measured by using HACH test Kit (Model FF-1A Cat. 2430-02). A water temperature ($^0$C) and salinity (ppt), were recorded directly on the spot by a Celsius thermometer and a refractometer (Atago, japan).

### 2.4 Soil quality parameters

After collection of soil samples from the selected ghers, samples were air dried and crushed without any granules. Then the tagged samples were sent to Soil Resource Development Institute (SRDI) Khulna for analysis of its parameters. Their analyses procedures are described below. Samples were air-dried and results were expressed as the total dry matter, T-DM (g/kg). Soil pH was determined from a soil suspension in distilled, de-ionized water (soil: water ratio of 1:5, using a digital pH-meter. Phosphate concentrations were determined by shaking the soil samples with 0.5 M NaHCO3 solution (pH 8.5). Phosphorus in the extract was determined by developing blue color using stannous chloride reduction of phospho-molybdate complex and measuring the color spectrophotometrically at 660 nm wavelength [1]. All colorimetric examinations were done using standard calibration curves. Total-P (mg/100g) was measured by ascorbic acid method (APHA, 1998).To determine the total nitrogen, and sulfur, samples were oven dried at 45$^0$C for 2 h and crushed with a mortar. The total nitrogen was determined by using the Kjeldahl method [20, 21] To determine, sulfur, the samples were treated first with water and then with 6M HCl and the parameters were determined by using an elemental analyzer [27]. The organic content of the soil (also called loss of ignition) was determined by combustion of samples in porcelain crucibles at 550 $^0$C for 12h in a muffle furnace and the final product of the combustion was expressed as the ash content of the sediment [6].

**Plankton study**

For Qualitative and quantitative estimation of plankton were samples were collected at fortnightly intervals from the ghers by passing depth integrated water samples through fine-meshed plankton net (0.025 mm). After collection The samples were preserved immediately with 5% buffered formalin in the plastic bottles. Then Plankton density was estimated by using a sub-sampling technique, A Sedgwick–Rafter (S–R) cell was used under a calibrated binocular compound microscope for plankton counting. Plankton were identified to genera level and were counted using the formula proposed by [6] and was expressed as the number of cells per liter of water.

**Statistical analysis**

For all sampling techniques, three replicates were analyzed and means and standard deviations were calculated and expressed as mean (±SD). Significance of variations in the water quality parameters within ghers were tested using one way analysis of variance, ANOVA, which was followed by Duncan's multiple range test (Duncan, 1995) for significant values. Significance of correlation coefficients was calculated according to Zar (1999). Values were considered at 5% level of significance

## 3. Results

### 3.1 Shrimp farming techniques and farm management

Existed Shrimp culture techniques were evaluated from the degree of management applied (Table 1) throughout the production cycle from the initial stage of Gher preparation to harvesting of shrimp. Per hectare shrimp yields were calculated from the final biomass obtained in each individual Gher. Gross yield was expressed as production in kg/ha/cycle. Average size of Shrimp Gher was 0.39 ha in size with a mean depth of 1.70 m (Table 2).

**Table 1:** Generalized scenario of management regimens in selected shrimp Gher

| Issues | Applications |
|---|---|
| Gher size (ha) | 0.26-0.53 (mean±SD = 0.39± 0.12) |
| Gher dikes | Stable and well-maintained |
| Design and layout | Planned and designed |
| Water control | Concrete gates of inlets and outlets |
| Water exchange | Tidal exchange (10–20% per day) |
| Depth (m) | 1.6-1.8 ( mean1.7 m) |
| Source of fry | Hatchery |
| Stocking density (No./m2) | 400–500 |
| Rearing period | 4–5 months |
| Crops/yr | 2 (February–July and July–November) |
| Feed used | Supplemental pelleted feeds |
| Aeration | Continuously |
| Cumulative mortality | 20–25% |
| Survival rates | 75–80% |
| Bleaching Powder used (kg/ ha/cycle) | 250–300 |
| Plankton Producers used (kg/ha/cycle) | Yeast, Chitagur: 100–250; |
| Production (kg/ ha/ cycle) | 2822–3000 (mean ±SD=2900±100) |

### 3.2 Growth, survival and yield parameters

The mean stocking density of *Penaeus monodon*, was 103033.33kg/ha/C post larvae (PL) and yield varied between 4275 to 9645.66 kg /ha/cycle with the range of survival rate being 75–90% (mean 80.22 %) and the individual weight at harvest ranging 30–38g (mean 34 g).

