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Foreword

Fisheries sector plays an important role in the economy and livelihood of Bangladesh in terms of nutrition, employment and export earnings. Since inception, Bangladesh Fisheries Research Institute (BFRI) has been implementing research programmes reflecting the national developmental needs and policy. BFRI has so far innovated 57 improved aquaculture and management technologies through demand driven research. A good number of such technologies have been disseminated in the field in various degrees. During 1992-2015, fish production has increased by more than three folds from 1.2 million mt to 3.70 million mt due to dissemination of the developed technologies. As a consequence, Bangladesh attained 4th position in the globe in freshwater aquaculture production.

One of the important mandate of BFRI is to carry out and co-ordinate fisheries research in different disciplines. The goal of the research is to develop improved aquaculture and management technologies for sustainable development of the fisheries sector. The Institute prioritizes annual research programmes incorporating suggestions and recommendations of different stakeholders like other NARS Institutes of the country. Before that, our learned and experienced scientists from different regional research stations and sub-stations initiate the research programmes previously identified through regional workshops every year on the basis of the demand driven problems covering inland closed, inland open water and marine open water ecosystems.

The research programmes and the activities implemented by the institute during 2012-2015 for development of the sector have been presented in this report. This 3-year report (2012-13, 2013-14, 2014-15) focuses mainly on the research activities of the Institute. A total of 130 research projects were implemented in different stations and sub-stations of the Institute during the reporting period. Other activities included are technology innovation, training, publication, finance etc. of the Institute.

The main outputs of BFRI in terms of technology generation for aquaculture production and policy guidelines formulation for sustainable fisheries development of open waters need to be matched with the government support of infrastructure, extension, finance and above all, effective implementation of suggested guidelines for management. Only then, the expected outcome of the research could be harnessed for the meaningful development of the fisheries and in achieving well-being of people in the country. We hope this report will be useful to researchers and planners of different national and international organizations for the formulation of project proposal and policy guidelines for fisheries development.

Dr. Yahia Mahmud
Director General

Contents

Executive Summary

General

The BFRI is an autonomous research organization and linked up administratively with the Ministry of Fisheries and Livestock, Government of the Peoples Republic of Bangladesh. The general direction, administration and supervision of the affairs of the Institute are vested in a Board of Governors. BFRI has so far innovated 57 improved aquaculture and management technologies through demand driven research.

The Headquarters of the Institute is located at Mymensingh. The institute functions through its various stations and sub-stations. In addition to the Headquarters, there are five research stations *viz.*, Freshwater Station, Mymensingh; Riverine Station, Chandpur; Brackishwater Station, Paikgacha, Khulna, Marine Fisheries and Technology Station, Cox's Bazar and Shrimp Research Station, Bagerhat. There are also five sub-stations *viz*., Freshwater Sub-station, Jessore; Riverine Sub-station, Rangamati; Floodplain Sub-station, Santahar; Riverine Sub-station, Khepupara and Freshwater Sub-station, Sayedpur.

Research

A total of 42 research programmes were implemented during the reporting period in 2012-13, 43 in 2013-14 and 45 in 2014-15 in different stations and sub-stations of the institute. Remarkable research progress/achievements obtained in different stations and sub-stations of the institute are briefly highlighted below:

Stock improvement and dissemination of commercially important tilapia and koi through genetic selection
Growth performance of BFRI-GIFT F-8 generation were conducted for a period of 5 months in ponds. There were two treatment groups, where offspring of founder population was treated as T1 and offspring of F-8 generation, which produced from 50 families was considered as T-2. It was observed that upgraded fish had 49.03% higher harvest weight than that of the founder population. The F-5 generation of Thai koi showed 25.39% higher growth than non selected group.

Development of feeds with probiotics and optimization of feeding strategies for important fish farming
Feeding trials were conducted to develop and optimize of feeds with probiotics and feeding strategies for *Pangasianodon hypophthalmus*. It is logical to conclude that feed incorporated with the probiotics (Bactocell, *Bacillu*, Levucell) can be used as a fish feed additives in *P. hypopthalmus* culture, to enhance fish health, better feed efficiency and growth performance.

Investigation and identification of emerging fish diseases and development of their control strategies
A total of 85 bacterial strains were isolated from 120 samples of infected shing (*Heteropneustes fossilis)*. The isolation frequencies of these 85 strains upon anatomical parts of infected shing were: infected skin and fin 32.94%, gill 14.11%, liver 11.76% and kidney 38.82%. On the other hand, bacteria of *Streptococcus* sp. were isolated from diseased tilapia that isolated bacteria showed grams positive coccus. Isolates *Streptococcus* sp_1 and *Streptococcus* sp_2 were showed γ-haemolysis but *Streptococcus* sp_3 was showed α-haemolysis in blood agar.