**Table 2:** Stocking, survival rate, growth and yield of *Penaeus monodon* in selected semi-intensive shrimp Ghers

| Ghers No. | Size (ha) | Stocking density(ha$^{-1)}$ | Survival Rate%) | Average Weight(g) | Gross yield | Total (kg/ ha/ cycle) |
|---|---|---|---|---|---|---|
| 1 | 0.40 | 98800 | 55 | 33 | 1793.2 | 4483 |
| 2 | 0.26 | 95000 | 50 | 36 | 1710 | 6576.92 |
| 3 | 0.52 | 123500 | 60 | 30 | 2223 | 4275 |
| 4 | 0.36 | 100000 | 75 | 32 | 2400 | 6666.66 |
| 5 | 0.60 | 110000 | 90 | 33 | 3267 | 5445 |
| 6 | 0.25 | 90000 | 85 | 30 | 2295 | 9180 |
| 7 | 0.30 | 99000 | 79 | 37 | 2893.7 | 9645.66 |
| 8 | 0.36 | 100000 | 81 | 35 | 2835 | 7875 |
| 9 | 0.37 | 111000 | 83 | 38 | 3500 | 9459.45 |
| Mean | 0.38 | 103033.33 | 80.22 | 34 | 5099.34 | 7067.74 |

### 3.3 Water quality parameters

The recorded mean water quality parameters of semi-intensive ghers throughout the experimental period are shown in (Table 3). Temperature was found more or less similar and ranged from 27±3.96ºC, 24.7±5.59ºC and 26±5.63ºC in $T_1$, $T_2$ & $T_3$ treatments respectively. However water temperature had a positive relationship with DO (r=0.386).The Dissolved oxygen was recorded higher in $T_2$ & lowest in $T_1$ respectively and significantly different (p<0.01) in three treatments. The value of pH was found higher in $T_1$ than that of $T_2$ & $T_3$ treatments respectively and had a positive correlation with(r=0.468, p<0.01) salinity. The level of ammonia & alkalinity content was recorded trace & more or less similar amount in three treatments respectively. Alkalinity had a significant (p<0.01) inverse correlation with ammonia (r= -0.353) and nitrite (r= -0.353) indicating that higher alkalinity content reduced the ammonia and nitrite level of the farms. The maximum salinity was recorded in $T_1$, whereas the minimum salinity was observed at $T_2$ treatment respectively and highly significant (r= -0.868, p<0.01) in location. Presence of Iron was found 0 (zero) in $T_2$&$T_3$ and trace amount in $T_1$ treatments and had a positive correlation (r= -0.868, p<0.01) with location (Table 4).

**Table 3:** Water quality parameters of different gher sites under Semi-intensive Culture System

| Parameters | Mongla ($T_1$) | Bagerhat Sadar ($T_2$) | Khulna ($T_3$) |
|---|---|---|---|
| Temperature (°C) | 27±3.96 | 24.7±5.59 | 26±5.63 |
| pH | 8.2±0.26 | 8.1±0.56 | 8.0±0.50 |
| DO (mg/l) | 5.85±2.17 | 7.00±1.55 | 6.0±0.73 |
| Salinity (ppt) | 9.8±4.32 | 2.33±2.08 | 8.75±2.63 |
| Alkalinity (mg/l) | 167±21 | 147±15.59 | 154±37.31 |
| Ammonia (mg/l) | 0.1±0.1 | 0.05±0.05 | 0.0±0.0 |
| Nitrate | 0.0±0.0 | 0.0±0.0 | 0.0±0.0 |
| Iron | 0.15±0.15 | 0±0 | 0±0 |

**Table 4:** Pearson's correlations of water quality parameters of semi-intensive culture system

| | Location | Production | Temp | DO | pH | Salinity | Alkalinity | Ammonia | Nitrite | Iron |
|---|---|---|---|---|---|---|---|---|---|---|
| Location | 1 | | | | | | | | | |
| Production | .991 | 1 | | | | | | | | |
| Temp | -.174 | -.925 | 1 | | | | | | | |
| DO | -.046 | .[b] | .386** | 1 | | | | | | |
| pH | .430** | .993 | -.386** | -.329** | 1 | | | | | |
| Salinity | .868** | .925 | -.204 | -.083 | .468** | 1 | | | | |
| Alkalinity | -.363** | -.925 | .085 | .130 | -.187 | -.545** | 1 | | | |
| Ammonia | -.004 | -.925 | .043 | -.010 | -.041 | .023 | -.353** | 1 | | |
| Nitrate | .609** | .925 | -.243* | -.171 | .378** | .696** | -.353** | .030 | 1 | |
| Iron | .711** | .945 | -.115 | .114 | .317** | .525** | -.175 | -.095 | .455** | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
b. Cannot be computed because at least one of the variables is constant.

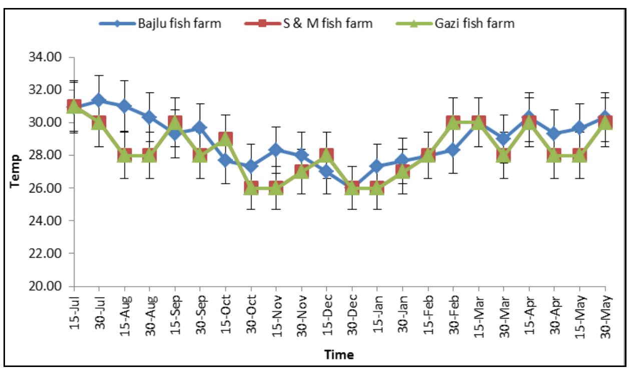


**Fig 1:** Fortnightly variation of temperature in three experimental farms.

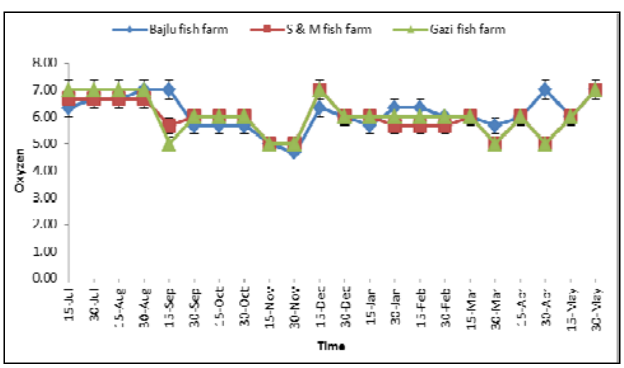


**Fig 2:** Fortnightly variation of $O_2$ in three experimental farms.

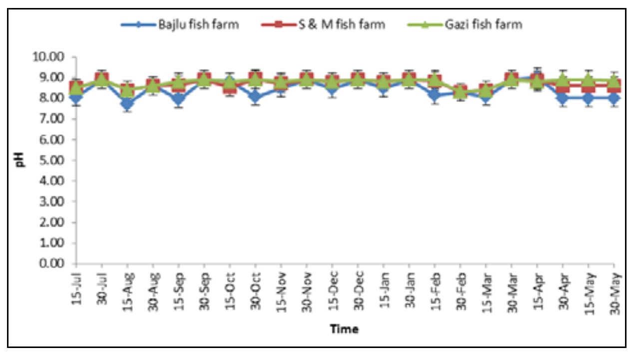


**Fig 3:** Fortnightly variation of pH in three experimental farms.

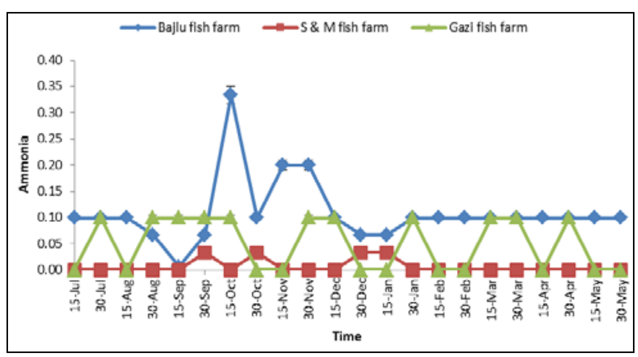


**Fig 4:** Fortnightly variation of $NH_3$ in three experimental farms.

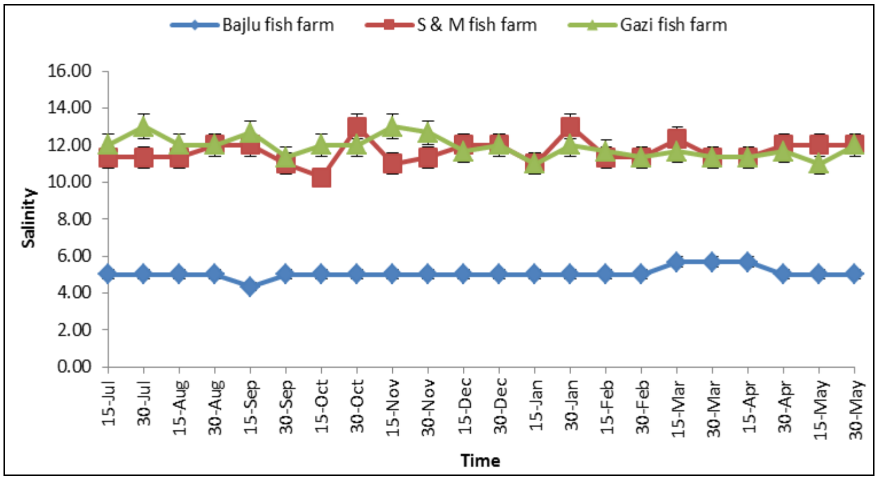


**Fig 5:** Fortnightly variation of Salinity in three experimental farms.

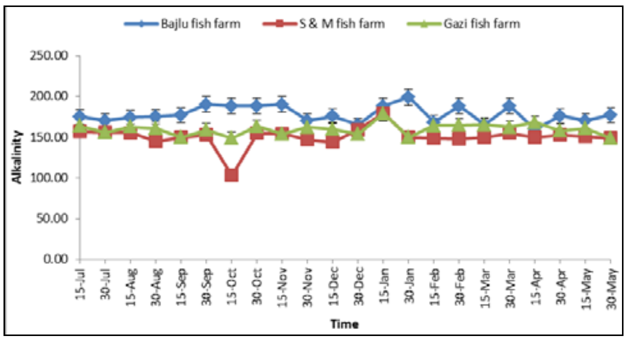