Field validation of selected high valued fish culture technologies for maximizing production
Culture of shing (*H. fossilis*), margur (*Clarias batrachus*) and tilapia (*Oreochromis nilotica*) in farmer's pond for a period of 7 months showed a mean harvest weight of shing, magur and tilapia were 37.23±3.14, 135.17±4.25 and 272±4.12 kg, respectively with a total production of 8.08 MT/ha/7 months.

Study on food, feeding habit and breeding biology of commercially important cuchia species, Monopterus cuchia
A total 35 pairs of broods (average female BW 340g & male BW 230g) were stocked during March in pond. The stocked broods were fed with ½ kg moribund fingerlings of taki, guchi and puia weekly and ½ kg spawn of carpio during experimental period. Water hyacinth, helencha and PVC pipes were provided in the pond to create suitable and safe shelter. During June month, an attempt was made to identify the spawning nests/holes and collected

naturally spawned juveniles from the pond. During collection of larvae, parents were found in every hole. *M. cuchia* provides parental care and guarded their larvae. Larvae were collected from the holes. About 10% larvae were found with yolk-sac. After collection larvae were shifted into cistern and tray.

Adoption of mass seed production and development of suitable culture technologies of some commercially important fish species in the North-West Bangladesh

To develop breeding technology of *Mystus vittatus*, **t**he broods (2♂:1♀**)** were injected a single doses Ovatide at the rate of 1.0, 1.5 and 2.0 ml kg^{-1} in both the males and females respectively. Immediately after administering the hormones spawners were released into breeding hapa settled in the concrete tanks of the hatchery containing dechlorinated tap water. After 22-30 hrs of injection, ovulation was occurred in all cases. Of them, 1.5 ml kg^{-1} showed the best breeding performances in terms of egg output rate, fertilization rate, hatching rate and survivability of hatchling. After absorption of yolk sac (2-3 days), the spawn were transferred into metallic trays and fed on *Artimea* up to 10 days to optimize rearing condition of larvae.

Biomonitoring of the Rivers Padma, Meghna and Dakatia

Among the heavy metals (Pb, Cd, Cr, Cu, Fe, Mn & Zn) the most dominant metal was Fe in both water and sediment followed by Mn. Concebtration of all the heavy metals in the sediments and water of rivers were in acceptable limit**.** In case of fish concentration of Fe was the highest followed by Zn.

Impact of environmental factors on abundance and distribution of important fishes in the River Meghna

Air temperature and water temperature range was limited from 15.6-30**°C** and 16.1-29**°C,** respectively. Transperancy also varied among the study sites in a wide range which was highest in Eklashpur 16-66 cm and lowest in Alexanzar 5-14 cm. Some of the parameters range were indicating the gradual fading of the freshness of rivers. The dominating phytoplankton is *Ulothrix* in Hazigang (459×10^2) and *Kaligang* (488×10^2), consequently zooplankton in Hazigang (27×10^2) representing the abundance of fish.

Changing pattern in limnology of Kaptai lake

Monthly variation of air temperature ranged from 21.04^0C to 31.52^0C. The fluctuation of water temperature varied from 20.42 to 30.38^0C. The pH of water always found to be alkaline in nature and it varied between 7.08 and 8.20. Free CO_2 ranged between 3.32 to 7.81 mg/l. The value of total alkalinity was found to fluctuate from the minimum of 64.91 mg/l to the maximum of 90.68 mg/l. Rainfall varied from 24.58 mm to 00.00 mm with mean value of ($x \pm$ SD: 8.90± 9.71mm). In the study, highest mean abundance of Euglenophyceae, Cyanophyceae, Bacillariophyceae and Chlorophyceae were found in January 2014, August 2013, June 2014. Highest mean abundance of Copepoda, Rotifera, Cladocera and Crustacea were found in January 2014, August 2013, June 2014. The findings of the present study will be helpful for the future researcher to work on these aspects and replace the discrete data about water quality parameter and plankton abundance of Kaptai lake.

Diversification of culture practice for optimizing production of the shrimp (Penaeus monodon) culture system in the coastal ghers

All water quality variables except dissolved oxygen and salinity were congenial for culture of shrimp in all stocking ponds in both short cycles and long cycle culture systems. Salinity level was drastically fluctuated during the culture period. In the 2^{nd} crop of short (60 days) culture, average growth of shrimp was 18.10g, 15.27g and 13.37g and production of shrimp was 338.55 kg/ha, 516.03 kg/ha and 708.52 kg/ha at 3, 5 and 7 nos/m^2 density, respectively.