**Fig 6:** Fortnightly variation of Alkalinity in three experimental farms.

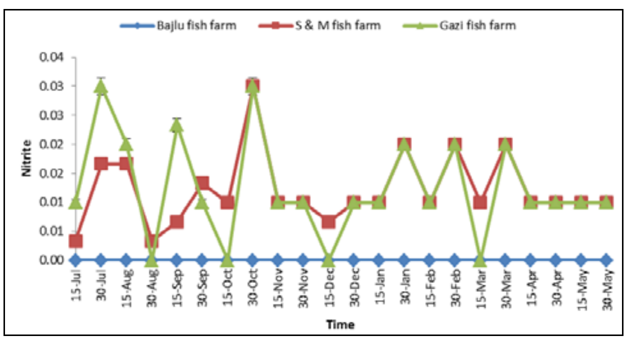


**Fig 7:** Fortnightly variation of Nitrite in three experimental farms.

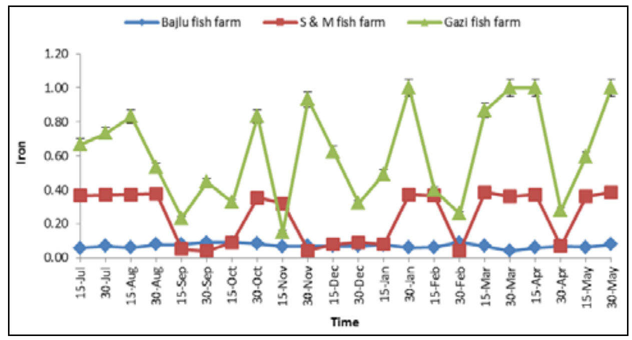


**Fig 8:** Fortnightly variation of Iron in three experimental farms.

### 3.4 Soil quality parameters

The recorded mean soil quality parameters are shown in (Table 5). Among the parameters such as pH, organic content and total nitrogen and available phosphorus, there was no significant ($p$>0.01) difference found in three treatments. However organic content highly correlated(r= 0.891) with production. The soil pH was inversely correlated with total nitrogen (r= -0.207) and potassium (r= -0.014) which reveals that pH increased with decreasing level of total nitrogen and potassium in three farms (Table 6). The highest value of organic content found in $T_3$ followed by $T_2$& $T_1$ treatments (Table 5) and significantly ($p$<0.05) correlated with available phosphorus (Table 6). The mean soil salinity was found maximum in $T_1$ compared to $T_2$ & $T_3$ treatments significantly ($p$<0.05) correlated with phosphorus (r= 0.702), sulphur (r= 0.973), zinc (r= 0.935) and location (r= 0.880) which indicated that Sulfar, Zn, P proportionately increased with the increase of soil salinity (Table 6)

**Table 5:** Soil characteristics of different gher sites under Semi- Intensive Culture System

| Parameters | S&M Farm, Mongla ($T_1$) | Bajlu Farm, Bagerhat Sadar ($T_2$) | Gazi Farm, Khulna ($T_3$) |
|---|---|---|---|
| Organic matter. (%) | 2.88±2.00 | 3.07±1.60 | 3.23±1.98 |
| pH | 7.7±0.36 | 7.6±0.40 | 7.76±0.38 |