Development of technique for breeding and larval rearing of mud crab, Scylla olivacea

Highest number of crabs spawned with a salinity level of 30 ppt and highest spawning success of 68.75% and fertilization rate of 88.65% was also achieved from the same salinity level, followed by 25 ppt salinity. On the other hand, an initial mass mortality was observed during hatching. At the end of Z1 stage, the survival was only 33.33%. The mortality of larvae from Z1 to Z2 stage was slower, while the mortality increased drastically from Z2 to Z3 stages and onwards. At the end of the experiment, only 0.75% of the larvae reached to the Z5 stage.

Development of breeding, seed production and culture technology of green back mullet Chelon subviridis

Three different level of salinity *viz.*, 20, 25 and 30 ppt was tried to optimize required level of salinity for breeding of green back mullet. Only in 30 ppt salinity, green back mullet responded for breeding. The spawning period, fertility rate, hatching period, hatching rate and survival of green back mullet were 30-35 hrs, 97%, 21-25 hrs, 98% and 11 days respectively. In 20mg/kg and 25mg/kg Ovupin hormone dose, green back mullet responded for breeding. In

20mg/kg Ovupin hormone dose, the spawning period, fertility rate, hatching period, hatching rate and survival of green back mullet were 34-36 hrs, 80%, 23-26 hrs, 82% and 6 months approximately.

Investigation into soil-water charecteristics of shrimps farms under existing culture practices

The water temperature ranged from 27±3.96^{o}C, 24.7±5.59^{o}C and 26±5.63^{o}C in the experimental ghers of Mongla, Bagerhat sadar upazila and Khulna, respectively. The pH of water at the experimental ghers of Mongla, Bagerhat sadar upazila and Khulna varied from 8.2±0.26, 8.1±0.56 and 8.0±0.50, respectively. Dissolved oxygen was recorded within a range of 5.85±2.17 mg/l, 8.1±0.56 mg/l, 8.0±0.50 mg/l and ammonia was recorded 0~0.2, 0~0.1 and 0 mg/l at Mongla, Bagerhat sadar upazila and Khulna respectively. The maximum salinity was recorded in Mongla 9.8±4.32, whereas the minimum salinity was observed at Bagerhat sadar 2.33±2.08 and Khulna 8.75±2.63 during the experimental period. Iron was present as 0.15±0.15 in Mongla whereas at Bagerhat sadar and Khulna the presence of Iron was found 0. On the other hand, the value of soil organic matter was found as 2.88±2.00%, 3.07±1.60% and 3.23±1.98% in Mongla, Bagerhat sadar and Khulna respectively. The mean value of pH was recorded 7.7±0.36, 7.6±0.40 and 7.76±0.38 in Mongla, Bagerhat sadar and Khulna respectively. The average value of soil salinity was maximum in Mongla (8.83±5.42 ds/m) compared to Bagerhat (5.83±4.87ds/m) and Khulna (6.92±3.43 ds/m). The average value of phosphorus was found the highest in Khulna (17.28±9.14 µg/g) followed by Bagerhat sadar (16.39±7.62µg/g) and Mongla (13.41±5.83µg/g). Average Total nitrogen was 0.184±0.11%, 0.135±0.038% and 0.139±0.04% in Mongla, Bagerhat Sadar and Khulna, respectively. The presence of sulphar was maximum at Khulna (120.38±43.45µg/g) compared to Mongla (105.32±53.39µg/g) and Bagerhat Sadar upazila (89.69±41µg/g) as well.

Investigation into shrimp/prawn diseases and their control strategies in South-Western region

Investigation of immerging diseases was carried out on 12 randomly selected *ghers* in context to aqua ecology and pathogens. Another 12 ghers were also sampled under case study. Most of the ghers (70%) found to be in trouble due to poor pond preparation, inadequate feeding and lower water depth. Due to lower water depth and sudden rainfall, 80% of the ghers having *P. monodon* attacked by WSSV in the month of March to May. However, the water depth tend to rises from late May towards June and onward, stocked golda (*M. rosenbergii*) of the previous year badly infected by the complex form of infection by different group of bacteria. The initial treatment, therefore, replied with reducing the mortality to 5% and successful molting of over 37% of larvae to PL. PCR test for the presence of MrNV was also performed but found negative.