| Salinity (EC) (ds/m*) | 8.83±5.4 | 5.83±4.87 | 6.92±3.4 |
| Phosphorus (µg/g) | 13.41±5.83 | 16.39±7.62 | 17.28±9.14 |
| Total $N_2$ (%) | 0.184±0.11 | 0.135±0.038 | 0.139±0.04 |
| Potassium (m.eq./100g) | 0.814±0.20 | 0.614±0.123 | 0.602±0.159 |
| Sulfur (µg/g) | 105.32±53.39 | 89.69±41 | 120.38±43.45 |
| Zinc (µg/g) | 7.73±5.05 | 9.96±4.93 | 8.86±5.49 |

**Table 6:** Pearson's Correlations of soil quality parameter of semi-intensive culture systems

| Location | Production | pH | Salinity | Organic | K | N | P | S | Zn | Location |
|---|---|---|---|---|---|---|---|---|---|---|
| Production | 1 | | | | | | | | | |
| pH | .984 | 1 | | | | | | | | |
| Salinity | .892 | .023 | 1 | | | | | | | |
| Organic | .891 | .011 | .299 | 1 | | | | | | |
| K | .586 | -.014 | .128 | -.049 | 1 | | | | | |
| N | .379 | -.207 | .132 | -.070 | -.036 | 1 | | | | |
| P | .934 | .285 | .702** | .346* | .263 | .215 | 1 | | | |
| S | .928 | .043 | .973** | .264 | .098 | .176 | .646** | 1 | | |
| Zn | .935 | .081 | .935** | .271 | .176 | .183 | .652** | .927** | 1 | |
| Location | .991 | .207 | .880** | .276 | .233 | .114 | .884** | .852** | .810** | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

### 3.5. Qualitative and quantitative plankton count

A number of zooplankton groups were dominated over phytoplankton groups in semi-intensive farming systems. Euglenophyceae, Rotifers, Copepods, Crustaceans Bacillariophyceae, Cyanophyceae, Chlorophyceae were available groups in three treatments and higher quantities of zooplankton compared to phytoplankton were recorded might be due to availability of nutrients and favorable water quality parameters.

**Table 7:** Qualitative and quantitative estimation of plankton in three fish farms

| Group | Spp. | S&M Farm Mongla, Bagerhat($T_1$) | Bajlu Farm, Bagerhat Sadar($T_2$) | Gazi Farm, Dakop, Khulna($T_3$) |
|---|---|---|---|---|
| Chlorophyceae, | *Gonatozygon* | - | - | - |
| | *Volvox* | (5 x $10^3$ nos./L) | (3 x $10^3$ nos./L) | (2 x $10^3$ nos./L) |
| Cyanophyceae | *Microcystis* | (30 x $10^3$ nos./L) | (23 x $10^3$ nos./L) | (1 5x $10^3$ nos./L) |
| Bacillariophyceae | *Melosera* | (5 x $10^3$ nos./L) | (14 x $10^3$ nos./L) | (9 x $10^3$ nos./L) |
| | *Cyclotella* | (3 x $10^3$ nos./L) | (7 x $10^3$ nos./L) | (4 x $10^3$ nos./L) |
| | *Nitzschia* | (6 x $10^3$ nos./L) | (12 x $10^3$ nos./L) | (8x $10^3$ nos./L) |
| | *Fragilleria* | Not Found | (20x $10^3$ nos./L) | Not Found |
| | *Diatom* | - | - | - |
| Euglenophyceae | *Euglena* | - | (5 x $10^3$ nos./L) | - |
| Rotifers, | *Brachionus* | (27 x $10^3$ nos./L) | (19 x $10^3$ nos./L) | (28 x $10^3$ nos./L) |
| Copepods, | *Cyclops* | (18 x $10^3$ nos./L) | (18 x $10^3$ nos./L) | (18 x $10^3$ nos./L) |
| | *Mesocyclops* | | | |
| | *Diaptomus* | (12 x $10^3$ nos./L) | (8 x $10^3$ nos./L) | (9x $10^3$ nos./L) |
| | *Moina* | (11x $10^3$ nos./L) | (3 x $10^3$ nos./L) | (14 x $10^3$ nos./L) |
| Crustaceans | *Nauplius larvae* | (28 x $10^3$ nos./L) | (22 x $10^3$ nos./L) | (30x $10^3$ nos./L) |