Location-wise seasonal catch assessment of shark and trawl fisheries in Bangladesh

Sharks are mainly caught by artisanal fishery. True sharks are mainly caught by shark net (modified gill net) followed by hooks & lines and rays are mainly caught by hooks & lines or long lines but the major bulk composition of rays. Catch was higher in the month of Dec.-March in relation with effort. Seasonal abundance of elasmobranches was found maximum in the January-March quarter and it was above 35% of the total catch. In the year of 2013-14, from the yield (Y) and exploitation rate (E), the total stock of sharks, skates and rays were calculated as 327.6 t, 350.41t and 2317.5 t respectively. From the yield (Y) and fishing mortality (F), the standing crop (P') of sharks, skates and rays were estimated as 176.44, 90.43 t and 1030.0 t respectively.

Development of culture technique and utilization of seaweeds

A new natural seaweed bed from Nuniarchara to Nazirartek areas of Backkhali river and Moheshkhali Channel estuary of Cox's Bazar was discovered. *Hypnea musciformis and Enteromorpha intestinalis* are the main seaweed *species* of this seaweed bed. Some chemical parameters of water and soil of this seaweed beds were analyzed and found comparable to the Saint Martin Island. Seaweeds culture experiment was conducted in St. Martin during January to March. Coir rope was used as net material for substrate with net size was 2x2m^2. Four corners of the nets were tied with rocks placed 25 cm above from the bottom. *Hypnea musciformis*, *Padina tetrastromatica* and *Sargassum oligocystum* were selected for culture experiment. Seeds are attached with net by short length string. After 30 days of transplantation of seaweed seeds and cultured seaweed species were partially harvested and observed new buds were grown. Seaweed biomass was evaluated for each species separately. The highest weight specific growth rate was found in *Sargassum* sp. from 5.2% to 5.5% per day, followed *Caularpa racemosa* from 4.5% to 5.0% per day and the lowest weight specific growth rate in *Hypnea* sp. from 0.8% to 1.0% respectively.

Development of artificial breeding techniques of important marine fin fishes, mullets (Mugil cephalus)

Artificial breeding trial of *Mugil cephalus* L. using hormones was conducted from August, 2014 to February, 2015 in a fish hatchery, Cox's Bazar. In this experimental trial, average one kg sized *M. cephalus* were collected from

wild and reared in saline-water ponds to breed in captivity through hormone induction. The salinity of rearing ponds was maintained between 20-25ppt and in hatchery 24-25ppt with 22-25ºC temperature. Carp pituitary glands (CPG), HCG (Human chorionic gonadotropin) and LRH-A2 (Luteinizing releasing hormone) were used for hypophysation. The effective dosages of CPG 30mg/kg body weight, LRH-A2 150µg/fish with combination of 0.3 mL Domperidone and 0.5 mL Calcium injection, and HCG dose of 30,000 IU in case of female and 5,000 IU in case of male resulted spawning success. The GSI value of fecund fishes ranged from 7.92 to 12.38, egg diameter of matured fish between 550 to 600µm and that of fertilized egg from 650 to 700µm. Fecundity was calculated as 735 to 900 nos/g. The fish started spawning between 44-48 h and cell division was observed after the first hour of spawning but severe mortality occurred after 6 h.

Improvement of dried fish production system suitable for large-scale entrepreneurs and producers

To produce hygienic dry fish in large scale, a model of improved traditional fish drying was developed by Marine Fisheries & Technology Station, BFRI, Cox's Bazar. Total dry fish processing unit was covered with fine mesh net to protect infestation. Dryer structure were box type with a length of 100 feet and 30 feet width (available drying space 15,000 sq. feet). The drying structure was built 4 feet above ground (+ 6 feet fish drying facilities). Bottom surface area was used for drying of pomfret and small fishes. Bamboo rows were used for Bombay duck and ribbon fishes. Fish drying capacity was estimated as 3,000 kg dried fish per lot. Study was also conducted to evaluate the quality of dried fish products produced in improved traditional fish dryer. The final moisture content of the dried fish sample reached below 20%.

Availability of marine pearl producing bivalves in south-eastern coast of Bangladesh and culture potentialities

A total of 7 pearl bearing bivalve species were identified in the coast with a salinity of 18-34 ppt, pH 8.1-8.3 and water depth ranged 0.2-2.0 meter in their habitat. From the collected bivalves, most abundant oyster species windowpane oyster, *Placuna placenta* was reared in fiber glass tanks with seawater for a period of 6 months. During rearing highest survival rate of 88% was observed in T1 with sandy and gravel substratum and lowest survival rate of 78% was found in T2 with muddy substratum. Average temperature and salinity were varied between 24 °C-25 °C and 21-26 ppt respectively. From the reared oyster, highest 54 nos. small pearls in the month of April and lowest 7 pearls in December from a single *P. placenta* were obtained.