## 4. Discussion

Semi-intensive farming system relied on stocking of hatchery seeds, application of lime and fertilizers and supplemental feeding. Gross yield (14998.05 kg/ ha/cycle) (Table 1) indicates a level that only obtainable from semi-intensive culture system as reported by Deb (1998). Our result of yield (production between 4275 to 9645.66 kg /ha/cycle) was higher than Islam *et al.* (2004) who reported an average yield of *Penaeus monodon* ranged from 484 kg/ha/cycle to 562 kg/ha/cycle for semi-intensive shrimp culture systems in Bangladesh. Variations of yield in three culture system due to the variations in stocking and management system.Water quality for aquaculture refer to the quality of water that enables successful growth and production of the desired organisms. The maintenance of good water quality is essential for survival, growth and production of commercial aquaculture species. The metabolic rate of cold-blooded aquatic animal is closely related to the water temperature. Water temperature varies with the season, length of the day, water depth and meteorological condition. In the present study, water temperature was remains optimum ranged. The optimum production of both shrimp and prawn found at temperature range of 25-30°C [19] which was similar to the present study. According to Rather *et al.* (2012) the dissolved oxygen ranged over 6 ppm during dry season and over 4 ppm during wet season in which was similar to the present findings. Poernamo (1992) had been reported that the tolerance DO for shrimp culture <3 mg /L (3-10 mg /L) and optimum range 4-7 mg/L. Cheng *et al.* (2003) and Lazur (2007) reported that DO values higher than 5 mg/L have often been recommended for semi-intensive culture system. This is very similar to finding of the present study. pH is the concentration of hydrogen ions ($H^+$) present in water is a measure of acidity or alkalinity. The pH scale extends from 0 to 14 with 0 being the most acidic and 14 the most alkaline. In the present study, pH ranged 8.2±0.26, 8.1±0.56 & 8.0±0.50 in three shrimp farms, which was similar to the aquaculture standard value [5]. Ammonia in water exists in two forms, as ammonium ions ($NH_4^+$), which are nontoxic, and as the un-ionized toxic ammonia ($NH_3$). The desirable range of ammonia for shrimp farming is < 0.1 ppm and for prawn farming is 0 ppm. It was reported that the half of shrimp production was reduced in Bangladeshi farms due to the presence of ammonia > 0.45 ppm [19]. In this experiment, average ammonia content was 0 to 0.1ppm in three shrimp farms respectively. This level of ammonia in shrimp farm was near to the optimum level. Among the various form of nitrogenous nutrients, $NO_3$ is the most important factor for shrimp and prawn culture. It is the available form of nitrogen for phytoplankton and other plants. Nitrate is the final product of the aerobic decomposition of organic nitrogen compounds, which are generated from nitrite by oxidation and reduce to ammonia by bacterial action. The recommended level of nitrate for shrimp farming is 0.0 to 0.3 ppm and for prawn farming <0.1ppm [18, 19]. The observed value of $NO_3$ was 0 ppt of three semi-intensive shrimp farms, respectively. The findings of the present study were similar to the optimum level of nitrate requirement for shrimp and prawn farming. Alkalinity is the buffering capacity of water and represents its amount of carbonates and bicarbonates. The suitable range of alkalinity for shrimp farming is 60 -180 and for prawn farming is 20 to 300 ppm [9, 19]. In this study, average alkalinity content was 167±21, 147±15.59 and 154±37.31 mg/L in shrimp farms, respectively. The research finding was similar to the the recommended level of alkalinity of shrimp farming which might be due to the appropriate management system. Salinity represents the total concentration of dissolved inorganic ions, or salts in water. The optimum range of salinity for prawn farming is 12-16 ppt and for shrimp farming 5-30 ppt [9, 19]. In this experiment, the mean salinity was 9.8±4.32, 2.33±2.08 and 8.75±2.63 ppt in shrimp farms, respectively. The finding of the present study was more or less similar to the recommended salinity level in shrimp farming.

The observed value of soil pH varied from 7.6±0.40 to 7.76±0.38 in shrimp farms in which is similar to the findings of Islam *et al.* (2003) who reported that optimum range of pH for shrimp production at 7.8 to 8.0. The average value of organic content in the present study was 2.88±2.0 %, 3.07±1.60 and 3.23±1.98% in shrimp farms. Banerjea (1967) reported that soil with less than 0.5% organic matter is low productive, 0.5 to 1.2% average productive, 1.5 to 2.5% high productive and greater than 2.5% as less productive which is very identical to the present study. The findings of the present study revealed that the amount of dead plankton and the uneaten feed was higher in the shrimp farm. The average value of total nitrogen in the present study of shrimp farms was 0.184±0.11, 0.135±0.038 and 0.139±0.04% which was similar to the findings of Islam *et al.* (2003) who reported that the total nitrogen content ranged from 0.11 to 0.18% in shrimp farming. The average phosphorous content was 0.02, 23.46 and 8.54 ppm in prawn, shrimp & prawn and shrimp farms, respectively which was similar to the finding of Islam *et al*. (2003).

## 5. Conclusion

Semi-intensive shrimp farming spread and intense rapidly due to its economic returns and the present research reveals that suitable water quality parameters reduced adverse effects such as higher mortality, viral death and enhanced yields etc. However, studies of impacts on surrounding environment are also essential for reducing emerging catastrophe and sustaining economic viability of this newly developing semi intensive system.

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